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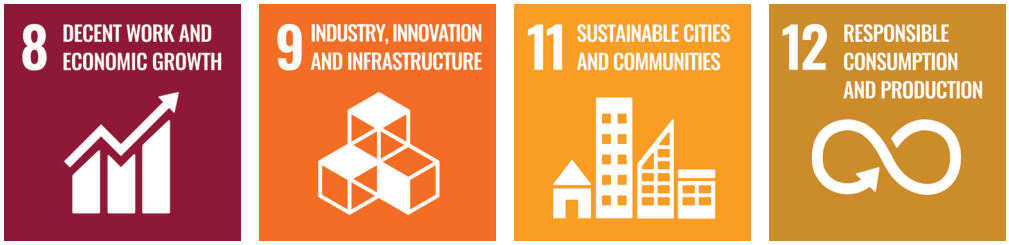
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From Research to Relevance: Universities Driving Regional Development



Content

Foreword..... 9

REGION

Almir Alihodžić, Jasmina Džafić, Selma Aličković:
DYNAMIC INTERACTION OF INTERNATIONAL CAPITAL MARKETS: A CASE STUDY OF THE CAPITAL MARKET IN BOSNIA AND HERZEGOVINA 13

Katarina Bačić, Nikolina Pomenić, Irena Đokić:
INNOVATION ECOSYSTEMS IN THE ADRIATIC MARITIME SECTOR: ENABLING DIGITAL AND GREEN TRANSITIONS 36

Goran Ćorluka, Ante Bradarić, Senka Borovac Zekan:
OVERTOURISM IN HISTORICAL CITIES – A LOCAL RESIDENT'SPERSPECTIVE 50

Jasmina Džafić, Emir Hečimović:
SMALL MARKETS, LONG MEMORIES: VOLATILITY, LIQUIDITY, AND PRICE DISCOVERY IN SOUTHEAST EUROPE 67

Viktória Gerdesics, Petra Putzer:
FROM INTERNATIONALISATION TO RAISING AWARENESS – UPFBE'S APPROACH OF BEING GLOBAL AND ACTING LOCAL 87

Amra Hamzić, Senija Musić:
LOCAL GOVERNMENT UNITS IN THE FUNCTION OF ABSORBING PRE-ACCESSION FUNDS IN BOSNIA AND HERZEGOVINA.....104

Ivona Huđek Kanižaj:
PRIMARY SCHOOL POPULATION AS EARLY STRUCTURAL SIGNAL OF REGIONAL DIVERGENCE IN CROATIA 124

Radmila Pavličić, Sonja Brlečić Valčić:
INNOVATIVE AND SUSTAINABLE HEALTHCARE SYSTEM OF THE REPUBLIC OF CROATIA WITHIN THE EUROPEAN CONTEXT.....139

Lidija Pranjić, Ksenija Milošević, Hrvoje Volarević:
THE EU LEGISLATIVE AND ACADEMIC FRAMEWORK FOR THE RESOLUTION OF CREDIT INSTITUTIONS AND INSURANCE UNDERTAKINGS.....153

Ana Sousa, Olga Pereira:
FROM MEMORY TO METAHUMANS: RETHINKING CULTURAL HERITAGE FOR SUSTAINABLE REGIONAL DEVELOPMENT 170

ENTREPRENURSHIP

Mirko Cobović, Nikolina Butumović, Maja Vretenar Cobović:
DIGITAL TRANSFORMATION, PERCEIVED BENEFITS, AND INVESTMENT INTENTIONS IN MICRO AND SMALL ENTERPRISES IN EASTERN CROATIA 189

Tóth Csenge:
CAN ENTREPRENEURIAL ATTITUDES BE BOOSTED THROUGH HACKATHONS? EVIDENCE FROM A UNIVERSITY-BASED EXPERIMENTAL STUDY 207

Ewelina Florczak:
SOCIAL ENTERPRISES AND INCLUSIVE ECONOMIC GROWTH AT THE LOCAL LEVEL 236

Ivona Mikulandra Volić, Marija Opačak Eror, Alica Kolarić:
I HAVE NO TIME TO WASTE: OVERCOMING A LACK IN CAPABILITIES DURING PERCEIVED OPPORTUNITY EXPLOITATION AMONG CROATIAN SUCCESSFUL DROPOUT ENTREPRENEURS 253

Damir Piplica:
CORRUPTION AND ACCESS TO ENTREPRENEURIAL FINANCE IN CROATIA 268

Boris Sruk:
EFFECTUATION IN MODERN ENTREPRENEURSHIP: A REVIEW OF THEORETICAL AND EMPIRICAL EVIDENCE 285

DEVELOPMENT

Romina Alkier Tomić, Jasmina Okičić,Vedran Milojica:
PERCEPTIONS, PREFERENCES, AND TRAVEL INTENTIONS OF FOREIGN TOURISTS TOWARD COSMETIC SURGERY SERVICES IN KVARNER.....301

Valerija Botrić:
YOUTH OVEREDUCATION IN CROATIA 322

Rita Brás, Carina Silva, Telma Mendes:
EXPLORING THE RELATIONSHIP BETWEEN QUALITY OF LIFE AND THE DEGREE OF INTERNATIONALISATION OF THE ECONOMY: EVIDENCE FROM PORTUGAL (2005-2022) 341

Marijana Cesarec, Ivan Vujičić:
APPLICATION OF ARTIFICIAL INTELLIGENCE IN SOCIAL CARE: OPPORTUNITIES, CHALLENGES AND FUTURE DIRECTIONS.....360

Teresa Dieguez, Paula Loureiro:
RETHINKING AGE FOR A LONG-LIVED SOCIETY 376

Anita Dremel, Narcisa Vrbešić-Ravlić:
BEYOND COMPLIANCE: CO-CREATING GENDER-INCLUSIVE UNIVERSITIES IN EUROPE.....398

Marija Faullend Heferer, Zdravka Biočina:
STORYTELLING OF SUCCESSFUL CROATIAN FOOD BRANDS.....414

Jasmina Gržinić:
SUSTAINABLE TOURISM LEARNING AND REFLECTIVE PRACTICE AT A CROATIAN UNIVERSITY 433

Tomislav Jakopec, Milan Puvača:
CYBERSECURITY AS A KEY STAKEHOLDER IN THE FISCALIZATION PROCESS.....455

Ana Ježovita, Marija Gregurec:
AUDITORS' PERCEPTION OF ARTIFICIAL INTELLIGENCE ADOPTION IN FINANCIAL STATEMENT AUDITS – CASE FROM CROATIA 471

Sara Melkić, Tomislav Hernaus:
UNIT AMBIDEXTERITY AND PERFORMANCE: THE MEDIATING ROLE OF CROSS-TRAINING.....487

Alexandra Posza, Vivien Csapi:
REAL OPTIONS AND ESG: A BIBLIOMETRIC ANALYSIS OF AN EMERGING RESEARCH FIELD 503

Luka Samaržija:
ANALYSIS OF THE IMPACT OF SUPPLY CHAIN MANAGEMENT FACTORS ON THE COMPETITIVE ADVANTAGE OF LODGING UNITS UTILIZING THE AIRBNB PLATFORM 521

Helena Silva, Olga Pereira:
INTERNATIONALISATION AND SOCIAL LICENCE TO OPERATE IN THE LITHIUM INDUSTRY: STAKEHOLDERS' PERSPECTIVES FROM THE PORTUGUESE CONTEXT 539

Miljana Simić, Marina Gregorić, Philipp Schorn:
CROSS-CULTURAL CHALLENGES IN AI-DRIVEN MARKETING CAMPAIGNS: STRATEGIES FOR EFFECTIVE LOCALIZATION AND CONSUMER ENGAGEMENT.....555

Selma Smajlović, Slađana Filipović:
MACHINE LEARNING APPLICATIONS IN VEHICLE INSURANCE: A BIBLIOMETRIC REVIEW OF RESEARCH TRENDS.....573

Roman Šubić, Ingrid Pejković, Ivana Načinović Braje:
EDUCATIONAL AND SOCIODEMOGRAPHIC BACKGROUND AS A PREDICTOR OF STUDENTS' SOCIAL CAPITAL.....598

Toni Šušak, Luka Mladineo:
DO COMPANIES MANIPULATE EARNINGS TO AVOID EXTERNAL AUDIT OBLIGATION? EVIDENCE FROM CROATIA.....613

Jelena Tomić, Tomislav Klarin:
DEVELOPING MOTIVATIONAL LEADERSHIP IN PRESCHOOL EDUCATION INSTITUTIONS: CHALLENGES AND OPPORTUNITIES.....624

Filip Vuković, Ozren Pilipović, Nenad Rančić:
FINANCING AND SOCIAL BENEFITS OF „MINOR SPORTS "- CASE STUDY OF ZAGREB FENCING FEDERATION.....641

Anamarija Zron, Nika Stipetić-Kalinić:
ARTIFICIAL INTELLIGENCE FOR FOOD WASTE PREDICTION - A BIBLIOMETRIC ANALYSIS.....659

FOREWORD

The world we live in has changed dramatically over the past year. Crises are no longer occasional events but challenges we face every day. Yet, each crisis brings an opportunity to learn and to build a better and safer environment.

The 15th International Scientific Conference "Region, Entrepreneurship, Development" (RED 2026) seeks to offer answers to pressing questions — how can we create ompetitive regions and strengthen entrepreneurship to develop opportunities for all?

The 15th International Scientific Conference "Region, Entrepreneurship, Development" (RED 2026) received more than 70 papers from around the world, indicating the relevance of the topic and the growing interest of researchers in these areas. The reviewers made an invaluable contribution to the creation of this collection, assisting both the researchers and us, the organisers, in selecting 37 papers that demonstrated scientific excellence in their chosen fields and methodologies.

The Proceedings of the 15th International Scientific Conference "Region, Entrepreneurship, Development" (RED 2026) include contributions from researchers in Bosnia and Herzegovina, Croatia, Hungary, Germany, Poland, Portugal, and Serbia. This year's theme, From Research to Relevance: Universities Driving Regional Development, highlights how research in entrepreneurship, innovation, and regional development can foster societal transformation and impact.

We believe that innovative solutions to global crises should emerge from the synergy and cooperation among the private, public, and educational sectors. With these proceedings, we offer our contribution to this collective effort.

The RED Conference continues to provide a valuable platform for researchers to connect, define problems, and offer solutions to the major challenges facing our regions and societies today.

Anamarija Delić, PhD
Head of Organizing Committee



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RED 2026

REGION

A scientific paper

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DYNAMIC INTERACTION OF INTERNATIONAL CAPITAL MARKETS: A CASE STUDY OF THE CAPITAL MARKET IN BOSNIA AND HERZEGOVINA

ABSTRACT

This research examines the determination of stock index movements in the capital market of Bosnia and Herzegovina in relation to movements in the capital markets of developed countries, developing countries, and EU member states. This empirical research covers the period 2016–2024 and analyses eleven indices of developing countries, EU member countries, and developed countries: SASX-30, BIRS, CROBEX, BUDAPEST, DAX, SBITOP, BELEX15, FTSE MIB, BIST, ATX5, and S&P500. In the analysis, the methods of descriptive statistics, correlation analysis, the least squares model, and the Granger causality test were applied to identify interdependence, causality, the direction of causality, and transmission of shocks between markets. The findings show that using the least squares method, the strongest statistically significant impact on the SASX-30 index was achieved by CROBEX, DAX, BELEX15 and S&P500. Also, the strongest statistical influence on the BIRS index was achieved by CROBEX and BELEX15. Turnover on the Zagreb and Frankfurt Stock Exchanges had a statistically significant influence on the return of the SASX-30 index. On the other hand, the results showed that the BIRS index is sensitive to changes in turnover on the Ljubljana and New York Stock Exchanges. Regarding the impact of market capitalization on the SASX-30 index, only market capitalization on the Ljubljana Stock Exchange had a positive, statistically significant impact. The only statistically significant influence on the BIRS index was the Banja Luka Stock Exchange. The results of the Granger Wald causality test show a two-way relationship between SASX-30, ATX5, and BIST. Likewise, the results show a two-way relationship between the BIRS index and BELEX15.

***Key words:** Capital markets, Stock market indices, Market capitalization, Turnover on the capital market.*

1. Introduction

The capital market in Bosnia and Herzegovina can be classified as a frontier capital market. Such markets are typically characterized by relatively low market capitalization and limited liquidity. At the same time, they often exhibit a certain level of openness, but also face challenges such as political instability and weak integration with developed financial markets. In terms of investment activity and growth potential, the capital market in Bosnia and Herzegovina has not yet reached a level that could significantly support broader economic development.

Apart from commercial banks, which occasionally participate in the government debt market, the presence of large institutional investors remains very limited. Banks are primarily oriented toward government securities due to their relatively high profitability and low risk. Furthermore, the participation of individual investors in the capital market is still modest. This can be explained by several factors, including relatively low household income levels, limited experience with stock market trading, and the absence of a strong investment culture (Central Bank of Bosnia and Herzegovina, 2016).

Therefore, the main objective of this research is to analyze the strength and nature of the relationships between stock market indices and to evaluate the extent to which the capital market of Bosnia and Herzegovina is integrated into global financial flows.

This paper is structured into five sections. The first section introduces the topic and provides a brief overview of the capital market in Bosnia and Herzegovina, as well as the main objectives of the study. The second section reviews the relevant literature and formulates the research hypotheses. The third section presents the research methodology. The fourth section discusses the empirical results obtained using the ordinary least squares (OLS) method and the Granger causality test. The final section provides concluding remarks and recommendations.

2. Review of relevant literature

Comincioli and Wesleyan (1996) analysed the influence and relationship between stock prices, as a leading economic indicator, and the GDP of a country. Using the Granger model, **they** concluded that the stock market helps predict the economic activity of a country. It was discovered that changes in GDP were, inter alia, caused by changes in stock prices. This knowledge is very important for the economy of a country as it provides additional support in the conduct of the country's economic policy and improves the position of the stock market. Agarwal and Mohtadi (2004) in their research concluded that the development of the stock market, represented by changes in the value of market capitalization, generates financial resources for better support to companies, that is, companies can use more capital by issuing shares and increasing the liquidity of shares.

Ciner (2001) examined the relationship between oil prices and the stock market. Changes in oil prices, according to this research, have an impact on the stock market and stock index returns. Emphasizing the importance of testing non-linear relationships in addition to linear ones, the results of the empirical analysis indicate that shocks in oil prices in fact affect the non-linear return on the stock market index. Also, the study finds that stock index returns influence oil futures markets, indicating a feedback relationship, especially in the 1990s.

Li & Majerowska (2008) examined the links between the developed German capital market and the capital markets in Poland and the Czech Republic, using daily stock returns for the period from January 1998 to December 2005. They concluded that the two emerging markets were weakly correlated with the German capital market. However, Syriopoulos and Roumpis (2007) indicate that long-term relations between German and several capital markets from Central and Eastern Europe exist both in the period before the accession of these countries to the European Union and in the period after the accession.

The liquidity of shares refers to the mobility of shares, that is, the frequency of share trading during the trading period. The more frequently the share trading occurs, the more liquid the stock can be said to be. Therefore, the liquidity of the share is in accordance with the number and size of the transactions made with the shares (Wira, 2012). Liquid stocks are stocks which investors often trade. Investors assume that these stocks should be purchased because they have a clearer prospect of profit unlike illiquid stocks. However, there is an inverse relationship between the level of liquidity and the size of the profit, where the lower the liquidity of the stock, the greater the profit that can be made. Therefore, stocks with low liquidity have a higher risk compared to liquid stocks, while higher stock risk is identical to higher profit (Shammakhi & Mehrabi, 2016).

Dobardžić (2013) investigated the connections between regional and developed capital markets with the capital market of Serbia. In the paper, he tested the possible coefficients of correlation of BELEX 15 and all other capital market indices. The results showed that the capital market of Serbia showed statistically significant positive coefficients of correlation with the Croatian, Slovenian, Hungarian, and German capital markets. In addition, the strongest interaction was recorded with the Slovenian capital market.

Dragota and Oprea (2014) investigated the informational efficiency of the Romanian stock market and found that the predictability of returns indicates that the Romanian stock market has a low level of efficiency. Moreover, the impact of new information is more intense before and after its publication. Ngare et al. (2014) support the existing literature that the stock market has a positive impact on economic growth. The findings of the study show that the economic growth of countries with developed stock markets grows faster than that of countries that do not have a stock market. On the other hand, Arestis et al. (2001) concluded that the stock market has less influence on economic growth than the banking sector. Bohl et al. (2017) analyse the relationship between trading volume and stock returns. Their findings suggest that trading activity contains important information about price dynamics, indicating that changes in trading volume may significantly influence stock return behaviour in financial markets.

Hou et al. (2018) investigate various anomalies in asset pricing and confirm that firm size, typically measured by market capitalization, remains an important factor in explaining differences in stock returns. Their findings support the existence of the size effect, indicating that market capitalization plays a significant role in return dynamics across equity markets.

Chirila & Chirila (2022) analyse volatility spillovers among stock market in Central and Eastern European countries as well as in Germany and France using the VAR model and the Diebold Yilmaz spillover index, with the aim of identifying opportunities for portfolio risk reduction. Particular attention is given to the period of the COVID-19 pandemic. The results indicate that volatility spillovers among stock markets are fluctuating, suggesting the need for continuous updating and adjustment of portfolio weights in accordance with the observed changes in volatility spillovers.

The results of the study by Endri et al. (2024) show that integration of the Indonesian stock market with the stock markets of its major trading partners is relatively low in the long run. This finding suggests that investors from the eight major trading partner countries can diversify their portfolios through international investments in the Indonesian stock market and vice versa. In the short run, the Indonesian stock market and the stock markets of its major trading partners are integrated, with the exception of China. Therefore, the Chinese stock market has become attractive for Indonesian investors seeking to generate profits, and vice versa.

3. Methodology and data

This research aims to examine the connection and interdependence of the capital market of Bosnia and Herzegovina with selected regional and developed capital markets. The methodological approach is based on the analysis of time series of stock market indices, trade volume, and market capitalization.

3.1. Data sources and sample

The conducted research is based on secondary data on the movement of stock market indices, turnover, and market capitalization on selected capital markets. The observed period covers the interval from 2016:Q1 to 2024:Q4, whereby a single database was formed for all variables for mutual comparability. Throughout the paper, the term „market index“ refers to the value of the respective stock market index used in the empirical analysis.
The analysis includes the following variables:
• indices of the capital market of Bosnia and Herzegovina: SASX-30 and BIRS, which were used as dependent variables,
• stock market indices of regional and developed markets: CROBEX, BUDAPEST, DAX, SBITOP, BELEX15, FTSEMIB, BIST, ATX5, and S&P500 - used as independent variables,
• turnover on selected stock exchanges,
• market capitalization of selected capital markets.
Turnover and market capitalization include data from the following markets:
• Sarajevo (SASE),
• Banja Luka (BLSE),
• Zagreb (ZGSE),
• Montenegro (MNESE),
• Ljubljana (LJSE),
• Frankfurt (FRSE),
• New York (NYSE).
All series are pre-matched in terms of time frequency and data availability.

3.2. Analysis methods used

Certain quantitative methods were applied in the research. The initial methodology is based on the application of descriptive statistics, which is used for a basic review of the characteristics of the observed time series (arithmetic mean, standard deviation, minimum, and maximum). The obtained data describe the observed variables in the analysed period. Correlation analysis is used to determine the degree of connection between the movements of stock market indices. Pearson's correlation coefficient was applied to measure the strength and direction of the linear association between variables. The values of the coefficient range from −1 to +1, where positive values indicate the common movement of the market, while negative values indicate the

opposite movement. This analysis provides a preliminary insight into the mutual integration of capital markets.

The main analytical part of the work is based on the application of multiple linear regression using the method of least squares (Ordinary Least Squares - OLS). The goal of the regression analysis is to determine to what extent changes in international and regional markets influence the movement of the index in Bosnia and Herzegovina. The analysis includes three models: index yield model, turnover influence model, and market capitalization influence model. The Granger-Wald causality test examines the existence of cause-and-effect relationships between observed capital markets. Statistical significance was assessed at the 5% level, using the t-test and F-test.

3.3. Regression models

Following Arcand et al. (2015), we began our estimations by regression equations using the method of least squares (OLS). Klein and Weill (2018) indicate that OLS regression is not only a useful method for describing the data, but also for providing a first (biased) estimate of the coefficients. All calculations typically use a 5% significance level. Therefore, the significance test was performed for all variables using the t-test at a significance level of 95% (Chmelarova, 2007).

The analysis is based on three groups of regression models in which the dependent variables are the indices of the capital market of Bosnia and Herzegovina, which will be presented below:

Model 1: Impact of international stock indices on SASX-30

$$SASX30_t = \alpha + \beta_1 CROBEX_t + \beta_2 BUDAPEST_t + \beta_3 DAX_t + \beta_4 SBITOP_t + \beta_5 BELEX15_t + \beta_6 FTSEMIB_t + \beta_7 BIST_t + \beta_8 ATX5_t + \beta_9 SP500_t + \varepsilon_t$$

Model 2: The impact of international stock market indices on BIRS

$$BIRS_t = \alpha + \beta_1 CROBEX_t + \beta_2 BUDAPEST_t + \beta_3 DAX_t + \beta_4 SBITOP_t + \beta_5 BELEX15_t + \beta_6 FTSEMIB_t + \beta_7 BIST_t + \beta_8 ATX5_t + \beta_9 SP500_t + \varepsilon_t$$

- $SASX_{30t}$ – Sarajevo Stock Exchange index at time t
- $BIRS_t$ – Banja Luka Stock Exchange index at time t
- CROBEX_t, DAX_t, $S\&P_{500}$_t, etc. – international stock market indices
- α – constant (intercept) of the model
- β_i – regression coefficients
- ε_t – random error (residual) of the model

Model 3: The impact of turnover on the SASX-30 index

$$SASX30_t = \alpha + \beta_1 SASE_TRN_t + \beta_2 BLSE_TRN_t + \beta_3 ZGSE_TRN_t + \beta_4 MNESE_TRN_t + \beta_5 LJSE_TRN_t + \beta_6 FRSE_TRN_t + \beta_7 NYSE_TRN_t + \varepsilon_t$$

Model 4: The impact of turnover on the BIRS index

$$BIRS_t = \alpha + \beta_1 SASE_TRN_t + \beta_2 BLSE_TRN_t + \beta_3 ZGSE_TRN_t + \beta_4 MNESE_TRN_t + \beta_5 LJSE_TRN_t + \beta_6 FRSE_TRN_t + \beta_7 NYSE_TRN_t + \varepsilon_t$$

- $SASX_{30t}$ – Sarajevo Stock Exchange index at time t
- $BIRS_t$ – Banja Luka Stock Exchange index at time t
- SASE_TRN_t, BLSE_TRN_t, etc. – turnover on the respective Stock Exchange at time t
- α – constant (intercept) of the model
- β_i – regression coefficients
- ε_t – random error (residual) of the model

Model 5: Impact of market capitalization on SASX-30

$$SASX30_t = \alpha + \beta_1 SASE_MC_t + \beta_2 BLSE_MC_t + \beta_3 ZGSE_MC_t + \beta_4 MNESE_MC_t + \beta_5 LJSE_MC_t + \beta_6 FRSE_MC_t + \beta_7 NYSE_MC_t + \varepsilon_t$$

Model 6: Impact of market capitalization on BIRS

$$BIRS_t = \alpha + \beta_1 SASE_MC_t + \beta_2 BLSE_MC_t + \beta_3 ZGSE_MC_t + \beta_4 MNESE_MC_t + \beta_5 LJSE_MC_t + \beta_6 FRSE_MC_t + \beta_7 NYSE_MC_t + \varepsilon_t$$

- $SASX_{30t}$ – Sarajevo Stock Exchange index at time t
- $BIRS_t$ – Banja Luka Stock Exchange index at time t
- SASE_MC_t, BLSE_MC_t, etc. – market capitalization of the respective stock exchanges at time t
- α – constant (intercept) of the model
- β_i – regression coefficients
- ε_t – random error (residual) of the model

Based on the above discussion, this paper will investigate one main and two auxiliary hypotheses:

- **BRH:** *There is a significant positive/negative correlation between the capital market in Bosnia and Herzegovina and selected regional and developed capital markets.*

- **ARH 1:** *Increased turnover on the capital market in B&H, as well as on selected regional and developed capital markets, has a statistically significant/non-significant impact on the value of the SASX-30 and BIRS stock market indices.*

- **ARH2:** *Increased market capitalization in the capital market in Bosnia and Herzegovina, as well as in selected regional and developed capital markets, has a statistically significant/non-significant impact on the value of the SASX-30 and BIRS stock index.*

4. Empirical findings

The following section presents the results of the descriptive statistics, correlation analysis, and the estimates obtained using the ordinary least squares (OLS) method.

4.1. Descriptive statistics

The descriptive statistics reported in Table 1 present the trends in returns, standard deviation, and the minimum and maximum values of stock market indices for emerging markets, EU candidate countries, and developed economies over the period 2016 – 2024.Therefore, Table 1 reports descriptive statistics for the percentage changes (returns) of the stock market indices used in the analysis. The total number of observations is 3.288, which ensures mutual comparability of the results.

Table 1: Descriptive statistics of percentage changes of stock market indices of capital markets of developing countries, EU member states and developed countries for the period: 2016-2024

Variable	Observation	Mean	Std.dev.	Min	Max
SASX-30	3.288	0.0218	0.272	-1.708	3.815
BIRS	3.288	0.012	0.680	-6.029	8.833
CROBEX	3.288	-0.100	3.521	-100.0	4.570
BUDAPEST	3.288	0.009	1.926	-100.0	6.146
DAX	3.288	0.022	0.880	-9.834	7.129
SBITOP	3.288	1.443	86.401	-100.00	4,949.70
BELEX15	3.288	-0.011	1.811	-100.0	2.969
FTSEMIB	3.288	0.018	0.951	-9.784	6.598
BIST	3.288	0.042	8.409	-100.0	413.09
ATX5	3.288	11.094	222.597	-97.956	7.129
S&P500	3.288	0.034	0.757	-7.103	6.712

Source: *Authors' calculations*

The average rates of stock market indices return for developing countries, individual EU member states, and developed countries show very small deviations from zero except for Austria and Slovenia, which are in line with the theoretical assumption of many approaches and models for measuring market risk, which assume that the long-term average daily return is zero. The standard deviation shows significant fluctuation and volatility in certain stock market indices, especially the stock market indices of Austria, Slovenia, and Turkey, while the indices of smaller markets, such as the capital market in Bosnia and Herzegovina, record a lower degree of oscillation. Furthermore, the range between the minimum and maximum values additionally confirms the pronounced differences in movement between developed and less developed capital markets. The extreme value reported in Table 1 for the SBITOP index (-100 and 4,949) represent the minimum and maximum changes recorded in the dataset during the observed period. These values indicate significant fluctuation in the Slovenian capital market and reflect periods of increased market volatility, which are common in smaller and less liquid regional

stock markets. Such variations may also be associated with changes in investor sentiment and adjustments in regional financial markets.

4.2. Correlation analysis

Pallant (2010) states that correlation is very important in showing the direction and strength of a continuous connection between observed variables. According to Cohen (1988), correlation coefficients between 0,10 and 0,29 indicate a small relationship, values between 0,30 and 0,49 represent a moderate relationship, while coefficient above 0,50 indicate a strong relationship. Table 2 presents the results of the Pearsons correlation coefficient between the SASX-30 stock market index as the dependent variable and the following stock market indices as independent variables: CROBEX, BUDAPEST, DAX, SBITOP, BELEX15, FTSEMIB, BIST, ATX5 and S&P500.

Table 2: Pearson's coefficient of correlation between the SASX-30 stock market index and stock market indices of developing countries, EU member countries and developed countries for the period: 2016.- 2024

		SASX-30	CROBEX	BUDAPEST	DAX	SBITOP	BELEX15	FTSEMIB	BIST	ATX5	S&P500
SASX-30	Pearson Correlation	1.000	0.735	0.838	0.859	0.211	0.845	0.831	-0.821	-0.028	0.954
	Sig. (2-tailed)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.107	0.000
CROBEX	Pearson Correlation	0.735	1.000	0.896	0.862	0.174	0.922	0.895	-0.476	-0.253	0.798
	Sig. (2-tailed)	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BUDAPEST	Pearson Correlation	0.838	0.896	1.000	0.938	0.186	0.931	0.950	-0.556	-.0159	0.922
	Sig. (2-tailed)	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DAX	Pearson Correlation	0.859	0.862	0.938	1.000	0.191	0.914	0.968	-0.680	-0.172	0.949
	Sig. (2-tailed)	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000
SBITOP	Pearson Correlation	0.211	0.174	0.186	0.191	1.000	0.195	0.189	-0.171	-0.039	0.207
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.027	0.000
BELEX15	Pearson Correlation	0.845	0.922	0.931	0.914	0.195	1.000	0.923	-0.564	-0.182	0.892
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000

FTSEMIB	Pearson Correlation	0.831	0.895	0.950	0.968	0.189	0.923	1.000	-0.594	-0.225	0.908
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000
BIST	Pearson Correlation	-0.821	-0.476	-0.556**	-0.680	-0.171	-0.564	-0.594	1.000	0.039	-0.793
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	0.026	0.000
ATX5	Pearson Correlation	-0.028	-0.253	-0.159	-0.172	-0.039	-.0182	-0.225	0.039	1.000	-0.088
	Sig. (2-tailed)	0.107	0.000	0.000	0.000	0.027	0.000	0.000	0.026	-	0.000
S&P500	Pearson Correlation	0.954	0.798	0.922	0.949	0.207	0.892	0.908	-0.793	-0.088	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-

Source: *Authors' calculations*

Table 2 presents the correlation results for the period 2016 – 2024. The SASX-30 index shows a strong positive correlation with several international stock market indices, including the S&P 500, DAX, BELEX15, BUDAPEST, FTSEMIB, and CROBEX. The connection of the SASX-30 stock market index with leading international stock market indices, such as S&P 500 (United States), DAX (Germany), FTSE MIB (Italy), BUDAPEST (Hungary), and with regional indices, such as BELEX15 (Serbia) and CROBEX (Croatia), can be explained through the high degree of global integration of contemporary financial markets. Global investors, especially institutional funds, invest in different regions, and changes in their investment portfolio formation strategies caused by movements on major stock exchanges (S&P 500, DAX) are also reflected in smaller, frontier capital markets, among which is the capital market of Bosnia and Herzegovina. Another important factor is expectations and psychological effects. Given the limited liquidity of the capital market in B&H and the relatively small number of active participants, investors largely follow signals from developed markets. In this way, the changes that take place in the USA or Germany serve as a global signal, which is then reflected on the capital market in Bosnia and Herzegovina. Also, an important aspect of connection refers to the trade and investment connection of the real sector of B&H with individual EU member states and countries of the region, where Germany, Italy, Serbia, and Croatia are considered the most important foreign trade partners of B&H. In this regard, the movements on the given stock exchanges can also influence the prediction of the movement of the stock index of the Sarajevo Stock Exchange (SASX-30). For the sake of illustration, the coverage of imports by exports in 2024, between Bosnia and Herzegovina and Croatia, was about 93%. The coverage of imports by exports between B&H and Germany was about 59%. And the coverage of imports by exports between B&H and Italy was about 30% (The Central Bank of Bosnia and Herzegovina, 2024).

Table 3: Pearson's coefficient of correlation between the BIRS stock market index and stock market indices of developing countries, EU member countries and developed countries for the period: 2016- 2024

		BIRS	CROBEX	BUDAPEST	DAX	SBITOP	BELEX15	FTSEMIB	BIST	ATX5	S&P500
BIRS	Pearson Correlation	1.000	0.789	0.755	0.725	0.191	0.795	0.767	-0.625	-0.0108	0.778
	Sig. (2-tailed)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CROBEX	Pearson Correlation	0.789	1.000	0.896	0.862	0.174	0.922	0.895	-0.476	-0.253	0.798
	Sig. (2-tailed)	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BUDAPEST	Pearson Correlation	0.755	0.896	1.000	0.938	0.186	0.931	0.950	-0.556	-0.159	0.922
	Sig. (2-tailed)	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000
DAX	Pearson Correlation	0.725	0.862	0.938	1.000	0.191	0.914	0.968	-0.680	-0.172	0.949
	Sig. (2-tailed)	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000
SBITOP	Pearson Correlation	0.191	0.174	0.186	0.191	1.000	0.195	0.189	-0.171	-0.039	0.207
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.027	0.000
BELEX15	Pearson Correlation	0.795	0.922	0.931	0.914	0.195	1.000	0.923	-0.564	-0.182	0.892
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000
FTSEMIB	Pearson Correlation	0.767	0.895	0.950	0.968	0.189	0.923	1.000	-0.594	-0.225	0.908
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	-	0.000	0.000	0.000
BIST	Pearson Correlation	-0.625**	-0.476	-0.556	-0.680	-0.171	-0.564	-0.594	1.000	0.039*	-0.793
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-	0.026	0.000
ATX5	Pearson Correlation	-0.108	-0.253	-0.159	-0.172	-0.039	-0.182	-0.225	0.039	1.000	-0.088
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.027	0.000	0.000	0.026	-	0.000
S&P500	Pearson Correlation	0.778	0.798	0.922	0.949	0.207	0.892	0.908	-0.793	-0.088	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-

Source: *Authors' calculations*

It is evident from the previous table that the highest positive correlation between the stock index of the Banja Luka Stock Exchange (BIRS) was recorded with the following stock indices: BELEX 15 (0.795), CROBEX (0.789), S&P 500 (0.778), FTSEMIB (0.767), BUDAPEST (0.755), and DAX (0.725). The connection between the indices of the Banja Luka and Belgrade Stock Exchanges can be explained by the fact that the dominant participation of about 65.01% of Telekom Serbia is present in the ownership structure of Telekom Srpska. The connection of the BIRS stock market index with the indices of individual EU member states can be explained by increased foreign trade relations.

4.3. Research results

Tables 4 to 10 show the results of the least squares analysis between the dependent variables, i.e., the SASX-30 and BIRS stock market indices, and the independent variables, i.e., the stock market indices: CROBEX, BUDAPEST, DAX, SBITOP, BELEX15, FTSEMIB, BIST, ATX5, S&P500, and turnover and market capitalization.

Table 4: Coefficients of independent variables in ordinary least squares regression for the period: 2016:Q1 - 2024:Q4

Regression model	**Ordinary Least squares method (OLS)**		
Dependent variable – SASX-30			
Independent variables	**Coeff.**	**Std. Error**	**Probability**
C	503,64	19,393	0,000
CROBEX	0,0169	0,0117	0,000
BUDAPEST	-0,007	0,0005	0,000
DAX	0,1047	0,0029	0,000
SBITOP	0,0014	0,0011	0,214
BELEX 15	0,7731	0,0437	0,000
FTSEMIB	0,0261	0,0014	0,000
BIST	-0,001	7,70E-05	0,000
ATX5	0,0010	8,91E-05	0,000
S&P500	0,4045	0,0087	0,000
Coefficient of determination	0,9497		
Adjusted coefficient of determination	0,94957		
F-Statistic	6.853,87		
Prob (F-statistic)	0,000		
Durbin-Watson stat	0,0362		

Source: *Authors' calculations*

By applying equations to the data obtained by the method of least squares in Table 4, we arrive at the following predicted model:

$$SASX - 30 = 503{,}64 + 0{,}017 * CROBEX - 0{,}007 * BUDAPEST + 0{,}105 * DAX + 0{,}001 * SBITOP + 0{,}773 * BELEX15 + 0{,}03 * FTSEMIB - 0{,}001 * BIST + 0{,}001 * ATX5 + 0{,}404 * S\&P500$$

From the previous table, it is evident that the adjusted coefficient of determination in the least squares model is 0,94957 or 94,96%. It indicates that 95% of the variation of the stock market index SASX-30 is explained by changes in stock market indices of developing countries, EU member countries, and developed countries (CROBEX, DAX, BELEX15, FTSEMIB, ATX5, S&P500), while the remaining 5% is explained by factors not specified in the model. The probability of the F-statistic in the least squares method has a value of 0.000, which shows that

the model is statistically significant at the 5% significance level because the p-value is less than 5%. The results of the conducted analysis show that the basic research hypothesis based on the assumption of the existence of a significant connection of the capital market of Bosnia and Herzegovina with selected regional markets, the markets of EU member states, and developed markets can be almost completely accepted. In the model for the SASX-30 stock index, it was determined that most foreign capital markets (CROBEX, DAX, BELEX15, FTSEMIB, ATX5, S&P500, BUDAPEST, BIST) have a statistically significant influence because the probability is less than 5%, except for the SBITOP stock index. Therefore, these findings confirm that the capital market in Bosnia and Herzegovina, although limited in terms of depth and liquidity, nevertheless shows a clear international connection, where the connection for developed capital markets is mainly manifested through a positive correlation.

Table 5: Coefficients of independent variables in ordinary least squares regression for the period: 2016:Q1 - 2024:Q4

Regression model **Dependent variable – BIRS**	**Ordinary Least squares method (OLS)**		
Independent variables	Coeff.	Std. Error	Probability
C	357,660	14,430	0,000
CROBEX	0,2027	0,0087	0,000
BUDAPEST	-0,0033	0,0004	0,000
DAX	0,077	0,0022	0,000
SBITOP	0,0011	0,0008	0,165
BELEX 15	0,2540	0,0325	0,000
FTSEMIB	0,0256	0,0011	0,000
BIST	-0,0006	5,73E-05	0,000
ATX5	0,0005	6,63E-05	0,000
S&P500	0,0923	0,00653	0,000
Coefficient of determination	0,78981		
Adjusted coefficient of determination	0,78923		
F-Statistic	1.363,62		
Prob (F-statistic)	0,000		
Durbin-Watson stat	0,0334		

Source: Authors' calculations

By applying the equation to the data obtained by the method of least squares in Table 5, we arrive at the following predicted model:

$$BIRS = 357{,}66 + 0{,}203 * CROBEX - 0{,}003 * BUDAPEST + 0{,}08 * DAX + 0{,}001 * SBITOP + 0{,}254 * BELEX15 + 0{,}02 * FTSEMIB - 0{,}001 * BIST + 0{,}001 * ATX5 + 0{,}092 * S\&P500$$

From Table 5, it is evident that the adjusted coefficient of determination in the least squares model is 0,7892 or 78,92%. It indicates that 79% of the variation of the stock market index BIRS is explained by changes in stock market indices of developing countries, EU member countries, and developed countries (CROBEX, DAX, BELEX15, FTSEMIB, ATX5, S&P500), while the remaining 21% is explained by factors not specified in the model. The probability of the F-statistic in the least squares method has a value of 0.000, which shows that the model is statistically significant at the 5% significance level because the p-value is less than 5%. The results of the conducted analysis show that the basic research hypothesis based on the assumption of the existence of a significant connection of the capital market of Bosnia and

Herzegovina with selected regional markets, the markets of EU member states, and developed markets can be almost completely accepted.

To avoid the problem of spurious regression caused by trending variables, the stationarity of the time series was tested using the Augmented Dickey-Fuller (ADF) unit root test. The results indicate that all stock market index return series are stationary at the 5% significance level.

Table 6: Dickey-Fuller test results without origin and trend width

Variables	t-Statistic	Possibility value	Result
SASX-30	-26,609	0,000	Stationary
BIRS	-29,718	0,000	Stationary
CROBEX	-16,521	0,000	Stationary
BUDAPEST	-28,508	0,000	Stationary
DAX	-52,813	0,001	Stationary
SBITOP	-19,173	0,000	Stationary
BELEX15	-53,556	0,001	Stationary
FTSEMIB	-29,425	0,000	Stationary
BIST	-56,336	0,001	Stationary
ATX5	-18,692	0,000	Stationary
S&P500	-51,574	0,001	Stationary

Source: Authors' calculations

Table 7 illustrates the results of the regression analysis based on the least squares model between the independent variables (turnover on the Sarajevo Stock Exchange, Banja Luka Stock Exchange, Zagreb Stock Exchange, Nex Montenegro Stock Exchange, Ljubljana Stock Exchange, Frankfurt Stock Exchange, and New York Stock Exchange) and the return on the SASX-30 stock index as a dependent variable. The value of the F-statistic for the method of least squares is 25,93 and the probability is less than 5%, which indicates that the model is very significant (Table 7). In this empirical section, least squares regression is discussed because of the numerous advantages it has over other estimation techniques. These advantages are primarily reflected in the best finding of the line that describes the relationship between the dependent and independent variables and gives the best trend line for the set of observed data.

Table 7: Coefficients of independent variables in ordinary least squares regression for the period: 2016:Q1 - 2024:Q4

Regression model **Dependent variable – SASX-30**	**Ordinary Least squares method (OLS)**		
Independent variables	**Coeff.**	**Std. Error**	**Probability**
C	1.594,72	185,48	0,000
SASE_TRN	2.55E-08	3.20E-07	0,936
BLSE_TRN	-5.70E-08	4.60E-07	0,902
ZGSE_TRN	4.34E-07	1.21E-07	0,001
MNESE_TRN	-1.15E-06	7.84E-07	0,154
LJSE_TRN	3.03E-06	1.18E-06	0,016
FRSE_TRN	1.18E-08	1.78E-09	0,000
NYSE_TRN	-1.93E-09	4.64E-10	0,000
Coefficient of determination	0,866352		
Adjusted coefficient of determination	0,832940		

Regression model Dependent variable – SASX-30	Ordinary Least squares method (OLS)		
Independent variables	**Coeff.**	**Std. Error**	**Probability**
F-Statistic	25,92934		
Prob (F-statistic)	0,000		
Durbin-Watson stat	1,375636		

Source: *Authors' calculations*

By applying equations to the data obtained by the method of least squares in Table 7, we arrive at the following predicted model:

$$SASX - 30 = 1.595 + 2.55E - 08 * SASE_{TRN} - 5.70E - 08 * BLSE_{TRN} + 4.34E - 07 * ZGSE_{TRN} - 1.15E - 06 * MNESE_{TRN} + 3.03E - 06 * LJSE_{TRN} + 1.18E - 08 * FRSE_{TRN} - 1.93E - 0 * NYSE_{TRN}$$

It is evident from the previous table that the adjusted coefficient of determination in the least squares model is 0.8329 or 83.29%. This indicates that 83% of the variation of the stock market index SASX-30 is explained by changes in turnover on certain stock exchanges (such as Zagreb Stock Exchange, Ljubljana Stock Exchange, and Frankfurt Stock Exchange), while the remaining 17% is explained by factors not specified in the model. The probability of the F-statistic in the least squares method has a value of 0.000, which shows that the model is statistically significant at the 5% significance level because the p-value is less than 5%. SASX-30 does not respond to domestic turnover due to low liquidity and inefficiency of the domestic capital market, but it does respond to turnover on the Zagreb Stock Exchange and the Frankfurt Stock Exchange because they represent information and capital centres relevant to the capital market in B&H. In addition, many companies in B&H have foreign owners and are connected to the EU financial system.

Quedraogo & Sawadogo (2022) analysed the dynamic relationship between turnover, returns, and volatility in 11 African capital markets. The authors used VAR/Granger causality and EGARCH models. The findings of this study differ from our empirical results. They concluded that there is a significant relationship between volume and returns, and that the direction of the relationship varies from market to market. The similarity with our obtained results in Table 6 is that in less developed and illiquid markets, the connection is weaker or unstable. From the previous table, it is evident that the rate of return on the stock exchange index SASX-30 generally does not react to changes in turnover on the stock exchanges (except for turnover on the Ljubljana and Frankfurt Stock Exchanges, where the probability is less than 5%). In this regard, we conclude that there is no statistical significance between the turnover of the selected stock exchanges and the stock market index SASX-30, therefore leading to the rejection of the first auxiliary hypothesis.

Table 8: Coefficients of independent variables in ordinary least squares regression for the period: 2016:Q1 - 2024:Q4

Regression model **Dependent variable – BIRS**	**Ordinary Least squares method (OLS)**		
Independent variables	**Coeff.**	**Std. Error**	**Probability**
C	747,374	90,890	0,000
SASE_TRN	3.24E-08	1.57E-07	0,837
BLSE_TRN	-1.02E-07	2.26E-07	0,654
ZGSE_TRN	4.51E-08	5.91E-08	0,452
MNESE_TRN	-3.54E-07	3.84E-07	0,364
LJSE_TRN	1.30E-06	5.78E-07	0,032
FRSE_TRN	2.11E-09	8.72E-10	0,022
NYSE_TRN	-8.01E-10	2.27E-10	0,001
Coefficient of determination	0,76603		
Adjusted coefficient of determination	0,70754		
F-Statistic	13,096		
Prob (F-statistic)	0,000		
Durbin-Watson stat	1,3159		

Source: *Authors' calculations*

By applying equations to the data obtained by the method of least squares in Table 8, we arrive at the following predicted model:

$$BIRS = 747{,}37 + 3.24E-08 * SASE_{TRN} - 1.02E-07 * BLSE_{TRN} + 4.51E-08 * ZGSE_{TRN} - 3.54E-07 * MNESE_{TRN} + 1.30E-06 * LJSE_{TRN} + 2.11E-09 * FRSE_{TRN} - 8.01E-10 * NYSE_{TRN}$$

It is evident from the previous table that the adjusted coefficient of determination in the least squares model is 0.7075 or 70.75%. This indicates that 71% of the variation of the stock market index BIRS is explained by changes in turnover on certain stock exchanges (such as Frankfurt Stock Exchange and Ljubljana Stock Exchange), while the remaining 29% is explained by factors not specified in the model. The probability of the F-statistic in the least squares method has a value of 0.000, which shows that the model is statistically significant at the 5% significance level because the p-value is less than 5%. Therefore, the most significant positive influence on the movement of returns on the BIRS stock index was the turnover on the Frankfurt Stock Exchange and the Ljubljana Stock Exchange, while on the other hand, the turnover on the New York Stock Exchange had the weakest negative influence on the movement of the BIRS stock index.

This finding suggests that investors in the capital market of Republika Srpska react to a greater extent to information coming from developed and more liquid European markets. Higher trading volume on those exchanges likely reflects relevant macroeconomic and financial signals spilling over to smaller and shallower markets. Therefore, the insignificant impact of domestic turnover may indicate limited informational efficiency, a small number of market participants, and a lower degree of integration of the local capital market into international capital flows. It is evident from Table 8 that the rate of return on the BIRS stock index generally does not react to changes in turnover on the stock exchanges (except for turnover on the Ljubljana and Frankfurt Stock Exchanges, where the probability is less than 5%). In this regard, we conclude that there is no statistical significance between the turnover of the selected stock exchanges and the stock market index BIRS, thus rejecting the first auxiliary hypothesis in this research.

Shrestha (2017) examined the relationship between trading volume and stock return volatility in the Nepalese stock market using monthly data covering the period from July 2005 to April 2017. The study applied the Ordinary Least Squares (OLS) method to investigate whether increases in stock prices are consistently associated with higher trading volumes and vice versa. Furthermore, the GARCH (1,1) model was employed to test whether trading volume has a significant impact on stock return volatility. The empirical results indicated a positive relationship between trading volume and stock return volatility, suggesting that the interaction between trading activity and return volatility is asymmetric. The findings of this study are not entirely consistent with results obtained in our research.

Market capitalization is one of the most important indicators in the capital market for investors. Higher market capitalization is identical to the high growth potential of companies with relatively low risk and can provide high profits to investors (Tjipto & Fakhruddin, 2008). In this regard, market capitalization can be called one of the indicators of the state of the capital market and the performance of issuers, where a higher market capitalization indicates that the capital market has a favourable situation and that the issuers involved in trading on the capital market have good performance (Soejoto, 2002). Also, the value of the market capitalization depends on the number of shares in circulation and the value of the shares at the closing.
Table 9 shows the impact of selected market capitalizations of developing countries, EU member countries, and developed countries on the stock market index SASX-30 through the method of least squares for the period: 2016:Q1 - 2024:Q4.

Table 9: Coefficients of independent variables in ordinary least squares regression for the period: 2016:Q1 - 2024:Q4

Regression model **Dependent variable – SASX-30**	**Ordinary Least squares method (OLS)**		
Independent variables	**Coeff.**	**Std. Error**	**Probability**
C	-883.32	422.53	0.0458
SASE_MC	1.04E-07	5.80E-08	0.0847
BLSE_MC	6.72E-08	8.06E-08	0.4118
ZGSE_MC	5.86E-10	3.55E-10	0.1097
MNESE_MC	2.57E-09	1.20E-07	0.9830
LJSE_MC	3.17E-08	6.85E-09	0.0001
FRSE_MC	-1.91E-09	6.25E-09	0.7621
NYSE_MC	4.41E-09	3.74E-09	0.2477
Coefficient of determination	0.96503		
Adjusted coefficient of determination	0.95629		
F-Statistic	110.40		
Prob (F-statistic)	0.000		
Durbin-Watson stat	1.3088		

Source: *Authors' calculations*

By applying equations to the data obtained by the method of least squares in Table 9, we arrive at the following predicted model:

$$SASX - 30 = -883.32 + 1.04E - 07 * SASE_{MC} + 6.72E - 08 * BLSE_{MC} + 5.86E - 10 * ZGSE_{MC} + 2.57E - 09 * MNESE_{MC} + 3.17E - 08 * LJSE_{MC} - 1.91E - 09 * FRSE_{MC} + 4.41E - 09 * NYSE_{MC}$$

It is evident from Table 9 that the adjusted coefficient of determination in the least squares model is 0.9562 or 95.62%. This indicates that 96% of the variation of the stock market index SASX-30 is explained by changes in market capitalization on certain stock exchanges (such as the Ljubljana Stock Exchange), while the remaining 4.0% is explained by factors not specified in the model. The probability of the F-statistic in the least squares method has a value of 0.000, which shows that the model is statistically significant at the 5% significance level because the p-value is less than 5%. The empirical results from the previous table indicate that only the market capitalization of the Ljubljana Stock Exchange has a statistically significant influence on the rate of return of the Sarajevo Stock Exchange index (SASX-30). This finding suggests the existence of financial connections and the transfer of information between markets, whereby changes in the size and value of the Slovenian capital market act as a signal to investors in the capital market in the Federation of Bosnia and Herzegovina. According to Banz (1981), smaller companies on the New York Stock Exchange (lower market capitalization) achieved a higher rate of return than larger companies in the period between 1936 and 1975. The absence of a statistically significant relationship suggests limited regional market integration, low cross-border capital mobility, and dominance of local investor behaviour. Therefore, market capitalization reflects size rather than active trading dynamics and does not necessarily transmit shocks to the SASX-30.

Table 10: Coefficients of independent variables in ordinary least squares regression for the period: 2016:Q1 - 2024:Q4

Regression model **Dependent variable – BIRS**	**Ordinary Least squares method (OLS)**		
Independent variables	**Coeff.**	**Std. Error**	**Probability**
C	588.368	327.73	0.083
SASE_MC	4.90E-08	4.50E-08	0.285
BLSE_MC	2.35E-07	6.25E-08	0.001
ZGSE_MC	2.92E-10	2.75E-10	0.298
MNESE_MC	-5.71E-08	9.27E-08	0.543
LJSE_MC	-1.70E-09	5.31E-09	0.751
FRSE_MC	5.75E-09	4.85E-09	0.246
NYSE_MC	1.81E-11	2.90E-09	0.995
Coefficient of determination	0.8466		
Adjusted coefficient of determination	0.80831		
F-Statistic	22.084		
Prob (F-statistic)	0,000		
Durbin-Watson stat	1.076		

Source: *Authors' calculations*

By applying equations to the data obtained by the method of least squares in Table 10, we arrive at the following predicted model:

$$BIRS = 588.37 + 4.90E-08 * SASE_{MC} + 2.35E-07 * BLSE_{MC} + 2.92E-10 * ZGSE_{MC} - 5.71E-08 * MNESE_{MC} - 1.70E-09 * LJSE_{MC} + 5.75E-09 * FRSE_{MC} + 1.81E-11 * NYSE_{MC}$$

Table 10 clearly shows that the adjusted coefficient of determination in the least squares model amounts to 0.8083 or 80.83%. This indicates that 81% of the variation of the stock market index BIRS is explained by changes in market capitalization on certain stock exchanges (such as the Banjaluka Stock Exchange), while the remaining 19% is explained by factors not specified in

the model. The probability of the F-statistic in the least squares method has a value of 0.000, which shows that the model is statistically significant at the 5% significance level because the p-value is less than 5%. Rajan & Zingales (2003) argue that the size of the financial market, commonly proxied by market capitalization, reflects the degree of financial development, openness, and investor protection. Larger markets tend to exhibit higher liquidity, broader participation, and stronger integration with global capital flows, which in turn shape the behaviour and responsiveness of stock returns.

Based on the results presented in Tables 9 and 10, it is evident that the rate of return on the SASX-30 stock index does not react to changes in the market capitalization of the selected stock exchanges (except for the market capitalization on the Ljubljana Stock Exchange, where the probability is less than 5%). In this regard, we conclude that there is no comprehensive statistical significance between the return on the SASX-30 stock index and the market capitalization of the selected stock exchanges, thereby rejecting the second auxiliary hypothesis in this research. Yoda et al. (2025) examine the relationship between financial performance and stock returns, considering market capitalization as a moderating factor. Using panel data from companies listed on the Indonesia Stock Exchange over the period 2013-2022 and applying the Ordinary Least Squares (OLS) model, the authors find that market capitalization has a positive and statistically significant influence on the relationship between financial performance and stock returns. The results suggest that firm with higher market capitalization tend to exhibit stronger return dynamics in the stock market. The findings of this study are not entirely consistent with results obtained in our research.

The term causality refers to the ability of one variable to predict the movement of another variable. If one wants to check whether event X causes event Y, it is necessary to analyse how much of the dynamics of variable Y in the current period can be explained by its own movement in previous periods, and whether the prediction of variable Y improves when the previous values of variable X are included in the analysis. This approach to causality is known as Granger causality (Granger, 1969). Table 10 shows the results of Granger-Wald causality tests between the stock market index of the Sarajevo Stock Exchange (SASX-30), stock market indices of neighbouring countries, EU member countries, and developed countries for the period 2016-2024.

Table 11: Causality via Granger Wald causality tests between the stock market index (SASX-30) and stock market indices of developed countries, developing countries in EU member states and developed countries for the period: 2016 – 2024

Equation	Excluded	F	df	df_r	Prob>F
SASX-30	CROBEX	1.885	4	486	**0.1897**
SASX-30	BUDAPEST	3.035	4	486	**0.070**
SASX-30	DAX	2.290	4	486	**0.131**
SASX-30	SBITOP	1.435	4	486	**0.292**
SASX-30	BELEX15	1.114	4	486	**0.402**
SASX-30	FTSEMIB	1.831	4	486	**0.199**
SASX-30	BIST	4.364	4	486	**0.026**
SASX-30	ATX5	5.318	4	486	**0.014**
SASX-30	S&P500	1.621	4	486	**0.243**

Source: *Authors' calculations*

It is evident from the previous table that the results of the Granger Wald test indicate the existence of bidirectional causality between the capital market in the Federation of Bosnia and Herzegovina (SASX-30), the capital market in Austria (ATX5), and the capital market in

Turkey (BIST). This further means that the historical movements of returns on the Vienna and Istanbul Stock Exchanges have a statistically significant predictive power on movements on the Sarajevo Stock Exchange, but the reverse is also true. This finding suggests a high degree of financial integration, information transfer, and the potential spillover effect of shocks among markets. Additionally, banking groups and companies from Austria and Turkey are present in certain percentages in the financial market of Bosnia and Herzegovina. Table 11 shows the results of Granger-Wald causality tests between the stock market index of the Banja Luka Stock Exchange (BIRS), stock market indices of neighbouring countries, EU member countries, and developed countries for the period 2016-2024.

The difference between the results obtained from the OLS regression model and the Granger Wald causality test can be explained by the methodological nature of these two approaches. The OLS regression model estimates the contemporaneous relationship between variables, capturing, the direct impact of trading volume on the dependent variable within the same period. In contrast, the Granger Wald causality test examines the predictive power of lagged values of one variable on another. Therefore, the Vienna and Istanbul stock exchanges may not exhibit a statistically significant contemporaneous effect in the OLS framework, but their lagged values can still provide useful information in predicting movements in the Sarajevo and Banjaluka Stock Exchange indices. This suggests that these markets may influence the domestic market with a time lag rather than through market reactions.

Table 12: Causality via Granger Wald causality tests between the stock market index (BIRS) and stock market indices of developed countries, developing countries in EU member states and developed countries for the period: 2016 – 2024

Equation	Excluded	F	df	df_r	Prob>F
BIRS	CROBEX	1.803	4	486	**0.165**
BIRS	BUDAPEST	1.969	4	486	**0.1407**
BIRS	DAX	0.882	4	486	**0.414**
BIRS	SBITOP	0.299	4	486	**0.741**
BIRS	BELEX15	7.983	4	486	**0.001**
BIRS	FTSEMIB	2.301	4	486	**0.101**
BIRS	BIST	0.759	4	486	**0.384**
BIRS	ATX5	0.262	4	486	**0.769**
BIRS	S&P500	2.594	4	486	**0.075**

Source: *Authors' calculations*

It is evident from the previous table that there is a full two-way causality between the capital market in the Republika Srpska and the Republic of Serbia. This means that changes in prices on the capital market in the Republic of Serbia predict changes in prices on the capital market of the Republika Srpska, as well as vice versa. Republika Srpska and the Republic of Serbia have strong trade and business ties, so changes in Serbia in terms of changes in certain macroeconomic parameters (interest rates, growth, fiscal measures, exchange rate expectations, regional risks) can indirectly affect the expectations of investors in Republika Srpska, especially for companies that operate regionally.

5. Conclusions

The capital market in Bosnia and Herzegovina belongs to the group of smaller capital markets, characterized by small market capitalization and liquidity on one hand, while on the other hand, this market is characterized by relative openness and greater political instability. Also, the high

fragmentation of the financial system of B&H has a particularly negative impact on the development and functioning of the capital market.

This study tested the mutual conditionality and causality between the capital market in Bosnia and Herzegovina and selected regional and developed capital markets. The research period covers the period from 2016 to 2024. The dependent variables in the paper are the SASX-30 stock index as a representative of the Sarajevo Stock Exchange and the BIRS stock index as a representative of the Banja Luka Stock Exchange. Stock market indices, turnover, and market capitalization on the capital markets of developing countries, EU member states, and developed countries are presented as independent variables. The methods of descriptive statistics, correlation analysis, the least squares method, and the Granger-Wald test of causality were applied in this research.

The findings obtained in this research using the method of least squares showed that the basic research hypothesis based on the assumption of the existence of a significant connection between the capital market in Bosnia and Herzegovina with selected regional capital markets of certain EU member states and developed markets can be fully accepted. The results of the least squares model showed that the SASX-30 stock index has a statistically significant correlation with the following stock indices: CROBEX, BUDAPEST, DAX, BELEX15, FTSEMIB, BIST, ATX5, and S&P500. Also, the BIRS stock market index has a statistically significant correlation with the same indices, except for the SBITOP index. These findings confirm that the capital market in Bosnia and Herzegovina, although limited in terms of depth and liquidity, nevertheless shows a clear international connection, where some effects are manifested in a positive and others in a negative direction.

The results obtained by applying the least squares model showed that the rate of return of the stock exchange index SASX-30 is sensitive only to changes in turnover on the Zagreb, Frankfurt, and Ljubljana stock exchanges. On the other hand, the rate of return of the BIRS stock index is sensitive only to changes in turnover on the Ljubljana and New York Stock Exchanges. With that in mind, we came to the conclusion of rejecting the first auxiliary research hypothesis, given that the turnover of all the observed stock exchanges has no statistically significant influence on the movement of returns on the SASX-30 and BIRS stock indices. This finding confirms the existence of regional and informational connectivity of the market, as well as the potential spillover of liquidity between neighbouring financial systems. On the other hand, the lack of influence on domestic and certain international stock exchanges can be explained by the smaller market depth, the different structure of investors, and the limited intensity of capital flows.

By testing the second research hypothesis using the least squares model, the results showed that only the market capitalization on the Ljubljana Stock Exchange has a statistically significant influence on the movement of returns on the SASX-30 stock index. Although the results confirm a certain degree of connection of the BIRS index with international capital markets, the results show that the market capitalization of foreign stock exchanges does not have a statistically significant effect on the return of the BIRS index. This finding suggests that investors in the Republika Srpska react to price and information signals from abroad, but that the size of those markets alone is not a key factor in the process of formation of domestic returns. In this regard, we concluded rejecting the second research hypothesis.

The results of the Granger-Wald causality test showed that there is a two-way relationship between the stock indices of the Sarajevo Stock Exchange, the Vienna Stock Exchange, and the

Istanbul Stock Exchange. Also, two-way causality between the Banja Luka and Belgrade Stock Exchanges was shown. Given that the Granger-Wald causality test did not fully confirm the existence of significant temporal causality, there is no evidence that changes in one period explain changes in another period.

Although shallow and underdeveloped, the capital market in Bosnia and Herzegovina is not completely isolated from global financial flows. The financial system of Bosnia and Herzegovina is dominantly bank-centric, and the results of this research indicate the need for further development of the capital market to increase its efficiency, depth, and ability to absorb and transmit international shocks. Connection with regional and global capital markets is a condition for further development, as well as a challenge for stability.

This study has certain limitations. The analysis is limited to a selected group of stock market indices and s specific time period. Future research could extend the analysis by including additional markets, longer time periods, and alternative econometric models in order to provide a deeper understanding of stock market interactions.

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A scientific paper

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INNOVATION ECOSYSTEMS IN THE ADRIATIC MARITIME SECTOR: ENABLING DIGITAL AND GREEN TRANSITIONS

ABSTRACT

One of the challenges of the maritime industries is the integration of new technologies and the shift towards net-zero emissions. Simultaneously, these requirements also represent an opportunity for innovation and enhancing the industries' competitiveness. This paper examines the strategic process and design that support innovation and competitiveness in maritime industries in cross-border regions. Specifically, the research question pertains to the key elements of an effective strategic process that involves multiple actors. A case study approach is adopted for this purpose. The innovation ecosystem approach was implemented by actors from two cross-border regions with strong economic ties - Western Slovenia and Adriatic Croatia, in a project-based cooperation aiming to strengthen the innovation outcomes of their maritime industries. The cooperation represents an insightful example, as it has taken place in smaller post-transitional regions, in a specific industry context where both competitive and cooperative elements coexist. One of the key results is a joint research and innovation strategy, formulated in an iterative and interactive process, structured on the Quadruple Helix model of innovation involving academia, industry, government and civil society. The aim of this paper is to illustrate the bilateral strategic process that led to a shared vision, goals and measures.
The findings of the case study highlight the importance of coherent needs of cross-border regions, as well as an iterative and evidence-based strategic process that combines a strong analytical foundation with continuous participation of the main actors. In the analytical phase, scientific methods were applied to collect qualitative and quantitative data on innovation activity which would later enable a triangulation of results and the subsequent continuation of the regional strategic cooperation, contributing to the effectiveness of the process. The findings further indicate that engaging participation contributed to the relevance of the joint strategy. The results also suggest that sustained policy support may be critical for long-term impact. This paper contributes to the literature on cross-border strategic processes in sector-specific contexts characterised by the coexistence of cooperative and competitive dynamics.

Key words: *Joint research & innovation strategy, maritime innovation ecosystem, stakeholder participation.*

1. Introduction

Croatia and Slovenia, two small European countries with access to the Adriatic Sea, have both built a strong economic specialisation in the maritime industries. The competitiveness of these industries is strongly influenced by technological innovation. In contemporary economies, innovation can be a result of company processes, and also a result of collaboration, involving multiple actors. This understanding of innovation was first formalised in the Triple Helix model (3HM) and subsequently extended through the Quadruple Helix model that conceptualises innovation as a collaborative process involving academia, industry, government, and civil society (the public or users). A concept that is closely associated with the Quadruple Helix model is that of innovation ecosystems. These are mostly networks of sectoral or regional actors with the aim of fostering innovation.

Maritime industries are undergoing a transition towards net-zero emissions and greater integration of new technologies (OECD, 2024). This issue was addressed by a cross-border project INNO2MARE, bringing together actors from Western Slovenia and Adriatic Croatia. This case provides an illustrative example of a joint strategic process and strategy development for two reasons: (a) it involves two smaller post-transitional regions building their specialisation on a common resource—the Adriatic Sea; and (b) it focuses on the maritime sector, characterised by the coexistence of competitive and cooperative dynamics. Following Bačić, Pomenić, and Đokić's overview (2026), the background can be summarised as follows. In both regions, the maritime sector is traditionally centred on shipbuilding (manufacturing), design offices, shipping (services) and major seaports (infrastructure). A broader sectoral definition also includes maritime associations, regional and local governments, and highly specialised IT service providers. Together, these actors constitute maritime innovation ecosystems (MIEs), which were mapped for both regions, using research methods in the early project phase. Differences in the configuration of the two regional MIEs were also noted. Across the Adriatic, there is already functional integration pertaining to multidimensional cross-border economic and operational connectedness, while a cooperation of institutions in innovation issues was lacking (PRIGODA & Euro ekspertiza, 2025). The benefits of such cooperation would be to reduce fragmentation of resources and increase innovation outcomes.

A bilateral research and innovation strategy was successfully developed, despite initial challenges. This paper aims to: (a) demonstrate the importance of adhering to an appropriate strategy design and stakeholder participation in a challenging context of cross-border cooperation; (b) address the challenges and risks that emerged during the strategic process, particularly in formulating vital elements of the shared strategy. The research question focuses on identifying the key elements of a strategic process aiming to foster innovation in cross-border regions, or more specifically: How the strategic process should be structured to achieve effective goal setting and impactful measures to foster innovation, in a cross-border and dynamic multi-actor setting?

This paper aims to contribute to the literature on cross-border strategies and strategic processes by illustrating a structured approach to engaging multi-actor systems in the co-creation of joint strategies. The findings may be of importance to policymakers, regional development agencies, and innovation stakeholders planning cross-border cooperation. The paper is structured as follows: after the introduction, a literature review is presented. This is followed by a description of the methodology applied in the paper and in the strategic process, and then the case study is presented. The paper concludes with a discussion and conclusions.

2. Literature review

This study is primarily concerned with the strategic process in a cross-border, sectoral, and innovative perspective. The strategic process is structured primarily on good practices and the national legal framework, while simultaneously drawing on relevant innovation concepts and models. Accordingly, the literature review integrates insights from three strands: a) strategic planning and strategy design processes, which constitute the central analytical lens of the study; b) the innovation (eco)system concept, which informs the strategic process of key actors and relationships; and c) the Quadruple Helix, as a model of participatory governance in the strategic process.

Critical questions in the design of cross-border strategies are those of how strategic objectives are defined and how cooperation activities translate strategic alignment into intended outcomes. These strategies set common goals and priorities among cross-border regions. Furthermore, they aim to strategically direct engagement of resources to accomplish shared goals. That is why goal setting is important. Cross-border planning requires consensus, which sometimes can lead to overly broad or weakly operationalised objectives (Decoville & Durand, 2017). In that case, the impact of the strategy may be weakened.

To mitigate these types of risks, an evidence-based approach is recommended as it helps identify priorities and target areas where cross-border cooperation can generate greater value. This approach also allows for evidence-informed decisions on joint action planning, but detailed and comparable data are often not available (OECD, 2024). Moreover, aligning joint cross-border objectives with broader programmatic frameworks and national strategies can enhance their effectiveness (Fogarasi, 2024). Cross-border cooperation is complex as regulations or guidelines for cross-border strategic planning are missing; thus, engaging relevant stakeholders in the design phase is important, as well as clarifying implementation roles and resources and envisaging a monitoring and evaluation mechanism (OECD, 2024). As to the question of effectiveness of a joint strategy, it will ultimately depend on its ability to translate strategic ambitions into concrete cooperation activities that generate tangible outcomes.

Innovation (eco)systems are networks of national, regional and/or sector-specific actors brought together by a shared objective of fostering and supporting innovation activities (Smorodinskaya et al., 2017). Within such ecosystems, interdependent actions among actors may lead to value creation and tangible innovation outcomes (Adner, 2017; Granstrand & Holgersson, 2020). Interactions within the ecosystem may be *complementary* (reflecting collaboration) or *substitutive* (reflecting competition) (Granstrand & Holgersson, 2020). For these reasons, trust is an important component of ecosystems and a determinant of their development (Steinbruch, Nascimento & de Menezes, 2022). Extending this perspective to cross-border contexts, Trippl (2006) conceptualises cross-border regions as integrated innovation spaces characterised by higher levels of complexity, but also by significant potential for synergies and shared growth through knowledge exchange, enhanced labour mobility, and foreign direct investment. In general, cross-border cooperation may be influenced by both supportive and limiting factors. More effective long-term results occur when cooperation is institutionalised, facilitating knowledge transfer, whereas administrative inefficiencies, cognitive distances, and funding-driven initiatives can reduce long-term impacts on innovation (Fogarasi, 2024). Research also suggests that managing diverse stakeholder perspectives is an important factor in facilitating cross-border cooperation (Borges et al., 2022).

Maritime innovation ecosystems (MIEs) can be understood as: (a) key cooperation networks that enable innovation; (b) instruments in strategy design that support multi-actor participation and the representation of heterogeneous perspectives; and (c) vehicles for subsequent strategy implementation. The shipbuilding activity as the central axis of the maritime industry is characterised by its capital and technological intensity, cyclical nature, and the orientation to the global market (Perić Hadžić & Karačić, 2013). Global maritime competition is intense and concentrated in Europe and Asia, with China leading in world orders (SEA Europe, 2024). This highlights the relevance of the MIE for innovation collaboration and the technological transition.

The maritime sector stands to benefit from the multi-actor interactions inherent in the Quadruple Helix model (4HM), which is grounded in the principles of collaborative and interactive innovation. As discussed in the Quadruple Helix literature (e.g., Cai & Lattu, 2022), different actors perform distinct roles in innovation processes. Academia contributes to knowledge generation and human capital development, industry translates knowledge into market-oriented solutions, government provides regulatory and policy frameworks, while civil society introduces broader societal perspectives. The multiple-helix approach applied in practice highlights the importance of engaging diverse stakeholders and enabling flexible collaboration across sectors, in support of knowledge exchange and innovation processes (Hernández et al., 2025).

Existing studies provide valuable insights into challenges related to cross-border strategy design, including strategic processes, the efficiency of cross-border strategies, policy alignment, and the application of participatory principles. However, integrated analyses that explicitly link innovation issues and cooperation in maritime cross-border and multi-actor contexts remain scarce, especially in the post-transitional setting. This paper addresses this gap by examining how challenges in joint strategy design were addressed. The literature suggests that cross-border innovation ecosystems are shaped by joint strategic orientation, stakeholder participation, and cooperation mechanisms. It further indicates that favourable strategic outcomes are supported by evidence-based strategic processes, whereas purely consensus-oriented planning often leads to insufficiently ambitious objectives and limited practical impact. The innovation ecosystems provide a structure conducive to innovation, while their performance depends on the interactions among actors.

3. Methodology

To address the research question, we employ the case study method. It is a qualitative research approach for an in-depth study of a scientific question and allows for various sources of data and information to be employed. The approach is particularly suitable for addressing the research question on key elements of an efficient strategic process as there are more underlying concepts applied (strategic process & design, innovation ecosystems, 4HM) and there are several underlying contexts (regional, sectoral, cross-border). The case is based on the project "Strengthening the capacity for excellence of Slovenian and Croatian innovation ecosystems to support the digital and green transitions of maritime regions", under the acronym INNO2MARE and is carried out in the period from January 2023 to December 2026. Partners include universities, companies, development agencies, and technical and business organizations, collectively representing the 4HM, mostly from Western Slovenia and Adriatic Croatia. Belgian partners were also involved, with their advanced MIE serving as an example during a project sub-phase.

This case provides a specific example of a joint strategic process and strategy design due to the following: (a) it involves two smaller post-transitional regions that build their industrial specialisation around a common resource—the Adriatic Sea; and (b) the focus is also on the maritime sector - characterised by the coexistence of competitive and cooperative dynamics. The post-transitional trajectory of the regions adds analytical value, as such settings are typically characterised by limited innovation capacities and transitioning industrial structures, making the design of effective strategic processes particularly challenging. Additionally, the process was complex because it involved actors from different domains (academia, industry, government, and civil society). This case complements existing examples in the cross-border strategy literature, which often emphasise public issues (such as transport infrastructure, joint environmental management, or capacity-building initiatives), where the public sector typically assumes a leading role in the strategic process.

Importantly, the project documentation was produced using both qualitative and quantitative scientific methods and serves as a primary source of information for the case study analysis. On the quality of the project documentation, it may be concluded that it allows for an appropriate case study analysis as this documentation is extensive, it covers relevant topics and was created using scientific methods. The quality and comprehensiveness of the documentation make it suitable for rigorous case study analysis, covering essential topics and applying scientific methods. Furthermore, the case study approach aligns well with the practical nature of strategic processes and strategy design.

The case study allows for an in-depth understanding of the challenges of the strategic planning process across multiple contexts relevant to the project—technological, environmental, regional, sectoral, and cross-border. As the analysis examines the case as an integrated whole rather than isolated variables, a holistic approach is applied (Yin, 2017). The study combines descriptive, explanatory, and to some extent exploratory elements, each where appropriate.

As a single case study, the findings are context-specific. However, they provide insights into the design of cross-border strategic processes and multi-actor participation. They may also help identify challenges that arise in strategic processes and explore ways of strengthening common ground. A potential limitation is researcher bias, which may be influenced by the research context and the authors' professional backgrounds. As domain experts, all authors participated in different stages of the project, allowing observation of the strategic process from multiple perspectives. Some authors were directly involved in the formulation of the strategic document and also employed observation as a research method. To mitigate potential bias arising from this involvement, a reflexive approach was adopted, with the authors explicitly acknowledging their roles and systematically triangulating their observations with project documentation.

4. Case study - a route to strategic framework

In this section, key elements of the joint research, development and innovation strategy design process for Western Slovenia and Adriatic Croatia are presented, highlighting some issues that emerged from the process.

4.1. Initial steps – the analytical phase

Various types of analyses conducted during the initial stage provided valuable insights into the current state of MIEs in Western Slovenia and Adriatic Croatia. An overview of research goals,

corresponding methods and collected data in this phase are presented in Tables 1 and 2, while the entire analytical phase is described in detail in Bačić, Pomenić, and Đokić, (2026). From a broader perspective, this phase can also be considered as part of the strategic process, as careful planning of analytical methods and their implementation was crucial to the overall quality of the joint strategy.

The analytical phase yielded several key insights. The MIEs were found to be structured differently (BSC & Lemur Legal, 2023), but needs, challenges, and attitudes were found to be similar (PRIGODA, 2023), indicating a potential coherence of regional actors. The strong regional importance of the maritime sector was confirmed by the results of the quantitative analysis, particularly in Adriatic Croatia, where above-average sector productivity was observed (Bačić, Pomenić & Đokić, 2026).

Several challenges emerged during the implementation of analytical methods. In some cases, data collection on innovation processes and outputs was constrained by business concerns regarding data confidentiality. In addition, engaging firms in workshops and surveys proved difficult due to time constraints and, for some, limited trust in strategic processes and in public policies. These challenges were mitigated through the use of multiple methods, as some companies preferred interviews over surveys, and vice versa. Additional effort was therefore devoted to this phase to ensure adequate response.

Table 1: Research goals and corresponding methods during the project's analytical phase

Research goal 1: Mapping the Innovation Ecosystem a. Desk research b. Questionnaire-based survey c. Semi-structured interviews	**Research goal 2: Identification of innovative Companies** d. Application of the innovation drivers' tool
Research goal 3: Identifying needs, opportunities, and gaps in the Ecosystem e. Stakeholder workshops	**Research goal 4: Estimating the economic contribution of the ecosystem** f. Economic analysis of stakeholders' business data

Source: Authors' adaptation based on Bačić, Pomenić and Đokić, 2026, pp. 9.

Table 2: Overview of data collected in the project's analytical phase, structured by method

Method 1: Questionnaire-based survey
Data collected: Thematic qualitative data related to the domains listed below. • Stakeholder research and development capabilities • Nature of stakeholder interactions — Collaboration: co-innovation processes, joint research and development projects, knowledge and technology transfer, academic and student collaboration — Competition: competition in global markets and within the local ecosystem • Innovation activities, including perceived enablers and inhibitors • Needs, gaps, and opportunities in relation to the digital and green transitions
Method 2: Semi-structured interviews
Data collected: In-depth thematic qualitative data covering the same domains as the Questionnaire-based survey, and additionally: • Stakeholder perspectives on business operations and the current state of the ecosystem • Concrete challenges and real-world business cases • Contextual insights
Method 3: Workshops
Data collected: Thematic qualitative data on the needs and gaps in the ecosystem, as listed below. • Communication and coordination among stakeholders • Workforce-related challenges • Academia–industry collaboration in education, research and development, and knowledge transfer • Barriers to accessing innovation funding • Issues related to regulation and governance • Overall innovation capacity and systemic barriers • Shared interests in future collaboration
Method 4: Descriptive statistics
Data: Company-level quantitative data extracted from the FINA database. • Key economic and financial indicators of the maritime sector provided.

Source: Bačić, Pomenić, and Đokić, 2026, pp. 9-10

Innovation gaps and related needs were addressed through the joint strategy. The underlying agenda of both MIEs was internationalisation, with the aim of positioning Western Slovenia and Adriatic Croatia on the global maritime innovation map. Workshops with project partners were organised to openly present and discuss the findings and conclusions of the extensive analytical phase. The stakeholders' reflections and validations, coordinated by the lead partner's coordination, were documented for future use.

Table 3: The results of the project's analytical subphases

THE ANALYTICAL PHASE

Subphases	**Data/methods/outputs**
Ecosystems' mapping	Mostly secondary qualitative data gathered through desk research, thematic qualitative data gathered through questionnaire-based survey, and thematic qualitative data from semi-structured interviews were used. Outputs: MIEs configuration was revealed, key actors were recognized, collaborative and competitive relations were identified.
Ecosystems' needs identified	Data from workshops, questionnaire-based survey, and semi-structured interviews were used. Outputs: Ecosystems' needs were observed.
Qualitative Analysis of MIEs	SWOT analysis was carried out to gain qualitative insights. Outputs: Contextual information was detailed. Potential competitive advantages, strengths and weaknesses were recognized. Technological trends assessment was summarized. External threats were revealed.
Analytical assessment of MIEs	The descriptive statistics method was used on company data from a business database. Outputs: Key economic indicators and results of quantitative analysis were provided.
Belgian MIE as a successful example	Exploratory comparative analysis was carried out, based on qualitative data from secondary sources. Outputs: Relevant good practices were identified; useful insights for ecosystem development were recognised; comparative inputs were provided for the strategy design process.
Validation and iterative refinement (continuous)	Stakeholder consultations, validation workshops, and iterative refinement were carried out. Outputs: Findings were validated; conclusions were refined; additional qualitative insights were integrated; triangulation of data was ensured.

Source: Authors

4.2. Adjustment of the approach

One of the expected project outputs was the formulation of the Long-term joint research and innovation strategy (hereinafter: The Joint Strategy). As no formal template existed for this document, it was agreed to combine both Croatian and Slovenian methodological approaches. In Croatia, the formulation of strategic planning acts is guided by a legal framework, specifically based on *the Act on the System of Strategic Planning and Development Management of the Republic of Croatia* (Croatian Parliament, 2017, 2022), whereas in Slovenia, long-term development documents are adopted in accordance with the Public Finance

Act, four-year State Programmes of Development Policies, and the mid-term fiscal strategy, which is updated annually.

4.3. Coherence with other strategic documents

Good practices for aligning the joint strategy with other official strategic documents were followed. Relevant strategies and policy documents from both countries were consulted, from the supranational, national, sectoral/multisectoral, and subnational levels. This alignment provided a broader strategic background on related issues, such as digitalisation, the green transition, the Blue Economy, labour market challenges, and governance. These documents were also consulted in subsequent strategic steps, during planning of higher-level elements, such as strategic goals and concrete measures. Correlating the joint strategy with relevant policy documents ensured consistency and complementarity with broader policy contexts, enhancing impact and relevance in several ways. Firstly, it strengthens the legitimacy of the strategy, increasing the likelihood of implementation. Secondly, it reduces the risk of misaligned strategic goals and instruments. Thirdly, it contributes to the potential success of both the cross-regional strategy and the higher-level documents.

4.4. Strategy formulation driven by workshops

During the strategy formulation process that lasted several months, a series of workshops was organised to ensure meaningful stakeholder participation, particularly to secure the future acceptance of the completed strategic document by the public sector. The first two workshops were critical to establishing the vision and defining the main strategic objectives, enabling a more streamlined subsequent progression.

Table 4: Strategy design of the Joint Strategy

STRATEGIC FRAMEWORK DESIGN

Subphases	Outputs
Vision defined	Iterative brainstorming in a workshop setting was carried out.
Strategic objectives and impact indicators defined	Series of workshops was carried out, discussion encouraged whereby project partners and consultants contributed inputs. Findings from the analytical phase were used as the foundation for group work.
Priority areas across strategic objectives defined	Workshop-based discussion with contributions from project partners and consultants.
Measures across priority areas designed	Measures include potential projects, activities, and indicators obtained through contributions from participants, project partners, and the consultant in a workshop setting.

Source: Authors

4.5. Vision as a desired state in the future

The vision defines the strategic direction toward a desired future state and is a key element of strategy development. Essentially, it is a concise statement describing what is expected to be achieved under ideal conditions. A vision should be both inspiring and ambitious, grounded in

evidence from various data sources. These principles guided the Joint Strategy formulation process. During this critical stage, maritime and joint strategies from other countries with extensive experience in the maritime sector were also consulted. Workshop participants were encouraged to contribute freely with ideas and suggestions, to generate valuable input. Once collected, these contributions were thoroughly discussed, finally leading to the following consensus vision (PRIGODA & Euro ekspertiza, 2025, p. 7):

Western Slovenia and Adriatic Croatia are innovative, resilient, and sustainably using marine space and resources developed contributing to emission reduction and supporting blue economy growth. The maritime research and innovation ecosystem of the region is globally recognized and adaptive, fostering Adriatic Sea cooperation, knowledge sharing, and advances in innovation and technology.

Participants also focused on identifying core values that would guide the strategy formulation and implementation, including research and pilot projects carried out within the project. Key values highlighted included *high-quality* (of project outputs), *independence and impartiality* (in research and innovation activities and outputs), and *relevance* (of topics that strengthening research & innovation excellence in both regions). *Effectiveness and efficiency* were also emphasised, meaning that project activities should achieve the desired impacts and provide value for money.

4.6. Hierarchy of Strategic Goals and Measures

The vision served as an overarching framework for defining the strategic objectives. Based on the authors' observations, a build-up of engagement resulted in highly interactive subsequent workshops. A hierarchy of goals was established: strategic objectives were followed by relevant priority areas, and then by measures. Participants expressed a strong interest in developing a strategy with tangible socio-economic impacts. Four strategic objectives were defined:

I. Digital advancement of the MIE
II. Green transition of the MIE
III. Attractive and in full capacity MIE's labour market
IV. Excellence in MIE's governance

These objectives were supported by 15 priority areas and 27 measures, including preliminary lists of potential projects and activities. Measures were refined and the lists of projects and activities were defined in the final workshop. Correspondingly, a set of indicators was designed to monitor future strategy implementation, to provide early warnings of negative divergences or potential bottlenecks. Effort was put into concretising measures to produce future impact, by elaborating them in detail, for example: information on target groups or users was provided, responsibility for implementation, monitoring indicators, and potential funding sources. It was found that some initiatives could be financed through combined sources, such as EU funds and programmes, state, regional, or local budgets, and private capital where projects align with private-sector interests. Principles of equality, diversity, and inclusion were addressed as a horizontal theme.

Additionally, stakeholder consultations on the joint strategy and the complementary action plan were conducted on two occasions. The purpose was to discuss the document, allow for final refinements and to secure stakeholder acceptance of the document. Although the strategy design

followed a planned schedule, it was not rushed, and the iterative approach enabled stakeholders to contribute and provide feedback even on earlier proposals.

4.7. Impact

It was acknowledged that MIEs of Adriatic Croatian and Western Slovenia are not isolated from other innovation ecosystems across Europe and beyond. Coherence of the Joint Strategy with other relevant strategic documents created the potential to widen the impact. Most actors taking part in the project demonstrated a strong willingness to engage and provide support in the strategy implementation. Still, maintaining public-sector participation was challenging and could affect the level of institutional support needed for the successful implementation of the Joint Strategy. This was addressed through policy alignment and additional consultations with stakeholders, including the public sector.

5. Discussion and conclusions

The case study method was applied to a cross-border project to address questions related to efficient goal setting and the design of measures within a *Long-term joint research and innovation strategy* (hereafter: The Joint Strategy). Strengthening the capacity for excellence of two maritime innovation ecosystems was the overarching goal, to support a technological shift to new technologies and the green transition. Two major project phases were essential to the strategic process: the analytical and the strategic phases.

During the analytical phase, data collection was crucial. In this phase, several research methods were rigorously employed, allowing for triangulation of results. The data and information collected in this phase were vital for the overall quality of the strategic process. It was necessary to collect reliable data on innovation activities in maritime companies in both regions. Initially, a survey was envisaged as the prime method of data collection. Achieving an adequate response rate proved difficult as in some cases there was a lack of trust in the process, a lack of time, or confidentiality issues. After careful consideration, semi-structured interviews were also introduced, ensuring adequate participation of companies and extra time was devoted to this phase. An important outcome of this approach was that not only planned data on innovation activity were gathered, but also in-depth and contextual data, enabling better understanding by analysts. Companies took part in workshops that were structured on the Quadruple Helix model, which also brought together academia, the public sector, and the civil sector.

Both participating cross-border regions are small, post-transitional, and highly specialised in maritime activities. Applying the same methodology to mapping of two MIEs allowed for a rigorous comparative analysis. In addition to expected sectoral similarities and differences, new insights emerged. These pertain to the driving force behind maritime innovation. In Adriatic Croatia, shipbuilding and design offices serve as the main drivers, whereas in Western Slovenia, the Port of Koper acts as the hub of innovation activities. There was a question as to how these structural differences would reflect on the needs of two ecosystems. Nonetheless, the articulated needs were quite similar in both cases, e.g., the need for wider technological uptake, modernising study programmes, more funding opportunities, a mindset change “from providing service to innovation and production” and other industry-related issues. The ecosystems’ needs were observed and analysed objectively, using several types of collected primary data and largely including those that were directly expressed through the surveys, interviews and workshops.

The project's cooperation mechanism played an important role in both the strategic design and the preceding analytical phase. Coordination was complex, involving 19 project partners from diverse domains and countries, structured on the Quadruple Helix model (4HM). Companies, academia, the government/public sector, and civil society/users took part in the process throughout, reflecting the idea of a modern innovation system based on collaboration. Regular stakeholder consultations and occasional workshops were not a formality but served as an opportunity for validation of findings and refinement of conclusions.

One of the main expected outcomes was an impactful Joint Strategy, or, essentially, an ambitious document. The requirement for an evidence-based strategy was met through a series of studies and documents that served as the foundation for formulating the strategic vision and other key elements. Good practices were pursued in ensuring the alignment with relevant policy documents. The gradual build-up of stakeholder engagement was an important building block of the strategic process. The vision formulation was an iterative and unhurried process. It was created gradually during workshops, where the expression of ideas, opinions, and feedback was encouraged. Other key elements of the Joint Strategy were defined using the same approach. A difficulty that appeared was the limited public-sector presence during some workshops, while simultaneously their participation and acceptance of the document was quite important in terms of impact and subsequent implementation. This was addressed through additional consultations.

A distinctive feature of the strategy design process was the partners' insistence on adhering to a set of values throughout the design and in planning subsequent activities. These included *high-quality* (of project outputs), *independence and impartiality* (in research and innovation activities), *relevance* (topics that strengthen excellence in research & innovation), and *effectiveness and efficiency* (in delivering intended impacts and in ensuring value for money). Care was taken to present the completed Joint Strategy to project actors and validate it through additional consultations alongside the workshops. This approach facilitated document refinement, stakeholder acceptance, and the necessary government participation.

Overall, the results highlight the importance of coherence between stakeholder needs, analytical insights, and wider policy alignment in shaping effective strategic frameworks. In particular, the early and continuous stakeholder engagement, methodological triangulation, and alignment with wider policy frameworks are key elements for structuring coherent strategic objectives and designing evidence-based measures to support innovation processes. Furthermore, the cross-border dimension adds complexity, while it also offers potential synergies.

The case study presented may be used in the future as a reference for researchers, practitioners, and policy makers seeking to design and implement cross-border strategies that foster innovation, regional development, and sectoral transformation.

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OVERTOURISM IN HISTORICAL CITIES – A LOCAL RESIDENT'SPERSPECTIVE

ABSTRACT

The purpose of this study is to examine the attitudes of local residents of the historic core of the city of Split toward the impacts of overtourism, with particular emphasis on perceptions of overcrowding, loss of authenticity, quality of life, and the economic effects of tourism. The research is based on the assumption that an excessive concentration of tourism activities in spatially constrained historic cities generates complex social, spatial, and economic pressures that go beyond purely quantitative indicators of tourism flows.

The study was conducted using a quantitative research methodology and a structured survey questionnaire. Data were collected from a sample of 271 respondents—residents of the historic core of Split—during July and August 2025 using computer-assisted personal interviewing (CAPI). Respondents' attitudes were measured using a five-point Likert scale, and the data were analysed through descriptive and composite statistical analysis, including the calculation of thematic indices of overtourism perception, social pressure, and the economic effects of tourism.

The results indicate that local residents strongly perceive overcrowding of the historic core during the tourist season, rising living costs, and changes in everyday life patterns as key negative effects of overtourism. At the same time, respondents also recognize significant economic benefits of tourism for the local community, pointing to an ambivalent relationship between residents and tourism development. The findings confirm that overcrowding represents the central symptom of overtourism and that its negative effects initially manifest through social and economic aspects of everyday life, while longer-term impacts on authenticity and cultural heritage develop more gradually.

The contribution of this study lies in providing empirical evidence on the perception of overtourism from the perspective of residents of a historic city, thereby complementing existing theoretical models of overtourism and sustainable tourism. The paper contributes to a better understanding of the multidimensional nature of overtourism in Mediterranean historic cities and provides a relevant basis for the development of sustainable and participatory destination management models.

Key words: *overtourism; historic cities; local residents; overcrowding; sustainable tourism.*

1. Introduction

Tourism is a complex socio-economic phenomenon that is examined in the scientific literature through various dimensions—economic, social, cultural, and spatial (Lavaredas et al., 2025). Its importance stems from the fact that it has become one of the world's largest industries and a key generator of income, employment, and social change (Hall & Page, 2014). In the European context, tourism accounts for approximately 10% of the European Union's gross domestic product (GDP) (Eurostat, 2022). Historically, European tourism has demonstrated remarkable resilience and adaptability (ETC, 2025). Despite economic challenges and geopolitical instability, tourism in the EU has stabilized as one of the most important economic sectors, with travel demand remaining exceptionally strong. At the same time, these developments highlight persistent challenges such as seasonality, uneven regional development, and the growing problem of overtourism. Hence, tourism emerges as a driver of socio-economic growth while also producing broader social and environmental effects (Hang & Jang, 2025).

The development of tourism in its contemporary form is closely linked to processes of globalization and mobility. Ease of travel, the expansion of low-cost airlines, the sharing economy, and the digitalization of reservation systems have enabled an unprecedented increase in tourist flows (Gössling, Scott & Hall, 2020; Guttentag, 2015). Digital disruption has also generated numerous challenges, particularly in urban destinations, where the expansion of short-term rental platforms has contributed to rising housing prices and changes in population structure. Beyond its economic and social dimensions, tourism is also examined through its spatial dimension. The concentration of tourist flows in specific destinations creates intense pressure on local communities and resources (Foronda-Robles, Galindo-Perez-de-Azpillaga & Armario–Perez, 2025). Alongside the many positive aspects of tourism development, there has been an increasing recognition of its negative impacts, most commonly associated with overtourism. This phenomenon occurs when tourism is excessively concentrated in time and space, resulting in negative economic, environmental, and socio-cultural effects. Overtourism has become one of the key issues in contemporary tourism development, particularly in urban environments (Capello, Cerisola & Panzera, 2026) and historic cities (Sances-Montanes, Romero-Oleja & Castilla, 2023).

The distinctiveness of this research lies in its focus on the perceptions of local residents of a historic city as key stakeholders in understanding the phenomenon of overtourism. Unlike many studies that analyse overtourism primarily through indicators of tourist flows, carrying capacity, or economic effects, this paper emphasizes the subjective attitudes and lived experiences of residents who inhabit spaces of intensive tourism activity on a daily basis. The added value of the study stems from the fact that it is conducted in the historic core of Split—an area characterized by extremely limited spatial capacity, high cultural and historical value, and strong seasonal concentration of tourism. Split represents a paradigmatic example of a Mediterranean historic city that simultaneously derives substantial economic benefits from tourism while experiencing increasing social and spatial pressures. The relevance of the research is further enhanced by the fact that it is conducted during a period of full post-pandemic recovery of tourism flows, when patterns of intense concentration and overcrowding have re-emerged, providing insight into current destination management challenges.

The objective of this study is to examine the attitudes of local residents of the historic core of the city of Split toward the impacts of overtourism, with particular emphasis on perceptions of overcrowding, loss of authenticity, effects on quality of life, and the economic impacts of tourism. The research seeks to determine the extent to which the local community recognizes both the negative and positive aspects of intensive tourism development and to identify the key dimensions of social, spatial, and economic pressure generated by tourism. An additional objective is to contribute to a better understanding of the ambivalent relationship between local residents and tourism, in which economic benefits are perceived alongside growing dissatisfaction related to everyday life and the preservation of place identity. For that purpose, following research questions are formed:
RQ1: How do residents perceive overtourism in the historic core of Split?
RQ2: What dimensions shape residents' perceptions of overtourism?
RQ3: How do residents balance perceived economic benefits with social and spatial costs of tourism?
Based on the findings, the study aims to provide an empirical foundation for the development of more sustainable and participatory tourism management models in historic cities.

2. Literature Review

Overtourism has become one of the key challenges of contemporary tourism development, attracting increasing attention in academic, policy, and public debates (Mihalič, 2020; Koens et al., 2021). The term is used to describe situations in which tourism activity in a particular destination exceeds the spatial, infrastructural, or social capacities of the area, resulting in a decline in sustainability and a deterioration in residents' quality of life. Overtourism should not be understood solely as a quantitative phenomenon based on visitor numbers, but also as a qualitative issue reflected in its impacts on everyday life, cultural resources, and the environment (Koens et al., 2021; Briguglio & Avellino, 2026). The phenomenon is particularly pronounced in historic cities, where spatial constraints, the vulnerability of cultural heritage, and intense seasonal fluctuations create strong pressures on both the destination and the local community (Gössling, Scott & Hall, 2020). Recent tourism research emphasizes that overtourism should also be examined within a broader global context. Global crises such as the COVID-19 pandemic have further highlighted the vulnerability of destinations already under pressure. The sudden cessation of tourist flows during the pandemic revealed the high degree of tourism dependency in many destinations, while simultaneously opening space for reflection on more sustainable development models (Gössling, Scott & Hall, 2020). Most attempts to manage or reduce overtourism have been ineffective. Despite numerous proposed measures (limits, pricing, regulation), they have not been successfully implemented or sustained, as stakeholders (governments, industry, DMOs) are generally unwilling to limit tourism growth, even when overtourism is evident, due to the fact that economic interests consistently outweigh environmental and social concerns (Butler & Odds, 2022).

Historic cities represent complex urban systems where cultural heritage intersects with contemporary economic functions, making them particularly sensitive to tourism pressures due to limited spatial capacity, the fragility of heritage assets, infrastructural constraints, and tourism-induced socio-demographic transformations (De Luca et al., 2020; Koens et al., 2021). In such environments, tourism does not only generate economic benefits, but also triggers profound transformations that alter spatial structure, cultural identity, and social relations within the community. The concept of the tourist-historic city was developed by Ashworth and Tunbridge (1990; 2000), who emphasize that historic cities perform a dual function: heritage

preservation and satisfaction of tourism demand. While these cities possess exceptional cultural value and symbolic meaning, the tourism sector simultaneously recognizes these resources as the foundation of destination attractiveness. This overlap of interests often generates conflict, as heritage becomes commodified and spaces traditionally used by local residents are transformed into tourist zones. Consequently, the need to balance conservation and tourism exploitation becomes critical, since failure to do so leads to loss of authenticity and spatial degradation. Overtourism in historic cities is increasingly recognized as a complex and multidimensional phenomenon that extends beyond simple measures of visitor numbers and is primarily driven by the spatial and temporal concentration of tourism flows (Koens et al., 2021). In spatially constrained heritage environments, the concentration of large numbers of visitors generates significant challenges related to sustainability, preservation of place identity, and the quality of life of local residents (Sances-Montanes et al., 2023). These pressures manifest through a range of negative impacts, including the physical degradation of cultural heritage, loss of authenticity, and growing socio-economic and environmental strain, ultimately affecting both the tourist experience and the everyday functioning of local communities. From a sustainability perspective, overtourism reflects an imbalance in which tourism development exceeds environmental, social, and economic limits, highlighting the need for integrated approaches to restore equilibrium (Mihalič, 2020). At the same time, research emphasizes that these challenges are closely linked to structural and governance-related factors. In particular, inadequate urban planning and weak regulation of tourism-related land use—especially the expansion of short-term rentals—contribute to processes of gentrification, displacement of residents, and the erosion of residential functions in historic centres (De la Calle-Vaquero et al., 2021). These dynamics underscore the importance of integrated and participatory management approaches that combine urban planning, visitor management, and the active involvement of local communities in decision-making processes (De Luca et al., 2020). Furthermore, overtourism is increasingly associated with growth-oriented tourism models, where the continuous expansion of visitor numbers generates systemic pressures that undermine long-term sustainability and community well-being, prompting calls for a transition toward more balanced and degrowth-oriented approaches (Milano et al., 2021). In response, recent literature highlights the potential of sustainable destination management strategies, including the diversification of tourism products and the promotion of alternative forms such as ecotourism, to alleviate pressure on highly concentrated areas (Vergara Romero et al., 2025). Overall, these perspectives converge in viewing overtourism not merely as a quantitative issue, but as a structural and systemic challenge that requires a shift toward more balanced, sustainable, and community-oriented tourism development models.

Overtourism has emerged as a critical challenge in historic urban destinations, where the concentration of visitors in heritage-rich areas intensifies pressures on both residents and infrastructure. Within the literature, overcrowding is widely recognized as the most visible and immediate manifestation of overtourism (Gajić, Vukolić & Ranjbaran, 2026; Mihalič, 2020). It occurs when the number of visitors exceeds the physical, social, or environmental carrying capacity of a destination, resulting in congestion, degradation of public spaces, traffic pressures, and a diminished quality of experience for both tourists and local residents (Butler, 1980). In historic cities, these challenges are particularly pronounced due to limited spatial capacity and the inherent fragility of cultural heritage, which cannot accommodate unlimited growth in visitor numbers. However, contemporary research emphasizes that overcrowding is not merely a function of absolute visitor numbers, but rather of their uneven spatial and temporal distribution. Empirical studies in the European context demonstrate that tourism pressure tends to concentrate in specific urban areas—particularly historic city centres and iconic landmarks—within short timeframes, creating acute congestion and a strong perception of overcrowding

(Peeters et al., 2018; García-Hernández et al., 2017; Koens et al., 2018). Cities such as Barcelona and Venice exemplify this dynamic, where large volumes of visitors converge simultaneously in confined spaces, often exacerbated by cruise tourism and short-term stays that intensify peak-time pressures. As UNWTO (2018) notes, overcrowding becomes especially problematic when tourists and residents share the same everyday spaces, such as streets, markets, and public transport systems, leading to conflicts of use and a decline in residents' quality of life. The impacts of overcrowding extend beyond physical congestion to encompass broader social, economic, and cultural consequences. High visitor densities in historic districts have been linked to reduced resident well-being, the emergence of anti-tourism sentiments or "tourismphobia," and the gradual transformation of local communities (Milano et al., 2019; Foronda-Robles et al., 2025). In addition, global trends such as the expansion of low-cost air travel, the proliferation of digital accommodation platforms, and increased global mobility have intensified tourism flows, placing sustained pressure on urban spaces often beyond their carrying capacity (Gössling, Scott & Hall, 2020). In this context, overcrowding contributes not only to the physical degradation of cultural assets but also to rising living costs, commercialization of public space, and the displacement of local residents. Tourism-driven overcrowding has leads to significant socio-spatial transformations. Research indicates that increasing tourism pressures in these cities contribute to the depopulation of historic cores, as rising housing costs, changing land use patterns, and the commodification of urban space constrain everyday life for residents. Consequently, overcrowding should be understood as a multidimensional phenomenon in which spatial, social, and economic processes intersect (Mihalič, 2020). Addressing overcrowding as a core impact of overtourism requires coordinated and multi-level governance approaches. Effective responses depend on the collaboration of public authorities, private sector stakeholders, cultural institutions, and local communities (Damnjanović, 2021). Nevertheless, existing governance frameworks are often fragmented, and short-term economic priorities frequently outweigh long-term sustainability considerations, limiting the implementation of effective solutions. Recent research therefore advocates for a shift from traditional growth-oriented models toward more nuanced strategies focused on the management of visitor flows, including spatial redistribution, temporal dispersion, and real-time monitoring of tourist movements (Zubiaga et al., 2019). Overall, the literature consistently demonstrates that overcrowding in historic cities is not an incidental outcome but a structurally embedded consequence of contemporary tourism dynamics. As such, it represents a central dimension of overtourism that requires integrated, evidence-based, and context-sensitive policy responses.

Loss of authenticity is widely regarded as one of the most significant and visible consequences of overtourism in historic cities, directly affecting both the cultural integrity of destinations and their long-term sustainability. Authenticity encompassing historical continuity, cultural practices, and everyday life has long been identified as a central component of tourism attractiveness and experience (Cohen, 1988; MacCannell, 1973). However, as tourism intensity increases and visitor numbers exceed the spatial and social carrying capacities of historic environments, the cultural and social fabric of these destinations undergoes profound transformation. In such contexts, historic urban cores increasingly adapt to the demands of tourism consumption, often at the expense of their original functions and identities (Mihalič, 2020). Theoretical perspectives emphasize that authenticity in tourism is not an inherent or fixed attribute, but rather a socially constructed phenomenon shaped through interactions between visitors and host communities (Wang, 1999). Building on this, recent contributions highlight that authenticity is continuously negotiated and co-produced, but becomes vulnerable when tourism development prioritizes economic value over socio-cultural integrity (Rickly-Boyd, 2013). When these interactions are dominated by market forces and mass tourism

demand, authenticity is progressively replaced by staged, commodified, or simulated experiences. As Ashworth and Tunbridge (1990) argue, historic cities risk becoming "heritage products," where urban spaces are reconfigured as "stages" designed to meet tourist expectations rather than to sustain everyday life. This aligns with MacCannell's (1973) notion of "staged authenticity," which remains highly relevant in contemporary overtourism contexts. Empirical studies provide substantial evidence of these transformations in historic urban environments. García-Hernández et al. (2019) demonstrate that historic city centres are particularly susceptible to tourism pressure due to the concentration of cultural assets, leading to functional changes and loss of local identity. Overtourism results in destinations becoming "less about places to live and more about places to consume," reflecting a shift in urban purpose. Milano, Cheer, and Novelli (2019) further argue that overtourism drives the commodification of cultural heritage, transforming culturally rich urban spaces into standardized consumption landscapes. In line with this, Richards (2018) observes that global tourism dynamics contribute to the homogenization of destinations, where local distinctiveness is gradually replaced by globally recognizable tourism products. The transformation of urban functions is particularly evident in the restructuring of local economies and retail landscapes. Studies highlight how traditional businesses and community-oriented services are increasingly replaced by tourism-oriented activities, such as souvenir shops, short-term rentals, and hospitality venues (García-Hernández et al., 2019; Cocola-Gant, 2016). This process not only alters the economic structure of historic centres but also erodes the everyday practices that underpin authenticity. Gössling, Scott, and Hall (2020) emphasize that global tourism growth—facilitated by low-cost airlines and digital platforms—intensifies these pressures, accelerating the commodification of urban space. The loss of authenticity is also closely linked to residential displacement and demographic change. Research indicates that tourism-driven gentrification and the expansion of short-term rental platforms contribute to the depopulation of historic centres, undermining social cohesion and local culture (Cocola-Gant, 2016; Milano et al., 2019). As residents are displaced, the everyday social practices that give meaning to place gradually disappear, reinforcing spaces designed primarily for visitors rather than for local life. In such contexts, historic centres increasingly resemble "tourism theme parks," where authenticity is simulated and detached from lived experience. International organizations and recent empirical studies further underline the severity of these dynamics. UNWTO (2018) highlights that overtourism disrupts the balance between visitors and residents, leading to a loss of cultural integrity and local identity. UNESCO (2022) similarly warns that the erosion of authenticity threatens the Outstanding Universal Value of heritage sites. Perceived authenticity is a key determinant of visitor satisfaction, and its decline can negatively affect destination competitiveness. Consequently, the loss of authenticity not only represents a cultural and social issue but also poses significant risks to the long-term economic sustainability of tourism destinations. Overall, the literature from leading tourism journals consistently demonstrates that authenticity is a dynamic yet fragile resource that is highly vulnerable to the pressures of overtourism. The transformation of historic cities into spaces of consumption, the displacement of local communities, and the commodification of cultural practices collectively contribute to a gradual erosion of authenticity. Addressing these challenges requires a fundamental shift toward more sustainable and community-oriented tourism models that prioritize the preservation of local identity, everyday life, and socio-cultural integrity as core elements of destination development.

Despite these negative impacts, tourism continues to generate significant economic benefits, which helps explain its continued expansion. While overtourism is frequently associated with negative socio-cultural and environmental impacts, the literature consistently highlights that tourism also generates substantial economic benefits, which play a crucial role in shaping residents' attitudes and tolerance toward tourism development. Tourism contributes to

employment generation, local business development, infrastructure investment, and increased public revenues, particularly in historic cities where tourism often represents a dominant economic sector (Brida, Cortes-Jimenez & Pulina, 2016; Gössling et al., 2020). This duality reflects a central paradox in overtourism research. According to Social Exchange Theory, residents evaluate tourism based on a perceived balance between benefits and costs, supporting tourism development when the benefits outweigh the negative impacts (Ap, 1992). As Mihalič (2020) notes, overtourism represents a situation in which "economic benefits coexist with social and environmental costs," creating tensions in policy and governance. Similarly, Koens et al. (2018) highlight that residents in overtourism-affected destinations often display "pragmatic acceptance," recognizing the economic necessity of tourism despite its pressures, residents often tolerate tourism pressures as long as perceived benefits outweigh negative impacts. However, this tolerance is not unlimited. As tourism intensity increases and negative impacts become more visible—particularly overcrowding, rising living costs, and changes in everyday life—resident attitudes may shift from acceptance to irritation or resistance. Doxey's (1975) Irridex model provides a useful framework for understanding this progression, suggesting that destinations may evolve from stages of euphoria and apathy to irritation and antagonism as tourism pressures intensify. Empirical evidence from cities such as Barcelona and Venice demonstrate that, beyond a certain threshold, residents begin to express dissatisfaction and opposition to tourism growth, particularly when they perceive that economic benefits are unevenly distributed or captured by external actors (Milano et al., 2019). In overtourism contexts, the distribution of economic benefits plays a critical role in shaping local tolerance. While tourism may generate aggregate economic gains, these are often concentrated in specific sectors (e.g., hospitality, real estate), while broader community costs such as increased living expenses, housing shortages, and loss of public space are more widely experienced (Gössling et al., 2020; Cocola-Gant, 2016). Furthermore, research highlights that resident tolerance is closely linked to governance quality and the extent to which local communities are involved in decision-making processes (Nunkoo & Ramkissoon, 2011; Mihalič, 2020). When residents feel excluded from tourism planning or perceive that policies prioritize economic growth over community well-being, trust in institutions declines and opposition to tourism increases. Conversely, participatory governance and equitable benefit distribution can enhance social acceptance and support more sustainable tourism development. Overall, the literature suggests that the relationship between overtourism, economic benefits, and community tolerance is inherently dynamic and context-dependent. While economic gains can sustain a certain level of tolerance, they do not fully offset the negative impacts associated with overtourism. Instead, resident attitudes are shaped by a complex interplay of perceived benefits, lived experiences, and governance structures. These findings underscore the importance of moving beyond purely growth-oriented tourism models toward more inclusive and balanced approaches that ensure both economic viability and social sustainability.

3. Methodology

The empirical research was conducted in Split, Croatia, a historic coastal city that represents a highly relevant and appropriate case for examining the impacts of overtourism from a local resident perspective. The selection of Split as the study area is justified by several interrelated characteristics that position it as a representative example of a Mediterranean urban destination experiencing advanced tourism pressures. First, Split is characterized by pronounced seasonality, with a substantial concentration of tourist arrivals during the summer months. Such temporal concentration of tourism flows is widely recognized in the literature as a key driver of overtourism, as it intensifies pressure on urban infrastructure, public spaces, and local

communities within a limited time frame (Peeters et al., 2018; Koens et al., 2021). This makes Split particularly suitable for analysing residents' perceptions of overcrowding, congestion, and changes in everyday life during peak periods. Second, the city exhibits a high share of private accommodation within its overall tourism supply, largely facilitated by the rapid expansion of short-term rental platforms such as Airbnb. This structural feature is especially relevant in overtourism research, as previous studies have linked the growth of private accommodation to processes of tourism-driven gentrification, rising housing costs, and the displacement of local residents from historic urban cores (Cocola-Gant, 2016; Gössling et al., 2020). In this context, Split provides an ideal setting to explore how these dynamics are perceived and experienced by the local population. Third, tourism in Split is characterized by a high level of direct involvement of the local community in tourism-related economic activities. A significant proportion of residents participate in tourism through private accommodation rentals, hospitality services, and related sectors, making tourism a key source of income at the household level. This feature is particularly important for this research, as it enables the examination of the complex relationship between perceived economic benefits and tolerance of tourism-related pressures. As suggested by Social Exchange Theory (Ap, 1992), residents who derive direct economic benefits from tourism are more likely to exhibit higher levels of support or tolerance, even in the presence of negative impacts. Finally, Split's historic core, including the UNESCO-listed Diocletian's Palace, represents a spatially constrained heritage environment where tourism pressures are concentrated within a limited area. This makes it especially suitable for analysing core overtourism impacts such as overcrowding, loss of authenticity, and changes in urban functions, which are typically most visible in historic city centres (Ashworth & Tunbridge, 1990; García-Hernández et al., 2019). Taken together, these characteristics—high seasonality, the dominance of private accommodation, strong local economic involvement in tourism, and a spatially concentrated historic core—make Split a highly appropriate and theoretically grounded case study for investigating overtourism impacts from a resident perspective. The city provides a context in which both the positive and negative dimensions of tourism are strongly pronounced, allowing for a nuanced analysis of how local communities perceive and respond to overtourism pressures.

3.1. Research Design and Instrument

The study primarily adopts a quantitative research design based on a structured survey questionnaire, complemented by a single open-ended question that provides limited qualitative insight. The questionnaire items were developed based on an extensive review of the overtourism literature and key frameworks proposed by UNWTO (2018) and Koens et al. (2018). Items were selected to reflect core dimensions of overtourism, including overcrowding, socio-cultural impacts, and economic effects. Furthermore, the questionnaire was adapted to the specific research context—a historic city characterized by high tourism seasonality and strong local involvement in tourism-related activities—in order to ensure contextual relevance and improve the validity of the findings.

The questionnaire consisted of a combination of closed-ended and open-ended questions, enabling the collection of both numerical data suitable for statistical analysis and qualitative insights that provide a deeper understanding of respondents' attitudes and experiences. Closed-ended questions were formulated using a five-point Likert scale, allowing standardized measurement of variables and comparability of responses across respondents. Response categories ranged from 1 ("strongly disagree") to 5 ("strongly agree"). Data were subjected to parametric descriptive and composite statistical analysis, including calculation of means, standard deviations, and index values. An open-ended question was included to allow

respondents to freely express their opinions, attitudes, and suggestions, with the aim of complementing quantitative findings with qualitative data. This question focused on residents' views regarding necessary measures to address the problem of overtourism in historic cities. Responses to the open-ended question were analysed using qualitative content analysis. Following inductive coding, codes were grouped into thematic categories, and their frequencies were subsequently analysed quantitatively. This approach enables a more comprehensive understanding of the research problem by integrating numerical analysis with contextual interpretation. Prior to the main data collection, the questionnaire was reviewed for clarity and content validity by subject experts and informally pre-tested on a small group of respondents ($n \approx 10–15$), leading to minor adjustments in wording and structure.

3.2. Sample and Data Collection

The research was conducted on a sample of 271 respondents. Participants were recruited using purposive sampling to ensure the inclusion of individuals with relevant knowledge and experience. Inclusion criteria required respondents to be residents of the historic core of the city of Split, Croatia. Sample selection was aligned with the research objectives, and participation was voluntary and anonymous. Data collection took place during July and August 2025. Surveys were administered using computer-assisted personal interviewing (CAPI), whereby interviewers recorded respondents' answers directly into tablets. This approach ensured accuracy of data entry and reduced the likelihood of missing responses. The resulting dataset provides a reliable basis for analysing the studied phenomenon and for drawing conclusions and recommendations consistent with the research objectives.

4. Results and Discussion

The socio-demographic structure of the sample reflects key characteristics relevant to the research context, although it is not statistically representative in a strict probabilistic sense. The sample is predominantly female (83.8%), which aligns with common patterns in online survey research where women tend to participate more frequently. In terms of age, respondents are mainly within the working-age population, with the largest groups aged 18–29 (39.5%) and 30–44 (34.3%), followed by 45–59 (19.9%) and 60+ (6.3%), reflecting the digital distribution of the survey. The majority of respondents are permanently employed (64.2%), while students (13.3%), seasonal workers (9.2%), unemployed individuals (7.0%), and retirees (6.3%) are also represented. This structure is particularly relevant in the context of a tourism-dependent destination such as Split, as it captures perspectives of residents who are actively engaged in the local economy and most directly exposed to tourism impacts. Therefore, despite certain limitations, the sample can be considered analytically appropriate for examining residents' perceptions of overtourism.

4.1. Descriptive Analysis of Residents' Attitudes

This section presents a descriptive overview of residents' attitudes toward the key impacts of overtourism in the study area. The analysis focuses on central tendencies and variability of responses to Likert-scale items, enabling the identification of dominant perception patterns across core dimensions such as overcrowding, authenticity, quality of life, and economic effects. By examining these indicators, the section provides an empirical basis for understanding how residents perceive both the negative and positive consequences of tourism development.

Table 1: The arithmetic means and standard deviations of surveyed attitudes among local residents

Statement	M	SD	Interpretation
The city is overcrowded during the tourist season	4,18	1,10	Very high level of agreement
Overcrowding affects visitor satisfaction	4,16	1,07	Very high level of agreement
Cruise tourism increases overcrowding	3,98	1,12	High level of agreement
The authenticity of the historic city core has been compromised	3,69	1,21	Moderately high level of agreement
Tourism has a negative impact on cultural heritage	2,94	0,89	Neutral
Tourism has a negative impact on quality of life	2,88	0,93	Neutral
Tourism leads to changes in everyday life patterns	4,27	1,03	Very high level of agreement
Tourism leads to an increase in living costs	4,63	0,78	Extremely high level of agreement
Tourism provides economic benefits for local residents	4,17	0,97	High level of agreement
Tourism has a positive impact on the local economy	3,69	1,04	Moderate level of agreement

Source: Authors

The empirical results confirm the core assumptions of overtourism theory, which posits that excessive concentration of tourism activities leads to the exceedance of a destination's carrying capacity, particularly in historic cities characterized by limited spatial, infrastructural, and social resources (UNWTO, 2018). High mean values recorded for statements related to city overcrowding during the tourist season and its impact on visitor satisfaction suggest that the perceived social and spatial carrying capacity of the destination may be under significant pressure. This results in reduced quality of experience for both residents and visitors. The extremely high level of agreement with the statement concerning increased living costs confirms the presence of processes described by Milano (2019) through the concept of tourism gentrification. According to this perspective, intensive tourism development drives housing price increases, commercialization of space, and displacement of local functions, gradually reshaping urban space to meet visitors' needs rather than those of residents. The findings suggest that respondents perceive the economic consequences of overtourism as among its most direct and tangible effects. Very high agreement with statements regarding changes in everyday life patterns can be further interpreted in light of Doxey's Irridex, which describes the evolution of residents' attitudes toward tourism development. The results indicate a phase in which tourism significantly affects daily routines and behavioural patterns, consistent with a transition from apathy to irritation—characteristic of destinations exposed to prolonged pressure from mass tourism. High agreement with the statement that cruise tourism contributes to overcrowding can be interpreted through the concept of spatial-temporal concentration of visitors, identified by Koens, Postma, and Papp (2018) as one of the key mechanisms underlying overtourism. According to this approach, the issue is not necessarily the total number of tourists, but rather their simultaneous presence in limited spaces, particularly within historic cores, where intense pressure is placed on infrastructure, public spaces, and local functions. Moderately high agreement with the statement regarding the loss of authenticity of the historic core can be interpreted within the framework proposed by Milano (2019), who emphasizes cultural commodification as a key socio-cultural consequence of overtourism. According to this concept, local identity and heritage are gradually transformed into marketable products, reducing their original social and cultural functions. Although respondents do not

perceive this aspect as intensely as economic impacts, the results suggest the presence of early stages of such transformations. Neutral mean values recorded for statements concerning negative impacts on cultural heritage and quality of life can be linked to Butler's Tourism Area Life Cycle (TALC) model. According to Butler (1980), negative socio-cultural and heritage impacts tend to become more pronounced in later stages of destination development, after capacities have been under sustained pressure over time. The findings suggest that in the observed destination, perceived overtourism impacts are currently manifested primarily through economic and functional aspects, while longer-term effects are only gradually becoming apparent. At the same time, relatively high agreement with statements regarding the economic benefits of tourism confirms what Koens, Postma, and Papp (2018) describe as the overtourism paradox, whereby tourism simultaneously generates economic benefits and social costs. This paradox complicates the implementation of restrictive management measures, as tourism continues to be perceived as a key economic sector despite its growing negative impacts.

Overall, the results indicate a state that can be described as selectively perceived overtourism, consistent with the UNWTO approach emphasizing the need for timely visitor management before destinations enter a phase of structural degradation. The findings are consistent with previous empirical studies conducted in historic urban destinations. For example, Koens et al. (2018) and Peeters et al. (2018) similarly identify overcrowding as the most visible and widely perceived manifestation of overtourism, particularly in spatially constrained city centres. The strong perception of rising living costs observed in this study aligns with findings by Cocola-Gant (2016) and Gössling et al. (2020), who link tourism growth to housing pressure and urban restructuring. Furthermore, the coexistence of economic benefits and social costs confirms results reported by Milano et al. (2019), highlighting the ambivalent relationship between residents and tourism development in overtourism contexts.

4.1.1. Distribution of Responses and Thematic Indices

Analysis of response distributions revealed polarization in respondents' attitudes. Statements related to overcrowding and rising living costs exhibited strongly right-skewed distributions, higher agreement levels for statements related to overcrowding and living costs, while statements concerning cultural heritage and quality of life showed concentrations around the neutral category. This pattern suggests latent uncertainty or adaptation of residents to the long-term presence of tourism.

To provide a more comprehensive analysis of residents' perceptions, thematic indices were constructed by grouping conceptually related statements in line with theoretical dimensions of overtourism. Index values were calculated as arithmetic means of the corresponding variables, with higher index values indicating stronger expression of the observed dimension.

Overtourism Perception Index (OPI)
The Overtourism Perception Index (OPI) includes statements related to:

- city overcrowding,
- the impact of overcrowding on visitor satisfaction,
- the contribution of cruise tourism to overcrowding,
- loss of authenticity of the historic core.

The OPI value is 4.00, indicating a high level of perceived overtourism. This result suggests that residents of Split, on average, perceive the city as a destination exposed to significant spatial and functional tourism pressures, particularly in the context of seasonal concentration

and cruise tourism. This perception aligns with theoretical approaches identifying overcrowding and loss of authenticity as fundamental indicators of overtourism in historic cities (UNWTO, 2018; Milano, 2019).

Tourism Social Pressure Index (TSPI)

The Tourism Social Pressure Index (TSPI) includes statements related to:

- changes in everyday life patterns,
- increased living costs,
- negative impacts on quality of life.

The calculated TSPI value is 3.93, indicating a high level of perceived social pressure from tourism. The results suggest that negative tourism impacts are most strongly manifested through economic aspects of everyday life and the adaptation of residents' daily routines. These findings are consistent with literature emphasizing that changes in living costs and everyday practices are among the earliest and most visible social consequences of overtourism (Koens et al., 2018; Milano, 2019).

Tourism Economic Perception Index (TEPI)

The Tourism Economic Perception Index (TEPI) was constructed based on statements related to:

- perceived economic benefits for local residents,
- positive impacts of tourism on the local economy.

The TEPI value of 3.93 indicates a relatively high level of positive economic perception of tourism. This finding confirms that residents continue to perceive tourism as an important economic resource, despite simultaneously recognizing its negative social and spatial impacts. Comparative analysis of thematic indices shows that overtourism perception (OPI = 4.00) is slightly more pronounced than social pressure (TSPI = 3.93) and economic perceptions of tourism (TEPI = 3.93). This pattern indicates the simultaneous presence of strong negative and positive perceptions of tourism among local residents.

These results confirm the theoretical assumption of an ambivalent relationship between local residents and tourism, whereby economic benefits are perceived alongside increasing social and spatial costs (Butler, 1980; Koens et al., 2018). Within overtourism theory, such ambivalence is often interpreted as indicative of a phase in which destinations still derive significant economic benefits while experiencing growing dissatisfaction related to declining quality of everyday life and urban space.

The empirical findings are presented in relation to the research questions, allowing for a systematic examination of how the collected data addresses the study's key objectives.

RQ1: How do residents perceive overtourism in the historic core of Split?

The findings clearly indicate that residents strongly perceive the presence of overtourism, particularly through pronounced overcrowding during the tourist season and rising living costs. This is empirically confirmed by the high value of the Overtourism Perception Index (OPI = 4.00), as well as high mean scores for statements related to congestion, cruise tourism pressure, and changes in everyday life patterns.

These results suggest that overtourism is not only objectively present but also highly visible and widely recognized by the local population, supporting the interpretation that the perceived social and spatial carrying capacity of the destination may be under significant pressure.

RQ2: What dimensions shape residents' perceptions of overtourism?

The results demonstrate that residents' perceptions are clearly multidimensional, structured around three key dimensions identified through thematic indices:

- Spatial-functional pressure (OPI): dominated by overcrowding and congestion
- Social pressure (TSPI = 3.93): reflected in rising living costs and changes in everyday life
- Economic perception (TEPI = 3.93): linked to recognized economic benefits of tourism

Additionally, the findings show that not all dimensions are perceived equally. Economic and functional impacts are more strongly expressed, while impacts on cultural heritage and quality of life remain more moderate.

This confirms that overtourism perception is not a single construct, but a composite of interrelated dimensions, which represents a key contribution of the study.

RQ3: How do residents balance perceived economic benefits with social and spatial costs of tourism?

The results reveal a pronounced ambivalence in residents' attitudes, where strong recognition of tourism's economic benefits coexists with increasing dissatisfaction related to its negative impacts.

High values of the Tourism Economic Perception Index (TEPI = 3.93**)** indicate that residents acknowledge tourism as an important economic resource. At the same time, similarly high levels of perceived social pressure (TSPI = 3.93) and overtourism intensity (OPI = 4.00) highlight significant concerns regarding overcrowding, cost of living, and everyday life disruptions.

This coexistence of positive and negative perceptions reflects the "overtourism paradox**"**, where economic dependence on tourism moderates resistance despite growing social and spatial costs. The findings therefore confirm that residents do not evaluate tourism unidimensional, but rather through a trade-off between benefits and burdens.

5. Conclusion

The results of this study confirm that residents of the historic core of Split clearly perceive the presence of overtourism, particularly through pronounced overcrowding during the tourist season, rising living costs, and changes in everyday life patterns. High values of the Overtourism Perception Index and the Tourism Social Pressure Index indicate a situation in which the spatial and social carrying capacities of the destination may be under significant pressure, in line with the theoretical frameworks proposed by UNWTO (2018), Milano, Cheer, and Novelli (2019), and Koens et al. (2018). At the same time, the findings highlight the paradoxical nature of overtourism, as local residents continue to recognize tourism as an important source of economic benefits despite strongly expressed negative impacts. This ambivalence supports theoretical models suggesting that economic dependence on tourism often mitigates or delays stronger social reactions to its negative consequences, while simultaneously increasing the long-term risk of loss of authenticity and erosion of social cohesion.

The results further indicate that the negative effects of overtourism currently manifest most clearly through economic and functional aspects of everyday life, whereas perceptions of direct impacts on cultural heritage and overall quality of life remain more moderate. This suggests that the destination may be in a phase where longer-term socio-cultural consequences are still emerging, which further underscores the importance of timely and proactive management interventions.

The scientific contribution of this study lies in providing empirical evidence on the perception of overtourism from the perspective of local residents in a historic city, thereby complementing theoretical overtourism models that often remain at a conceptual level. The paper contributes

to the literature on sustainable tourism in the Croatian and broader Mediterranean context and confirms the relevance of a multidimensional approach in analysing overcrowding, gentrification, and loss of authenticity. From a practical perspective, the findings offer a valuable foundation for the formulation of local tourism policies, particularly in the areas of visitor management, regulation of cruise tourism, and control of short-term rentals, alongside more active involvement of the local community in decision-making processes. Based on the findings, several practical policy implications can be proposed. First, the implementation of visitor management measures, such as limiting cruise ship arrivals and introducing time-based entry controls in the historic core, could reduce peak-time congestion. Second, stricter regulation of short-term rentals is necessary to mitigate housing pressure and rising living costs. Third, diversification of tourism activities beyond the historic core and promotion of off-season tourism could help redistribute visitor flows. Finally, greater involvement of local residents in decision-making processes is essential to enhance social acceptance and ensure that tourism development aligns with community needs.

Despite its contributions, the study has certain limitations. First, it was conducted in a single destination, which limits the generalizability of the findings to other historic cities. Second, the study relied on a quantitative survey method which, while enabling analysis of a larger sample, does not provide deeper insight into individual experiences and resident narratives. In addition, the findings are based on respondents' perceptions, which may be influenced by seasonal conditions and individual economic interests. Future research should therefore focus on comparative analyses of multiple historic cities to identify similarities and differences in overtourism perceptions across different spatial and institutional contexts. The application of mixed-methods approaches, combining quantitative surveys with in-depth interviews and focus groups, is also recommended to achieve a more comprehensive understanding of residents' experiences. The constructed indices (OPI, TSPI, TEPI) were based on theoretically grounded grouping of variables; however, their internal consistency and dimensional validity were not formally tested using reliability analysis (e.g., Cronbach's alpha) or exploratory factor analysis. Therefore, the indices should be interpreted as indicative composite measures rather than fully validated scales. Future research should apply factor analysis and reliability testing to confirm the robustness of these constructs. Furthermore, longitudinal studies tracking residents' attitudes over longer periods—particularly in relation to the implementation of new management measures—would be valuable for assessing their effectiveness. Special attention in future research should be devoted to the relationship between economic dependence on tourism and residents' willingness to accept restrictive measures, as this represents a key issue for the sustainable development of historic cities.

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A scientific paper

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SMALL MARKETS, LONG MEMORIES: VOLATILITY, LIQUIDITY, AND PRICE DISCOVERY IN SOUTHEAST EUROPE

ABSTRACT

This paper examines how liquidity frictions influence stock market volatility dynamics in small equity markets, with particular attention to delayed price discovery. Conventional interpretations of volatility assume continuous price adjustment, an assumption often violated in thinly traded markets where prices update infrequently. In such settings, observed volatility may reflect not only underlying economic uncertainty but also the timing of information incorporation into prices. Using a regional sample from Southeast Europe, the paper investigates whether liquidity, proxied by price staleness in index data, systematically affects conditional volatility and whether these effects differ across markets with varying liquidity conditions.

The empirical analysis focuses on four benchmark equity indices: SASX-10 and BIRS from Bosnia and Herzegovina, CROBEX from Croatia, and BELEX15 from Serbia. Volatility is modeled using GARCH-type specifications with Student-t innovations to account for heavy-tailed return distributions. Liquidity enters the conditional variance equation through price-based proxies derived from index values, including exact price staleness and strict near-zero return indicators. Robustness is assessed using alternative liquidity definitions and IGARCH-based stress tests.

The results reveal clear cross-market asymmetries. In Croatia and Serbia, volatility dynamics are primarily driven by standard persistence and shock transmission mechanisms, while liquidity proxies have no statistically significant effect. In contrast, both stock markets in Bosnia and Herzegovina display strong, negative, and robust liquidity effects, indicating that volatility is dampened during periods of non-trading and realized in clusters once price discovery resumes. These findings suggest that volatility in small markets reflects a joint outcome of risk and price discovery, with important implications for cross-market comparability and risk assessment.

Key words: *volatility, liquidity, price discovery, GARCH, emerging markets.*

1. Introduction

Volatility plays a central role in financial economics. It is widely used as a measure of risk, uncertainty, and market efficiency, and it underpins empirical work in asset pricing, portfolio allocation, risk management, and financial regulation. A large body of empirical research has documented that financial return volatility is time-varying, highly persistent, and clustered,

motivating the widespread use of conditional heteroskedasticity models since the seminal contributions of Engle (1982) and Bollerslev (1986). Despite their empirical success, standard volatility models typically rely on the implicit assumption that prices adjust continuously and that observed returns fully reflect the arrival of new information.

This assumption may be problematic in small and thinly traded markets. In such environments, trading activity can be sporadic, prices may remain unchanged for extended periods, and information can accumulate without being immediately incorporated into prices. As a result, observed volatility may reflect not only changes in underlying economic uncertainty but also the timing and frequency of price discovery. In this context, price discovery refers to the incorporation of information into daily index values, rather than to high-frequency trading processes. Previous research on emerging and frontier markets has emphasised that market microstructure features such as liquidity and trading intensity can shape volatility dynamics (Amihud, 2002; Bekaert, Harvey and Lundblad, 2007; Milunovich and Minović, 2014), yet these factors are often omitted from empirical models due to data limitations (Lesmond, 2005).

This paper examines the interaction between liquidity and volatility in a regional setting where such frictions are particularly relevant. Focusing on four stock market indices from Southeast Europe, SASX-10 and BIRS from Bosnia and Herzegovina, CROBEX from Croatia, and BELEX15 from Serbia, the analysis exploits substantial cross-market heterogeneity in liquidity conditions while maintaining exposure to broadly similar regional and global shocks. Earlier empirical work documents high volatility persistence and pronounced non-normality in these markets, with indices from Bosnia and Herzegovina in particular characterized by thinner trading conditions relative to regional peers (Hečimović, 2016; Planinić, 2022).

Methodologically, the paper extends standard GARCH-type volatility models by allowing liquidity to enter directly into the conditional variance equation. Rather than treating volatility as a purely autoregressive process, this approach recognizes that market microstructure conditions can shift the level and dynamics of conditional variance. Liquidity is proxied using price-based measures of staleness derived from index-level data, following established approaches in the literature on non-trading and illiquidity in data-constrained markets (Lesmond et al., 1999).

The empirical analysis yields a clear cross-market asymmetry. In more liquid settings, volatility dynamics are dominated by standard persistence and shock propagation mechanisms, whereas in the stock markets of Bosnia and Herzegovina liquidity effects are economically and statistically meaningful, consistent with delayed price adjustment and episodic price discovery. These patterns become especially informative during the COVID-19 period, which provides a common stress episode across markets with markedly different liquidity structures.

Although the paper does not estimate formal long-memory volatility models, the findings point to long-memory-like behavior in an applied sense, arising from extreme persistence interacting with delayed price adjustment in illiquid markets. In this interpretation, near-integrated GARCH persistence coupled with illiquidity yields behavior that resembles long memory in practice even though the underlying process is modeled using standard GARCH specifications.

To guide the empirical analysis, we formulate a set of testable hypotheses on the relationship between liquidity and volatility in small equity markets:

H1: Price staleness is associated with lower measured conditional volatility in markets where non-trading is a persistent structural characteristic.
H2: The impact of liquidity on volatility is heterogeneous across markets and diminishes with increasing market liquidity.
H3: Volatility in illiquid markets exhibits near-integrated persistence reflecting delayed price adjustment, rather than purely economic risk dynamics.

The contribution of the paper is threefold. First, it provides evidence that liquidity frictions can materially shape volatility dynamics in small stock markets, even when only index-level data are available. Second, it highlights the distinction between observed and latent volatility, emphasizing that low measured volatility in illiquid markets does not necessarily imply low risk. Third, it offers a comparative regional perspective that clarifies how similar volatility models can yield different economic interpretations once liquidity and price discovery are taken into account.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the data. Section 4 outlines the methodology. Section 5 presents the empirical results for each market and robustness analysis. Section 6 provides a cross-market comparison. Section 7 concludes.

2. Literature Review

The econometric foundation of this paper lies in the literature on conditional heteroskedasticity, initiated by Engle's (1982) ARCH model and extended by Bollerslev's (1986) GARCH framework. These models have become the standard empirical tools for capturing volatility clustering and persistence in financial returns. Subsequent contributions have emphasized that financial return distributions exhibit excess kurtosis and heavy tails, motivating the use of non-Gaussian innovations in volatility models (Bollerslev, 1987; Baillie and Bollerslev, 1989). Hansen (1994) formalizes the use of the Student-t distribution in GARCH models and demonstrates its empirical relevance, particularly in environments characterized by extreme observations.

A substantial applied literature employs GARCH-type models to study volatility dynamics in emerging and small equity markets, where persistence is often pronounced and shocks decay slowly. Baillie, Bollerslev, and Mikkelsen (1996) show that volatility processes in financial markets can display very slow mean reversion, a result that has been widely documented in applied studies even when formal long-memory models are not estimated. This insight is particularly relevant for small markets, where structural frictions can reinforce persistence.
Within the context of Southeast Europe, earlier empirical work documents that stock market volatility is well described by GARCH-type processes but differs substantially across countries. Hečimović (2016) estimates symmetric/asymmetric GARCH for SASX-10 and BIRS, finding SASX-10 more volatile, low regional synchronization, high persistence, non-normality, and thinner BiH trading relative to peers. Planinić (2022) confirms high persistence and shock sensitivity for SASX-10/BIRS. For neighboring markets, Minović (2010) uses MGARCH for BELEX15, documenting time-varying conditional variances/covariances, while Erjavec and Cota (2007) model CROBEX volatility with GARCH(1,1), finding significant European spillovers (DAX/FTSE) but limited US influence. These findings establish a regional benchmark for interpreting volatility behavior and motivate a comparative approach.

While these papers confirm GARCH suitability for the region, none explicitly model liquidity or delayed price discovery, leaving open how thin trading conditions interact with volatility dynamics. When transaction-level data are unavailable, liquidity is often proxied using price-based measures derived from return behavior. Lesmond, Ogden, and Trzcinka (1999) propose the zero-return measure as an indirect indicator of illiquidity, based on the idea that non-trading and high transaction costs can suppress price movements. This approach has been widely used in empirical studies of emerging and frontier markets and is particularly suitable for environments characterized by infrequent trading.

More recent contributions highlight the importance of crisis episodes for understanding volatility behavior in emerging markets. Jakšić et al. (2025) analyze stock market volatility in Croatia and Serbia before and during the COVID-19 period and show that volatility dynamics differ across regimes, with the pandemic period exhibiting distinct patterns. Although their focus is on macroeconomic determinants rather than microstructure-based liquidity measures, their findings reinforce the view that stress episodes can reveal structural differences in volatility dynamics across markets.

Taken together, the literature motivates the present study along three dimensions. First, GARCH-type models with heavy-tailed innovations are empirically appropriate for modeling volatility in Southeast European equity markets. Second, liquidity and trading frictions are likely to influence volatility dynamics in small markets and can be proxied using price-based measures when richer data are unavailable. Third, crisis periods such as COVID provide informative stress tests in which the interaction between volatility, liquidity, and price discovery becomes more pronounced.

3. Data

The empirical analysis is based on daily stock market index data obtained directly from official representatives of the respective stock exchanges. Using data supplied by the exchanges themselves ensures consistency with officially reported index values and avoids reliance on secondary data providers.

The sample comprises four major stock market indices from Southeast Europe: SASX-10 and BIRS from Bosnia and Herzegovina, CROBEX from Croatia, and BELEX15 from Serbia. These indices differ in market size, trading frequency, and liquidity conditions, which allows the analysis to exploit cross-market heterogeneity in order to examine how volatility dynamics vary across liquidity regimes. Sample periods vary across indices due to differences in index inception dates.

Daily returns are constructed as log differences of daily closing index values and are expressed in percentage terms. The analysis is conducted at the daily frequency, which provides a balance between capturing volatility dynamics and accommodating the data limitations typical of small and thinly traded markets.

The analysis relies exclusively on index-level data. Information on trading volume, bid–ask spreads, or order book depth is not consistently available across markets and over the full sample period. While this limits the range of liquidity measures that can be considered, it reflects the practical constraints faced by researchers studying small equity markets and underscores the relevance of price-based liquidity proxies in such settings.

Table 1 presents summary statistics for the four index series over their respective sample periods. Return distributions exhibit pronounced excess kurtosis across all markets, motivating the use of Student-t innovations.

Table 1: Summary Statistics

Metric/ Exchange	SASX-10	BIRS	BELEX15	CROBEX
Start date	2004-12-29	2004-05-17	2005-10-04	1997-09-04
End date	2026-02-04	2026-02-03	2025-12-30	2026-01-30
Trading days	5,205	5,384	5,091	6,996
Mean return (%)	0.0080	0.0042	0.0048	0.0179
Std dev (%)	1.1165	1.0421	1.0585	1.3432
Skewness	0.43	3.40	0.02	-0.23
Excess kurtosis	11.09	93.80	20.60	28.53
Zero-return days (%)	6.83	14.91	0.49	0.16
Near-zero proxy (%)	7.77	15.77	1.49	1.16

Source: Authors

4. Methodology

4.1. Model specification

Let r_t denote the daily log return of a stock market index expressed in percentage terms. The return-generating process is specified as:

$$r_t = \mu + \varepsilon_t$$

where μ is a constant mean and ε_t is the error term. The error term is decomposed as:

$$\varepsilon_t = \sqrt{h_t} z_t$$

where h_t denotes the conditional variance and z_t is an independent and identically distributed innovation with zero mean and unit variance. Throughout the paper, h_t denotes the conditional variance, while volatility refers to its square root. To accommodate heavy tails, $z_t$is assumed to follow a standardized Student-t distribution with $\nu > 2$ degrees of freedom.

The conditional variance is modeled using a GARCH(1,1) specification augmented with a liquidity proxy:

$$h_t = \omega + \alpha \cdot \varepsilon_{\{t-1\}}^2 + \beta \cdot h_{\{t-1\}} + \gamma \cdot L_{\{t-1\}}$$

where $\omega > 0$, $\alpha \geq 0$, $\beta \geq 0$, and $\alpha + \beta < 1$ ensure positivity and covariance stationarity of the variance process. $L_{\{t-1\}}$ denotes a predetermined liquidity indicator capturing price staleness or extremely limited price movement, and γ measures the marginal effect of liquidity on conditional variance.

4.2. Liquidity proxies

Liquidity is proxied using price-based indicators constructed from index-level data. The baseline proxy is a price staleness indicator that equals one when the index value remains unchanged relative to the previous trading day and zero otherwise. This measure captures periods of non-trading or extremely limited trading activity at the index level and reflects delayed price adjustment in markets with low liquidity.

As a robustness measure, an alternative liquidity proxy is defined based on extremely small returns. Specifically, an indicator variable equals one when the absolute daily return falls below the first percentile of non-zero absolute returns for each index series. This proxy captures days with very limited price movement while allowing for minimal index updates and provides a broader measure of delayed price adjustment.

It is important to emphasize that these liquidity proxies are reduced-form, price-based indicators rather than exogenous structural measures of market frictions. Days with stale or near-zero returns may themselves be influenced by underlying volatility and information flows. In particular, very small returns may reflect periods of genuinely low volatility rather than illiquidity, making it difficult to fully disentangle trading frictions from subdued market conditions. As a result, the estimated coefficient on the liquidity term, γ, should be interpreted as capturing the joint outcome of trading behavior and volatility, rather than a one-way causal effect of liquidity on risk.

4.3. Robustness checks

Two robustness checks are conducted to assess the sensitivity of the results. First, all models are re-estimated using the alternative near-zero return liquidity proxy to ensure that the findings are not driven by the mechanical repetition of index values. Second, an integrated volatility specification is considered by imposing the restriction $\alpha + \beta = 1$. These IGARCH specifications serve as stress tests to verify that the estimated liquidity effects are not sensitive to the assumption of covariance stationarity.

5. Empirical Results

5.1. SASX-10

This section reports the empirical results for the SASX-10 index, the main benchmark of the Sarajevo Stock Exchange and one of the two indices representing stock markets in Bosnia and Herzegovina. The SASX-10 is characterized by low trading frequency and recurrent price staleness, which makes it particularly suitable for examining how liquidity frictions and delayed price discovery shape observed volatility dynamics in small markets.

The baseline GARCH(1,1) model with Student-t innovations reveals extremely high volatility persistence in SASX-10 returns. Both the ARCH and GARCH coefficients are statistically significant, and their sum is equal to 0.9998, indicating that volatility shocks decay only very slowly over time. This degree of persistence implies that volatility innovations have long-lasting effects on conditional variance and that short-run shocks can influence risk dynamics far into the future.

The estimated mean return is small and not statistically significant, which is consistent with standard findings for daily stock index returns and confirms that the dynamics of interest in this market operate primarily through the conditional variance rather than the mean process.
The estimated degrees-of-freedom parameter of the Student-t distribution is low and statistically significant, confirming pronounced excess kurtosis in SASX-10 returns. Extreme price movements therefore occur more frequently than would be implied by a Gaussian distribution, reinforcing the relevance of a heavy-tailed specification for modeling conditional volatility in this market.

5.1.1. Liquidity, non-trading, and conditional variance

Price staleness is a systematic feature of the SASX-10. Under the baseline liquidity definition, the index exhibits exact price staleness on 6.83 percent of trading days, indicating frequent periods of non-trading or extremely limited trading activity at the index level. When the alternative near-zero log return proxy is applied, the share of such days increases to 7.77 percent, suggesting that delayed price adjustment extends beyond strictly unchanged prices to days with minimal index movement. These frequencies confirm that illiquidity is not episodic but a persistent structural characteristic of the market.

When the liquidity proxy is included in the conditional variance equation, the estimated liquidity coefficient is negative and statistically significant. This result implies that periods following non-trading or near-non-trading days are associated with lower measured conditional volatility, after controlling for past volatility and past return shocks.

The negative liquidity coefficient does not imply that illiquidity reduces economic risk. It reflects volatility suppression during periods of delayed price adjustment: when trading is limited, prices fail to incorporate new information, compressing observed returns and understating volatility. Risk accumulates off-price and is released in clustered return realizations when trading resumes. The estimated liquidity effect therefore captures the timing of volatility realization and price discovery, not a reduction in underlying uncertainty.
Although the model does not include an explicit COVID indicator, the estimated conditional variance series shows elevated volatility during the COVID period. In the SASX-10, this increase is uneven and clustered rather than smooth. This pattern is consistent with the interaction between heightened uncertainty and limited trading activity, whereby shocks are incorporated into prices episodically rather than continuously. The COVID period therefore acts as a stress episode that amplifies both uncertainty and liquidity frictions, reinforcing delayed price discovery.

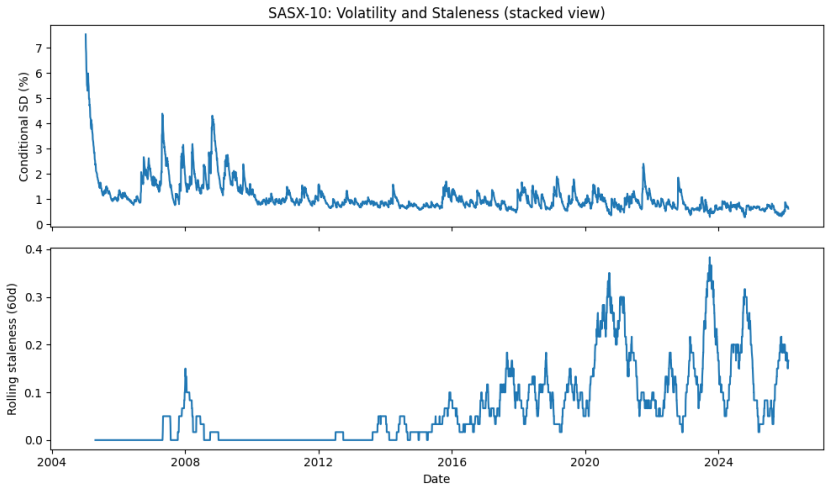
Robustness checks using the alternative near-zero log return liquidity proxy yield qualitatively identical results. The liquidity coefficient remains negative and statistically significant, with a magnitude comparable to that obtained under the exact staleness definition. Additional robustness checks based on an IGARCH specification, which constrains volatility persistence to unity, do not alter the qualitative conclusions.

In some specifications, the numerical optimizer reports that strict convergence criteria are not fully satisfied under the BFGS algorithm. This outcome is not uncommon in GARCH models with near-unit volatility persistence and heavy-tailed innovations. Importantly, parameter estimates are stable across alternative starting values and specifications, and the qualitative results are unchanged. The convergence flag therefore reflects numerical flatness of the likelihood surface rather than model misspecification or substantive instability of the estimates.

5.1.2. Graphical evidence and interpretation

Figure 1 presents a stacked representation of the estimated conditional volatility and the price staleness indicator for the SASX-10. The figure visually reinforces the econometric findings by showing that periods of low measured volatility coincide with clusters of non-trading or near-non-trading days, while volatility spikes tend to occur when prices update. This pattern provides direct graphical evidence of volatility suppression during stale-price periods and volatility release when price discovery resumes.

Figure 1: Conditional volatility and price staleness indicator for the SASX-10. Clusters of stale-price days coincide with periods of suppressed volatility, followed by sharp volatility releases when prices resume updating



Source: Authors

The SASX-10 results provide strong evidence that liquidity frictions play a central role in shaping observed volatility dynamics in the stock market of Bosnia and Herzegovina. A non-negligible share of trading days exhibits no or minimal price movement, volatility persistence is extreme, and return distributions are heavy-tailed. Volatility in this market therefore reflects not only changes in uncertainty but also the timing of price discovery.

Periods of apparent calm, characterized by price staleness, may conceal substantial latent risk, while volatility is realized in clusters when prices adjust. Ignoring liquidity and delayed price adjustment would therefore lead to a distorted interpretation of risk dynamics in the SASX-10, particularly during stress episodes.

5.2. BIRS

This section presents the empirical results for the BIRS index, the benchmark index of the Banja Luka Stock Exchange and the second index representing stock markets in Bosnia and Herzegovina. The BIRS is characterized by low trading frequency and pronounced price staleness, making it a particularly informative case for examining how liquidity constraints and delayed price discovery affect volatility dynamics in small markets.

Estimation results from the baseline GARCH(1,1) model with Student-t innovations indicate extremely persistent volatility dynamics in BIRS returns. Both the ARCH and GARCH coefficients are statistically significant, and their sum is approximately 0.9985, implying that

volatility shocks decay very slowly over time. This level of persistence indicates long-lasting effects of volatility innovations and pronounced clustering of conditional variance.
The estimated mean return is small and statistically insignificant, consistent with standard findings for daily stock index returns and confirming that the dynamics of interest operate almost entirely through the conditional variance rather than the mean process.

The Student-t specification is strongly supported by the data. The estimated degrees-of-freedom parameter is $\nu \approx 2.33$ and highly statistically significant, indicating extremely heavy-tailed return behavior. This implies a high frequency of extreme return realizations and substantial tail risk, even by emerging market standards.

5.2.1. Liquidity, non-trading, and conditional variance

When liquidity is explicitly incorporated into the conditional variance equation, the estimated liquidity coefficient is negative and highly statistically significant. The magnitude and sign of the coefficient are remarkably stable across alternative liquidity definitions, providing strong evidence of a robust liquidity effect.

The negative liquidity coefficient reflects a volatility suppression mechanism during periods of limited trading activity. On days characterized by non-trading or minimal price movement, observed returns are mechanically compressed, leading to lower measured volatility. Risk does not dissipate during these periods but accumulates off-price. When trading resumes and prices update, accumulated information is incorporated into prices, resulting in sharp increases in observed volatility.

This mechanism implies that volatility in the BIRS reflects not only changes in economic uncertainty but also the timing of price discovery. The strong and statistically significant liquidity effect indicates that delayed price adjustment is a central feature shaping volatility dynamics in this market.

The estimated conditional variance series shows a pronounced increase in volatility during the COVID period. In the BIRS, this increase is highly clustered rather than smooth, reflecting the interaction between heightened uncertainty and severe liquidity constraints. Volatility rises sharply when prices adjust, followed by periods of apparent calm associated with limited trading activity.

This pattern underscores the role of liquidity frictions in amplifying volatility during stress episodes and highlights the vulnerability of thin markets to episodic volatility release.
Robustness checks using alternative liquidity definitions yield qualitatively identical results. The liquidity coefficient remains negative, statistically significant, and economically large, while volatility persistence and tail behavior are stable across specifications.

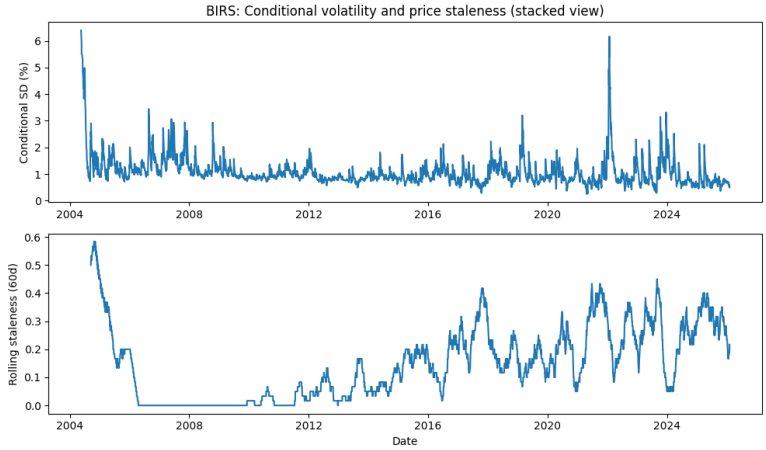
All estimated models converge cleanly under standard numerical optimization routines, and parameter estimates are stable across alternative starting values. These results reinforce confidence in the empirical findings and their interpretation.

5.2.2. Graphical evidence and interpretation

Figure 2 presents a stacked representation of the estimated conditional volatility and the price staleness indicator for the BIRS. The figure shows a strong alignment between periods of low

measured volatility and clusters of non-trading or near-non-trading days, followed by sharp volatility spikes when prices update. This visual evidence provides direct support for the volatility suppression and release mechanism identified econometrically.

Figure 2: Conditional volatility and price staleness indicator for the BIRS. Strong alignment between non-trading clusters and low measured volatility, with episodic spikes when prices adjust, consistent with the most pronounced liquidity effect in the sample



Source: Authors

The BIRS results provide some of the clearest evidence in the paper that liquidity frictions and delayed price discovery play a decisive role in shaping volatility dynamics. Volatility is extremely persistent, return distributions are very heavy-tailed, and liquidity effects are strong and robust.

In this market, volatility cannot be interpreted solely as a measure of uncertainty. Instead, it reflects a combination of underlying risk and the episodic incorporation of information into prices. Ignoring liquidity and non-trading behavior would therefore lead to a systematic underestimation of latent risk during calm periods and an overemphasis on volatility spikes when prices adjust.

5.3. CROBEX

This section presents the empirical results for the CROBEX index, the benchmark index of the Zagreb Stock Exchange. CROBEX represents the most liquid market in the sample in terms of price continuity and trading frequency, with largely uninterrupted price adjustment. This market therefore provides an important benchmark for assessing whether liquidity-related effects observed in smaller markets persist when liquidity constraints are weak or absent.

Estimation results from the baseline GARCH(1,1) model with Student-t innovations indicate that CROBEX returns exhibit standard volatility dynamics typical of liquid equity markets. Both the ARCH and GARCH coefficients are statistically significant, and their sum equals 0.996, indicating high but clearly mean-reverting volatility persistence. Volatility shocks therefore dissipate over time at a faster rate than in markets characterized by extreme persistence.

The estimated mean return is statistically significant, although economically small, a result that is not uncommon in long daily samples. The Student-t degrees-of-freedom parameter is statistically significant, indicating excess kurtosis relative to the Gaussian distribution. While tail risk is present, heavy-tailed behavior is more moderate than in thinner markets, consistent with more continuous trading and smoother price adjustment.

5.3.1. Liquidity, non-trading, and conditional variance

Price staleness is extremely rare in the CROBEX. Under the baseline liquidity definition, exact price staleness occurs on only 0.16 percent of trading days, indicating that the index almost always updates from one trading day to the next. When the alternative near-zero log return proxy is applied, the share of such days increases to 1.16 percent, reflecting occasional very small price movements but still confirming a high degree of trading continuity.

These frequencies are economically negligible. They indicate that delayed price adjustment is not a structural feature of the CROBEX but rather an exceptional occurrence. As a result, liquidity proxies based on price staleness exhibit very limited time variation and do not capture persistent liquidity frictions.

When the liquidity proxy is included in the variance equation, the estimated coefficient is statistically insignificant and economically close to zero. In a market with near-continuous trading, a significant liquidity effect would be hard to reconcile with observed price continuity. The insignificance of the liquidity term therefore serves as a validation of the empirical framework.

The estimated conditional variance series shows a clear increase in volatility during the COVID period. Unlike in illiquid markets, this increase is relatively smooth and persistent rather than episodic. Volatility rises sharply at the onset of the pandemic and remains elevated for an extended period before gradually declining.

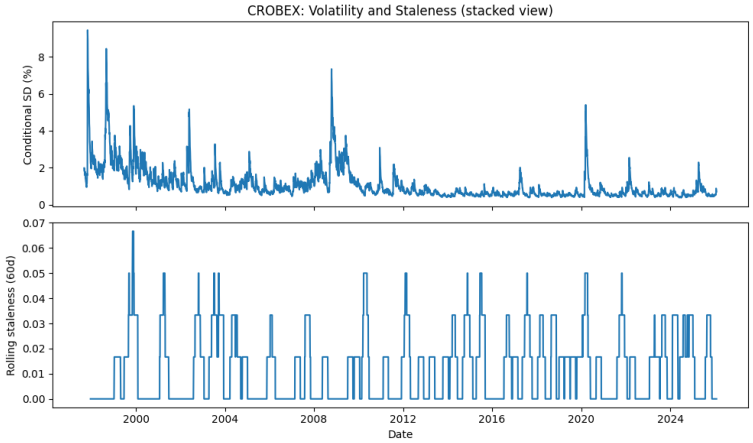
This pattern is consistent with continuous price discovery, whereby heightened uncertainty is incorporated into prices on an ongoing basis rather than being released episodically. The COVID episode therefore illustrates how similar global shocks can generate fundamentally different volatility dynamics depending on market liquidity.

Robustness checks using the alternative near-zero log return liquidity proxy yield results that are fully consistent with the baseline specification. The liquidity coefficient remains statistically insignificant, and the ARCH and GARCH parameters are stable across specifications.
All CROBEX models converge cleanly under standard numerical optimization routines. Parameter estimates are stable across alternative starting values, and no convergence warnings arise.

5.3.2. Graphical evidence and interpretation

Figure 3 presents a stacked representation of the estimated conditional volatility and the liquidity indicator for the CROBEX. The figure shows little systematic overlap between low volatility and non-trading or near-non-trading days, reinforcing the econometric finding that liquidity does not play a meaningful role in shaping volatility dynamics in this market. Volatility evolves smoothly and continuously, consistent with uninterrupted price discovery.

Figure 3: Conditional volatility and price staleness indicator for the CROBEX. Price staleness is virtually absent and volatility evolves smoothly and continuously, consistent with near-uninterrupted price discovery in the most liquid market in the sample



Source: Authors

The CROBEX results indicate that volatility dynamics in a relatively liquid Southeast European stock market are well described by standard GARCH mechanisms. Volatility is persistent but clearly mean-reverting, return distributions exhibit moderate heavy-tailed behavior, and liquidity-related effects are economically and statistically negligible.
In this market, volatility can be interpreted primarily as a measure of changing uncertainty rather than as an artifact of delayed price discovery. The absence of liquidity effects therefore strengthens, rather than weakens, the empirical conclusions.

5.4. BELEX15

This section presents the empirical results for the BELEX15 index, the benchmark index of the Belgrade Stock Exchange. The BELEX15 represents a market with relatively frequent trading and largely continuous price adjustment, though with somewhat more frictions than the most liquid market in the sample. This setting provides an informative intermediate case for assessing how volatility dynamics behave when liquidity constraints are limited but not entirely absent.
Estimation results from the baseline GARCH(1,1) model with Student-t innovations indicate that BELEX15 returns exhibit high but clearly mean-reverting volatility dynamics. The estimated ARCH and GARCH coefficients are both statistically significant, and their sum equals 0.9891, implying substantial volatility persistence combined with eventual reversion toward the unconditional variance. Volatility clustering is therefore present, but persistence is materially below the near-integrated behavior observed in very illiquid markets.

The estimated mean return is positive and statistically significant, although economically small. The Student-t specification is strongly supported by the data. The estimated degrees-of-freedom parameter is $\nu \approx 3.96$ and highly statistically significant, indicating pronounced excess kurtosis. Extreme return realizations therefore occur substantially more often than under a Gaussian benchmark, highlighting the relevance of heavy-tailed innovations even in markets with relatively continuous trading.

5.4.1. Liquidity, non-trading, and conditional variance

Price staleness is an infrequent but observable feature of the BELEX15. Under the baseline liquidity definition, exact price staleness occurs on 0.49 percent of trading days, indicating that the index almost always updates from one trading day to the next. When the alternative near-zero log return proxy is applied, the share of such days increases to 1.49 percent, reflecting occasional very small price movements while still confirming a high degree of trading continuity.

These frequencies indicate that delayed price adjustment is not a dominant structural feature of the BELEX15. Non-trading and near-non-trading days occur occasionally but do not persist over long periods, limiting their ability to systematically distort observed volatility.

When the liquidity proxy is included in the conditional variance equation, the estimated liquidity coefficient is negative but statistically insignificant ($\gamma \approx -0.04$, $p = 0.34$). The negative sign is consistent with a volatility suppression mechanism, but the lack of statistical significance indicates that this effect is weak and imprecisely estimated. This outcome should not be interpreted as a failure of the liquidity proxy or the modeling framework. Rather, it reflects the fact that liquidity constraints are rarely binding in this market. Because prices update on nearly all trading days, there is limited scope for systematic volatility suppression or delayed price discovery.

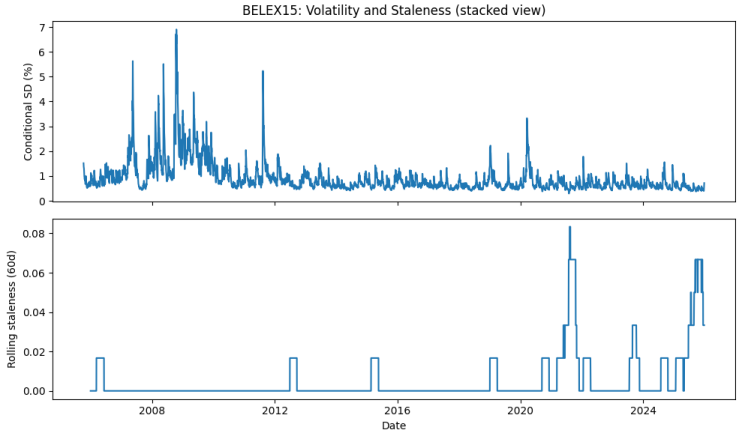
The estimated conditional variance series for the BELEX15 shows a pronounced increase in volatility during the COVID period. This increase is persistent and relatively smooth, indicating that heightened uncertainty was incorporated into prices on an ongoing basis rather than being released episodically. The subsequent decline in volatility suggests gradual normalization as uncertainty subsided.

Robustness checks using alternative liquidity definitions do not alter the qualitative conclusions. Parameter estimates are stable across specifications, and the liquidity effect remains statistically insignificant with a similar magnitude and sign.
All BELEX15 models converge cleanly under standard numerical optimization routines, and no convergence warnings arise.

5.4.2. Graphical evidence and interpretation

Figure 4 presents a stacked representation of the estimated conditional volatility and the price staleness indicator for the BELEX15. The figure shows that volatility evolves smoothly over time, with little systematic association between volatility levels and the occurrence of non-trading or near-non-trading days. This visual evidence corroborates the econometric finding that liquidity does not play a central role in shaping volatility dynamics in this market.

Figure 4: Conditional volatility and price staleness indicator for the BELEX15. Volatility dynamics are largely continuous with no systematic association between stale-price days and volatility suppression, consistent with the statistically insignificant liquidity coefficient



Source: Authors

The BELEX15 results indicate that volatility dynamics in the Serbian stock market are characterized by high but clearly mean-reverting persistence, substantial tail risk, and limited liquidity effects. Although non-trading and near-non-trading days do occur, their frequency is too low to materially distort observed volatility.

In this market, volatility can therefore be interpreted primarily as a reflection of changing uncertainty rather than as an outcome of delayed price discovery. Liquidity frictions exist but are not sufficiently strong to generate systematic volatility suppression or episodic volatility release.

5.5. Cross-Market Comparison

This section synthesizes the empirical findings across the four stock market indices examined in the paper: SASX-10 and BIRS from Bosnia and Herzegovina, BELEX15 from Serbia, and CROBEX from Croatia. Although all markets are small by international standards, they differ markedly in trading frequency, liquidity conditions, and the continuity of price adjustment. These differences are reflected systematically in volatility persistence, tail behavior, and the role of liquidity in shaping conditional variance.

Volatility persistence is high in all markets, but its degree varies meaningfully. The CROBEX exhibits persistent yet clearly mean-reverting volatility dynamics, with the sum of ARCH and GARCH parameters well below unity. BELEX15 displays stronger persistence, though still consistent with eventual reversion. In contrast, both indices from Bosnia and Herzegovina, SASX-10 and BIRS, exhibit near-integrated volatility processes, with persistence parameters extremely close to unity.

These differences are economically important. In CROBEX and BELEX15, volatility shocks decay over finite horizons, implying that markets gradually absorb disturbances through continuous trading. In SASX-10 and especially BIRS, volatility shocks dissipate extremely slowly, implying that the impact of shocks can persist for years. This pattern is consistent with the idea that in thin markets, limited trading activity prevents rapid resolution of uncertainty and prolongs the effects of shocks.

The role of liquidity differs sharply across markets. CROBEX is characterized by an almost complete absence of price staleness, with exact non-trading days accounting for a negligible fraction of observations and near-zero returns occurring infrequently. In this environment, liquidity proxies exhibit little variation and are statistically insignificant in the variance equation. This insignificance is informative: when trading is continuous and prices update regularly, volatility reflects information flow rather than market microstructure frictions.

BELEX15 occupies an intermediate position. Non-trading and near-non-trading days occur more often than in CROBEX but remain rare. Correspondingly, the liquidity coefficient is negative but statistically insignificant. The sign is consistent with a volatility suppression mechanism, but the infrequency of delayed price adjustment prevents liquidity from exerting a systematic influence on volatility dynamics.

In contrast, SASX-10 and BIRS exhibit substantial price staleness. In these markets, liquidity proxies are highly significant and robust across alternative definitions. The negative liquidity coefficients indicate that periods of limited trading suppress observed volatility, while volatility is released when prices eventually adjust. This mechanism implies that measured volatility in these markets reflects not only changes in uncertainty but also the timing of price discovery.
Return distributions are heavy-tailed in all markets, but the degree of tail risk varies systematically with liquidity. CROBEX and BELEX15 exhibit moderate excess kurtosis, consistent with standard emerging market behavior. SASX-10 and BIRS, by contrast, display extremely low estimated degrees of freedom, implying very heavy tails and a high frequency of extreme returns.

This pattern reinforces the liquidity interpretation. In markets where prices adjust episodically, the accumulation and release of information contributes to extreme return realizations. Heavy tails in SASX-10 and BIRS therefore reflect not only fundamental risk but also structural features of price formation.

The COVID period provides a natural stress episode for comparing market behavior. In CROBEX and BELEX15, volatility increased sharply but evolved smoothly over time, reflecting continuous price discovery under heightened uncertainty. In SASX-10 and BIRS, volatility during the pandemic was more uneven and clustered, with sharp spikes associated with price updates following periods of limited trading.

These contrasting patterns illustrate how similar global shocks can generate very different volatility dynamics depending on market structure. Liquidity constraints amplify volatility clustering in thin markets, while more liquid markets transmit uncertainty continuously.
Taken together, the cross-market evidence indicates that liquidity and trading continuity are key determinants of volatility dynamics in small stock markets. While high volatility persistence is a common feature across the region, extreme persistence, strong liquidity effects, and pronounced tail risk are concentrated in markets where non-trading and delayed price adjustment are frequent.

These findings support an interpretation of volatility in which market microstructure plays a central role alongside fundamental uncertainty. In the stock markets of Bosnia and Herzegovina, volatility reflects a combination of risk and episodic price discovery, leading to “long memory” behavior even in the absence of formal long-memory models. In more liquid regional markets, volatility behaves in line with standard GARCH dynamics and primarily reflects information flow.

The cross-market comparison therefore highlights that differences in volatility dynamics across Southeast European stock markets are not merely quantitative but structural, rooted in liquidity conditions and the mechanics of price formation.

6. Conclusion

This paper examines volatility dynamics in small Southeast European stock markets with a particular focus on the interaction between liquidity, price discovery, and conditional variance. Using GARCH-type models augmented with liquidity proxies, we analyze four benchmark indices: SASX-10 and BIRS from Bosnia and Herzegovina, BELEX15 from Serbia, and CROBEX from Croatia. The results reveal that while volatility persistence and non-Gaussian return behavior are common across the region, the mechanisms underlying volatility dynamics differ fundamentally depending on market liquidity and trading continuity.

Across all markets, volatility is persistent and returns exhibit heavy tails, underscoring the importance of flexible volatility models and non-Gaussian innovations. However, the degree of persistence varies meaningfully. In Croatia and Serbia, volatility is highly persistent but clearly mean-reverting, consistent with standard GARCH behavior in markets where prices adjust continuously. In contrast, the stock markets of Bosnia and Herzegovina exhibit near-integrated volatility processes, implying extremely slow decay of volatility shocks and long-lasting effects of disturbances.

A central contribution of the paper is the explicit incorporation of liquidity into the conditional variance equation. Liquidity effects are absent in CROBEX and BELEX15, where non-trading and near-non-trading days are rare and prices update almost continuously. This insignificance is economically informative: when liquidity constraints are not binding, volatility primarily reflects changes in uncertainty rather than market microstructure frictions. In contrast, liquidity plays a decisive role in both SASX-10 and BIRS. In these markets, negative and highly significant liquidity coefficients indicate that limited trading suppresses observed volatility, while volatility is released when prices update. Volatility therefore reflects not only risk but also the timing of price discovery.

These differences are further reflected in tail behavior. Return distributions are moderately heavy-tailed in Croatia and Serbia, while extremely heavy tails characterize the stock markets of Bosnia and Herzegovina. This pattern suggests that episodic price adjustment in thin markets contributes to the clustering of extreme returns and amplifies tail risk beyond what would be implied by fundamentals alone.

The COVID period provides a natural stress episode that reinforces these findings. In more liquid markets, volatility increased sharply but evolved smoothly as uncertainty was incorporated continuously into prices. In Bosnia and Herzegovina, volatility during the pandemic was more clustered, reflecting the interaction between heightened uncertainty and liquidity constraints. Stress episodes therefore magnify the role of market structure in shaping volatility dynamics.

Overall, the evidence indicates that differences in volatility behavior across Southeast European stock markets are structural rather than merely quantitative. In thin markets, delayed price discovery generates long-memory-like volatility dynamics even in the absence of formal long-memory models. Ignoring liquidity and non-trading behavior in such environments can lead to

a systematic misinterpretation of risk, understating latent volatility during calm periods and overstating it during episodes of price adjustment.

Beyond their econometric interpretation, the results have broader implications for regional financial development in Southeast Europe. The evidence that liquidity constraints materially shape observed volatility in smaller markets points to structural limitations in trading activity, market depth, and price formation. In such environments, low measured volatility may mask underlying risk, potentially distorting investment decisions and weakening the informational efficiency of prices. By contrast, more liquid markets exhibit volatility dynamics consistent with continuous price discovery, supporting more reliable risk assessment and capital allocation. These differences highlight the role of financial infrastructure and market development in shaping not only trading conditions but also the interpretation of key financial indicators.

From a policy perspective, the findings highlight the importance of market design and trading continuity for volatility dynamics and risk assessment. For researchers, they suggest that incorporating simple, data-driven liquidity proxies into volatility models can yield substantial insights when analyzing small and illiquid markets. Future work could extend this approach by examining intraday data, alternative measures of liquidity, or the interaction between liquidity and cross-market spillovers.

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APPENDICES

Table 2: Summary Statistics

Metric/ Exchange	SASX-10	BIRS	BELEX15	CROBEX
Start date	2004-12-29	2004-05-17	2005-10-04	1997-09-04
End date	2026-02-04	2026-02-03	2025-12-30	2026-01-30
Trading days	5,205	5,384	5,091	6,996
Mean return (%)	0.0080	0.0042	0.0048	0.0179
Std dev (%)	1.1165	1.0421	1.0585	1.3432
Skewness	0.43	3.40	0.02	-0.23
Excess kurtosis	11.09	93.80	20.60	28.53
Zero-return days (%)	6.83	14.91	0.49	0.16
Near-zero proxy (%)	7.77	15.77	1.49	1.16

Source: Authors

Table 3: SASX-10 baseline GARCH(1,1) with liquidity

Variable	*Coefficient*	*Std. Error*	*z-Statistic*	*p-Value*
μ	0.0031	0.0073	0.42	0.673
ω	0.0194	0.0028	6.91	< 0.001
α	0.0698	0.0105	6.63	< 0.001
β	0.9300	0.0105	88.17	< 0.001
γ (Liquidity)	−0.0604	0.0095	−6.38	< 0.001
ν (Student-t)	2.6669	0.0636	41.92	< 0.001

Source: Authors

Table 4: CROBEX baseline GARCH(1,1) with liquidity

Variable	*Coefficient*	*Std. Error*	*z-Statistic*	*p-Value*
μ	0.0339	0.0071	4.76	< 0.001
ω	0.0122	0.0035	3.49	0.001
α	0.1198	0.0121	9.92	< 0.001
β	0.8771	0.0121	72.66	< 0.001
γ (Liquidity)	0.0024	0.0345	0.07	0.946
ν (Student-t)	4.2324	0.4938	8.57	< 0.001

Source: Authors

Table 5: BELEX15 baseline GARCH(1,1) with liquidity

Variable	*Coefficient*	*Std. Error*	*z-Statistic*	*p-Value*
μ	0.0201	0.0091	2.21	0.027
ω	0.0252	0.0076	3.29	0.001
α	0.1790	0.0612	2.93	< 0.001
β	0.8101	0.0622	13.02	< 0.001
γ (Liquidity)	−0.0424	0.0447	−0.95	0.343
ν (Student-t)	3.9572	0.2954	13.40	< 0.001

Source: Authors

Table 6: BIRS baseline GARCH (1,1) with liquidity

Variable	*Coefficient*	*Std. Error*	*z-Statistic*	*p-Value*
μ	−0.0017	0.0055	−0.31	0.760
ω	0.0768	0.0133	5.75	< 0.001
α	0.1450	0.0237	6.12	< 0.001
β	0.8535	0.0238	35.82	< 0.001
γ (Liquidity)	−0.1023	0.0158	−6.49	< 0.001
ν (Student-t)	2.3340	0.0335	69.76	< 0.001

Source: Authors

Table 7: Robustness checks (all markets combined)

Market	*Model*	*α + β*	*γ (Liquidity)*	*ν*
SASX-10	Baseline	0.9997	−0.060***	2.67
SASX-10	Alt. liquidity	0.9997	−0.057***	2.67
SASX-10	IGARCH	1.0000	− 0.074***	2.65
CROBEX	Baseline	0.9969	0.002	4.23
CROBEX	Alt. liquidity	0.9967	0.281	4.24
BELEX15	Baseline	0.9891	−0.042	3.96
BELEX15	Alt. liquidity	0.9890	−0.023	3.96
BIRS	Baseline	0.9985	−0.102***	2.33
BIRS	Alt. liquidity	0.9985	−0.108***	2.33
BIRS	IGARCH	1.0000	−0.105***	2.30

Source: Authors

A scientific paper

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FROM INTERNATIONALISATION TO RAISING AWARENESS – UPFBE'S APPROACH OF BEING GLOBAL AND ACTING LOCAL

ABSTRACT

This paper examines how a business school can use its internationalisation and accreditation journey as a framework for embedding ethics, responsibility and sustainability into its everyday activities and for raising awareness of sustainability among students and regional stakeholders. Using the University of Pécs Faculty of Business and Economics (UPFBE) as a case, we explore how international visibility and global quality standards have led the School to aspire to become a committed actor in sustainable regional development.
The paper uses a qualitative, practice-based single-case design. It maps how ERS has been integrated through three key pillars: (1) curriculum (SDG-informed learning outcomes, dedicated courses and cross-curricular integration), (2) research (projects and publications addressing sustainability challenges relevant for the region), and (3) extra-curricular learning (student projects, partnerships with local SMEs, NGOs and public actors, and awareness-raising initiatives). The analysis is informed by the School's ongoing work on an ERS-focused strategic initiative and the development of an internal toolkit for collecting, processing and using sustainability-related data.
The case illustrates how internationalisation can act as a catalyst for making ERS a visible, strategic and measurable part of a business school's mission. It shows early outcomes in terms of redesigned curricula, more sustainability-oriented research portfolios and richer experiential learning opportunities that connect students with real regional sustainability issues. The paper offers imlications for business schools in similar regional settings on leveraging their international engagement to drive sustainability awareness and societal impact.

Key words: *business schools; sustainability awareness; ethics, responsibility and sustainability; internationalisation; regional development.*

1. Introduction

Business schools increasingly face expectations to demonstrate how they contribute to ethical, responsible, and sustainable business practice. These expectations reflect broader societal demands for transparent impact, the need to educate graduates capable of addressing sustainability challenges, and pressure on higher education institutions to align strategy, curriculum, and stakeholder engagement with sustainable development objectives.

Accordingly, many institutions seek to embed ethics, responsibility, and sustainability (ERS) not only through stand-alone courses, but also through programme-level learning outcomes, research priorities, and experiential learning opportunities.

At the same time, internationalisation and accreditation have become central organising principles for business schools. Internationalisation requires alignment with global expectations and engagement in internationally visible research, partnerships, and diverse student markets. Accreditation provides structured external reference points that shape internal governance, assurance of learning, continuous improvement routines, and strategic priorities. However, their role as catalysts for embedding ERS across the core missions of a business school remains underexplored, especially in regional contexts.

This paper addresses this gap through a qualitative case study of the University of Pécs Faculty of Business and Economics (UPFBE), a regional Hungarian business school pursuing "being global, acting local." We examine how internationalisation and accreditation have catalysed ERS integration and how this is operationalised through three pillars: (1) curriculum innovation, including SDG-informed programme learning outcomes and curriculum mapping; (2) research aligned with regional sustainability challenges; and (3) extra-curricular and stakeholder-engagement initiatives that strengthen sustainability awareness. We also discuss the development of an internal ERS measurement approach, a data toolkit supporting monitoring, reporting, and institutional learning regarding sustainability-related outcomes.

The paper is guided by the following research questions:
RQ1: How do internationalisation and accreditation processes catalyse the embedding of ERS in a regional business school?
RQ2: Through which institutional mechanisms is ERS integrated across curriculum, research, and extra-curricular engagement?

The study contributes in three ways: it provides a practice-based account of internationalisation and accreditation as drivers of ERS integration; it proposes a "three-pillar" view linking programme design, research orientation, and stakeholder engagement in a regional ecosystem; and it outlines an internal measurement toolkit that can support evidence-based management and reporting, offering transferable insights for schools seeking to align global standards with local sustainability needs.

2. Literature Review

2.1. Internationalisation as a Catalyst of Organisational Change

Internationalisation in higher education is commonly framed as more than cross-border mobility; it is a multi-dimensional institutional strategy that reshapes how universities define priorities, allocate resources, and organise core functions. For example, Yousef (2024) conceptualises institutional internationalisation through multiple dimensions (e.g. strategic vision, organisational changes, resources, and processes), explicitly treating "organisational changes" as an integral component rather than a side-effect. Seen this way, internationalisation becomes a change programme: it requires translating an external orientation (international students, partnerships, global visibility) into internal redesign (governance, roles, workflows, and performance management). In an Austrian case, Nao et al. (2025) show how internationalisation interacts with broader governance reforms (e.g. autonomy reforms and

performance-oriented steering), including monitoring and reporting practices that can shape institutional identities and priorities. A central change mechanism is organisational learning: internationalisation pressures institutions to adapt structures and cultures so they can absorb and institutionalise new practices (e.g. partnership management, international quality expectations, and intercultural capabilities). Hoai et al. (2023) link internationalisation strategies to changes in organisational cultures and structures, arguing that universities leverage internationalisation to become more like learning organisations.

Another mechanism is capability building and knowledge transfer across organisational boundaries. In their systematic literature review of internationalisation strategies for non-Western HEIs, Avolio and Benzaquen (2024) highlight that internationalisation involves deliberate managerial and organisational choices (e.g. strategy formulation and implementation patterns, partnerships, and capacity constraints) and note that post-COVID conditions further accelerated shifts toward online and hybrid international activities – changes that often require new routines and coordination mechanisms. Internationalisation drives change through curriculum and staff development, especially when institutions move beyond "performative" indicators (numbers of exchanges, international recruitment) toward more transformative goals (global/intercultural learning outcomes). Fry (2024), drawing on the notion of comprehensive internationalisation, treats internationalisation as an institution-wide, transformative process that reaches into teaching and learning design and requires organisational alignment to sustain it. This is echoed in the Japanese case studies by Goh et al. (2024), where intercultural competence initiatives are presented as a way to shift internationalisation from enrolment/mobility metrics toward more transformative development of faculty and student capabilities, implying new institutional practices and supports.

Overall, the literature positions internationalisation as a catalyst because it simultaneously reorients institutional strategy outward (legitimacy, competitiveness, partnerships) and requires inward organisational redesign (structures, processes, culture, and performance practices) to make that outward strategy operational and sustainable.

2.2. International Accreditation as a Driver of Organisational Change

International accreditation regimes (e.g. AACSB, EQUIS, AMBA) are typically discussed as external validation mechanisms, but the process of gaining and maintaining accreditation often functions as a structured organisational change intervention.

In the German business school context, Sziegat (2021) explicitly frames international accreditation as a response to coercive, normative, mimetic, and competitive pressures and uses institutional isomorphism to interpret why schools adopt accreditation standards and practices. This framing matters for organisational change because accreditation creates a powerful template for "how a legitimate school should look," prompting changes in governance, quality culture, and accountability systems. Empirically, accreditation is repeatedly associated with internal improvements that require redesign of processes and responsibilities. Ito's (2022) AACSB case study from Japan identifies benefits such as improved strategic planning, strengthened faculty qualifications and research contributions, and enhanced assurance of learning – changes that typically demand new data routines, committee structures, and cross-unit coordination. At a more general level, Fernandes and Singh's (2021) review positions accreditation and rankings as influential external mechanisms shaping institutional priorities in higher education systems, reinforcing the idea that such regimes can steer internal quality-management approaches. A key "change pathway" is the creation (or professionalisation) of

evidence systems. Accreditation requires institutions to demonstrate performance and continuous improvement, which pushes them to build information infrastructures and knowledge-management routines. Gabalán-Coello and Vásquez-Rizo (2026) describe an international accreditation model centred on learning-outcomes monitoring that incorporates a "cascade" information system and treats information/knowledge management as a transversal axis, i.e. a foundational organisational capability that cuts across units and levels. In practice, this often translates into new roles (quality officers, assurance-of-learning leads), new reporting cycles, and stronger integration between academic and administrative functions. Accreditation can also drive organisational change by reconfiguring language practices, boundary-spanning work, and "who counts as an expert." Vigier and Bryant (2023) show that French business schools face contextual and linguistic challenges due to English being the mandatory lingua franca and due to implicit Anglophone higher-education philosophies embedded in international accreditation requirements; schools therefore engage external experts as boundary-spanners to bridge knowledge and language gaps. This implies change not only in documentation practices, but also in internal power dynamics, expertise recognition, and knowledge-transfer processes.

At the same time, the accreditation-change relationship is not unambiguously positive: the literature also highlights burdens, potential misfit, and strategic dilemmas. Sziegat cautions that accreditation standards and "quality cultures" may not fit all schools or national contexts and argues for aligning accreditation decisions with mission, values, governance quality, and broader responsibility considerations (Sziegat, 2021). Relatedly, Prastiwi et al. (2025) (in a systematic review on managing dual accreditation) emphasise complexity and administrative burden when institutions navigate multiple accreditation logics simultaneously – conditions that can intensify internal coordination costs and create competing demands. Finally, accreditation also operates through external signalling effects that can motivate organisational change via competitive positioning. Jacqmin and Lefebvre (2021) treat business-school accreditations as third-party quality disclosure mechanisms for "experience goods" and find that international accreditations influence enrolment-related preferences in the French context, including a "triple crown" complementarity. However, signalling is stakeholder-contingent: Attree et al. (2026) show that business professionals' awareness and interpretations of accreditation signals are uneven, implying that schools may need to combine accreditation with deliberate stakeholder communication and relevance-building.

Taken together, international accreditation drives organisational change through institutional pressures toward legitimacy and standardisation, process and capability upgrades (strategy, assurance of learning, data systems), reconfiguration of expertise and boundary-spanning work, and competitive signalling dynamics that can amplify incentives to adopt accreditation-driven practices, while also generating tensions around burden and contextual fit.

2.3. Responsible Management Education (RME) and ERS

Responsible management education (RME) increasingly positions business schools as key institutions for shaping decision-makers who can recognise and respond to societal and sustainability challenges. In this literature, RME is typically framed not as a stand-alone topic, but as an institutional commitment that needs to be reflected coherently across teaching, research, and stakeholder engagement. A recent RME-focused systematic literature review (SLR) identifies recurring implementation patterns across curriculum integration, experiential learning, guest speakers, research projects, partnerships, innovation, and student engagement, and stresses the need for impact measurement rather than symbolic adoption (Lim et al., 2026).

Evidence from PRME signatory business schools similarly highlights leadership and institutional support as enabling conditions for embedding sustainability-related concepts into teaching practices at scale (Eustachio et al., 2024).

At the same time, critical work cautions that responsible management agendas can remain marginalised under institutional pressures such as accreditation expectations and research assessment regimes, which may reinforce mainstream curricula and privilege mechanistic research outputs (Ndubuka-McCallum et al., 2025). This tension is central to an ERS (ethical/responsible/sustainable) framing: formal commitments may translate into partial implementation unless the underlying incentive and evaluation systems are addressed. From a complementary angle, research on business ethics education points to a long-run shift from "ethics" toward broader sustainability concerns, while debates on integration and pedagogy remain unresolved – suggesting that ERS should not simply replace ethics, but requires intentional design in both content and teaching approaches (Jaganjac et al., 2024).

Higher education sustainability scholarship converges on a similar conclusion: progress typically requires curriculum transformation linked to organisational change and real-world sustainability practices (Machado-Davim, 2023). Moreover, institutional credibility and student-level outcomes are shaped not only by formal curricula but also by visible sustainability practices and their reputational/strategic effects. For instance, business school sustainability practices have been associated with internationalisation-related visibility and, through these mechanisms, with student satisfaction (Bagur-Femenias et al., 2023). In parallel, university social responsibility (USR) research conceptualises institutional responsibility through multiple impacts (educational, cognitive/research, organisational, and social) and suggests that strategies and programmes linking education and research to societal needs can strengthen perceived institutional contribution (Valencia-Arias et al., 2024; Chakra, 2025).

Taken together, the literature supports conceptualising ERS as a three-pillar institutional agenda rather than a purely curricular add-on: (1) curriculum embedding, (2) a research pillar that legitimises and advances ERS knowledge, and (3) extra-curricular/campus–community engagement that makes ERS visible and actionable. This aligns with holistic integration arguments in business education (Beamond et al., 2024), while also anticipating the risks of symbolic compliance and marginalisation identified in institutional critiques (Ndubuka-McCallum et al., 2025), thereby motivating a model that links pillar-based implementation to measurable early outcomes.

2.4. Sustainability Awareness and Learning Approaches

Sustainability education research consistently suggests that early outcomes, particularly sustainability awareness, are strengthened when learning moves beyond transmissive teaching toward authentic, complex situations that require judgement, collaboration and reflection. Evidence from authentic learning indicates that real-world, campus-linked sustainability tasks can develop students' soft skills and environmental awareness through reflective meaning-making (Watson Todd et al., 2025). Similarly, reviews in business and international business education converge on the need for multi-level solutions that combine pedagogy and curriculum with university-level stakeholder engagement and mindset change, implying that awareness is best understood as an emergent outcome of a broader learning ecosystem rather than a single course (Beamond et al., 2024).

This "ecosystem" view is echoed in higher education sustainability literature. SDG integration mapping work shows that sustainability-related activity concentrates mainly in education and knowledge production, while public debate and services are often underrepresented – despite their relevance for awareness raising beyond the classroom (Alfathy et al., 2024). Reviews also underline that curriculum change is most effective when connected to campus sustainability initiatives ("living lab" logic) and cooperation with society, because institutional practice makes sustainability tangible and reinforces learning (Machado-Davim, 2023).

Empirical studies add nuance to what sustainability awareness entails and how it can be strengthened. Student awareness is often described as multi-dimensional (cognitive, emotional and skill-based), and experiential formats (field visits, volunteering, student-led projects) are recommended to deepen emotional and practical engagement (Alshboul-Hamadneh, 2025). Research on ESD competencies likewise links competence development to affective dispositions such as environmental empathy, supporting the view that awareness and attitude formation can develop in parallel when pedagogy attends to both cognitive and affective dimensions (Sari et al., 2025). Value-based and participatory approaches have also been shown to translate awareness into more responsible habits and peer-led initiatives, highlighting the role of identity and values in sustaining pro-environmental orientations (Andriana et al., 2025). Within business education, student perceptions of SDG 8 integration similarly stress that pedagogical choices determine whether sustainability integration is experienced as meaningful and actionable (Elmassri et al., 2023).

Taken together, the literature supports a staged learning logic in which repeated ERS exposure and authentic experiences raise salience and conceptual understanding (awareness), reflective and value-linked learning strengthens sustainability-oriented attitudes, and structured application opportunities increase the likelihood that ERS will later be "used" in professional decision-making contexts.

2.5. Business Schools as Regional Actors – "Being Global, Acting Local"

Business schools operate in global accreditation and legitimacy systems, yet their societal value is increasingly judged through locally relevant impacts. USR literature provides a useful bridge: it frames universities as responsible actors through educational, cognitive/research, organisational, and social impacts, and shows that strategies and programmes which connect education and research with external communities can strengthen perceived institutional contribution (Valencia-Arias et al., 2024). A bibliometric and literature review of university social responsibility likewise underlines that universities' reputational and stakeholder relationships are shaped by active social and environmental engagement beyond marketing narratives (Chakra, 2025). This aligns with the "being global, acting local" imperative: global principles (e.g. SDGs, PRME) become credible when implemented through local partnerships, social programmes, and regionally grounded learning and research.

In practice, the regional actor role also appears in how schools operationalise societal impact standards. A concrete example is the operationalisation of AACSB's societal impact standard through a community partner internship programme assessing SDG 8 integration via an input-activity-output-outcome framework at organisational, student and faculty levels (Howell et al., 2025). Such models highlight that regional engagement can serve simultaneously as an impact pathway, and a learning design infrastructure enabling authentic experiences that support awareness and employability-related competencies. Relatedly, higher education policy research critiques "myopic" employability framings and proposes an ecosystem framework

(stakeholders, empowerment, recognition) for enabling "decent work", emphasising local socio-cultural conditions and multi-actor coordination, again reinforcing the need for regionally embedded education–work ecosystems rather than purely curricular interventions (Wall et al., 2024).

This regional actor logic also connects back to institutional constraints and incentives. Critical work on RM marginalisation suggests that accreditation-driven and research-assessment pressures can crowd out responsibility agendas (Ndubuka-McCallum et al., 2025). A research-quality assurance study shows that institutional evaluation systems may reward quantity over quality/impact, implying potential misalignment between research incentives and societal impact ambitions (Troncoso et al., 2024). These studies support treating the regional actor role as a governance and alignment challenge: for ERS to be enacted locally, business schools need coherent mechanisms linking curriculum, research priorities, and engagement activities (and measurement systems) that value societal impact rather than only traditional outputs.

2.6. Conceptual Framework (Summary Model)

Building on the preceding sections, we propose a conceptual framework in which awareness raising is the first observable outcome of an ERS learning ecosystem in a business school, supported by three mutually reinforcing pillars: curriculum embedding, research, and extra-curricular/campus–community engagement.

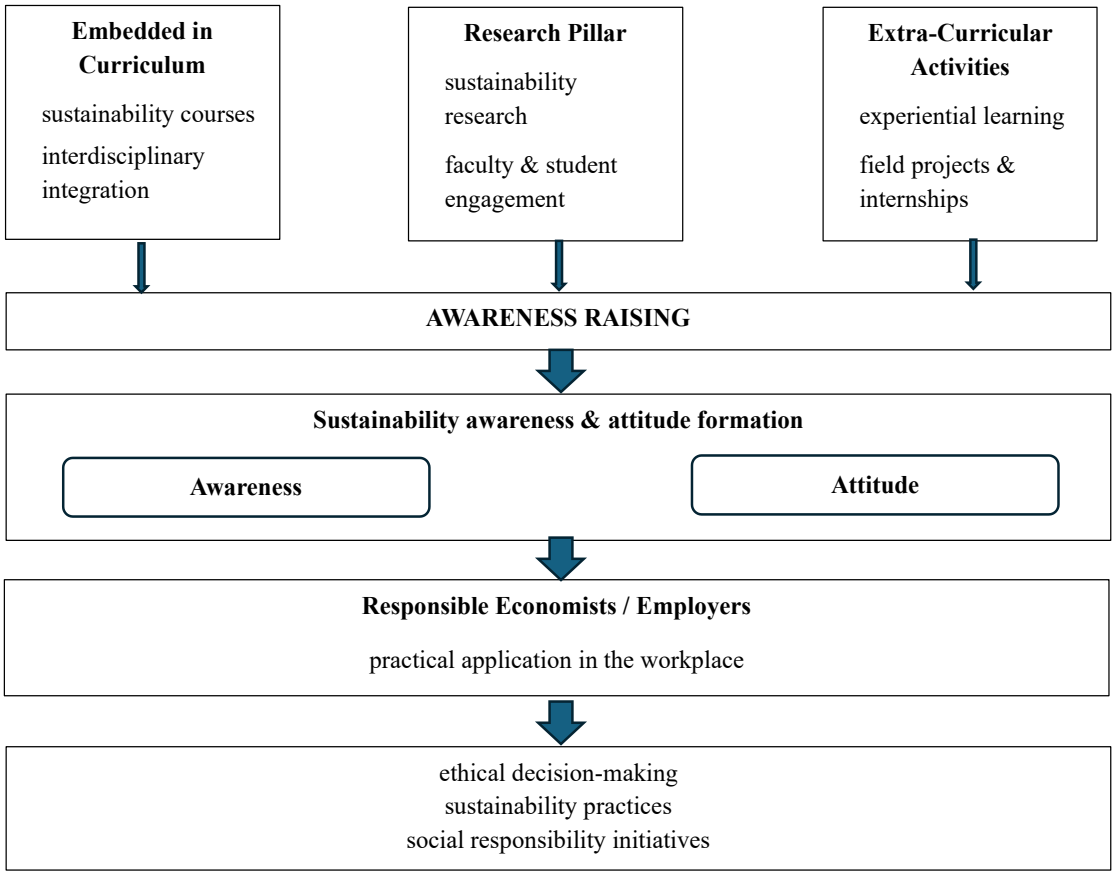
Pillar 1: *Curriculum embedding* (formal learning). Curriculum integration provides baseline ERS exposure and coherence at programme level. Prior work in RME and ethics education highlights that meaningful embedding depends on deliberate pedagogical design and programme-level alignment (Lim et al., 2026; Jaganjac et al., 2024), while PRME-related research points to the importance of institutional support for scaling sustainability teaching practices (Eustachio et al., 2024). Student perception research further suggests that pedagogy strongly shapes whether sustainability integration is perceived as relevant and actionable (Elmassri et al., 2023).

Pillar 2: *Research* (cognitive impact, legitimacy, and incentives). Research activity affects which knowledge domains are legitimised, resourced and translated into teaching and engagement. Responsibility-oriented scholarship treats cognitive impact as a core dimension of institutional contribution (Valencia-Arias et al., 2024; Chakra, 2025). At the same time, evaluation and incentive structures may constrain ERS integration by privileging narrow performance metrics or marginalising responsible management under external pressures (Troncoso et al., 2024; Ndubuka-McCallum et al., 2025). Therefore, the research pillar includes both knowledge production and the governance of incentives and measurement.

Pillar 3: *Extra-curricular and campus–community engagement* (informal/non-formal learning). Engagement provides authentic contexts that can intensify exposure, strengthen relevance, and connect learning to stakeholder needs. Evidence supports the role of real-world tasks, living-lab environments, and holistic integration linking pedagogy with stakeholder engagement (Watson Todd et al., 2025; Beamond et al., 2024; Machado-Davim, 2023). Structured engagement formats (e.g. community partner internships) offer operational templates for connecting engagement to measurable outcomes under societal impact expectations (Howell et al., 2025), while ecosystem perspectives highlight the importance of multi-stakeholder coordination in enabling impact pathways (Wall et al., 2024).

The framework (Figure 1) follows a staged pathway in which the three pillars jointly increase the intensity, variety and coherence of ERS exposure, making awareness the most proximal outcome. Over time, reflective and value-linked learning is expected to support attitudinal development, and repeated application opportunities (e.g., projects, internships, stakeholder collaborations) are expected to increase the likelihood and measurability of later "usage" in professional contexts.

Figure 1: Conceptual model of responsible management education (RME)



Source: Authors

3. Methodology

3.1. Research Design and Case Selection

This study adopts a qualitative single-case study design to examine how ethical, responsible, and sustainable (ERS) education can be embedded through a three-pillar institutional model (curriculum, research, and extra-curricular/stakeholder engagement) and how early outcomes can be monitored through internal measurement tools. A case study approach is appropriate because it allows for a contextualised understanding of an emergent organisational practice (i.e. ERS embedding) that is shaped by institutional strategy, governance, and regional stakeholder relationships. The selected case is UPFBE, a PRME signatory since 2020, where a Sustainability Centre (within the Centre for Applied Learning) was established in 2021 to strengthen and embed ERS aspects in operations aligned with the School's mission and strategy.

3.2. Data Sources

We relied on multiple data sources to enable triangulation across the three ERS pillars. First, we conducted a structured document analysis of institutional materials, using the 2025 PRME Sharing Information on Progress (SIP) Report as a primary evidence base, together with the self-assessment reports of the School from the past five years. The SIP Report provides detailed descriptions of the School's mission and strategy alignment with PRME principles, examples of ERS-related teaching activities, summaries of research projects linked to sustainability and responsibility, and descriptions of partnerships and engagement mechanisms.

Second, we incorporated internal operational information from the Sustainability Centre regarding recent initiatives that support ERS embedding (e.g. Sulitest integration at entry, mid-programme, and end-of-programme stages in the bachelor programmes; stakeholder-driven project collaborations; campus challenges; public talks and hackathons; SDG mapping; internship/practicum arrangements). These internal inputs were used to populate the three pillars and to identify measurable outputs.

3.3. Analytical Procedure: Mapping, Coding and Pattern Matching

Data were analysed through a theory-informed coding strategy guided by the conceptual framework. We applied a two-step procedure.

Step 1: *Mapping to the three pillars*: Each initiative, programme element, or practice was mapped to one (or more) of the three ERS pillars: (1) curriculum integration, (2) research aligned with sustainability challenges, and (3) extra-curricular learning and stakeholder engagement.
Step 2: *Outcome-oriented coding*: We then coded each element according to its expected contribution to the staged pathway (awareness raising, attitude formation, and potential later usage). This enabled pattern matching between observed practices and the framework's theoretical logic. For example, initiatives that provide repeated exposure to ERS content across contexts were coded as likely contributors to awareness raising; activities that include reflection, values, empathy, or responsibility dimensions were coded as attitude-supporting; and initiatives that create structured real-world application (e.g., internships, partner projects) were coded as usage-enabling.

4. Case Background: Internationalisation and Accreditation Journey of UPFBE

4.1. Institutional Profile and Regional Context

University of Pécs (UP) is Hungary's first university, founded in 1367, and today it is the largest and most prominent higher education institution in the South-Transdanubian region. UP operates as a privately funded research university governed by the Universitas Quinqueecclesiensis Foundation since 2021 and is accredited by the Hungarian Accreditation Committee (HAC) within the national higher education framework regulated by Act CCIV of 2011. UP maintains a strong international profile: it offers more than 100 programmes in English (and other foreign languages) and hosts international students from more than 136 countries. Across the university, the student population is reported at approximately 24,000, including about 5,500 international students.

University of Pécs Faculty of Business and Economics (UPFBE) is one of UP's ten faculties and is a prominent business school located in Pécs, in the centre of the South-Transdanubian region. Established in 1970, UPFBE is the oldest school of business and economics in Hungary outside the capital city, and is positioned as a leading regional actor with a strong "world of practice" orientation and stakeholder engagement. UPFBE's mission is educating excellent, solution-oriented, responsible business professionals to enhance sustainable development of the local and wider environment. Its vision emphasises a global mindset while maintaining a clear commitment to local and regional economic and social development (creating an inspiring global community with local impact). In its strategic framing, the School operates along three pillars – competitiveness, sustainable development, and excellence – supported by KPI-based monitoring. In terms of size and portfolio, UPFBE has around 2,400 enrolled students across tertiary vocational, undergraduate, master, doctoral and postgraduate levels, with more than 10% international students. The School runs multiple degree programmes fully taught in English, including the EFMD-accredited BSc in Business Administration and Management, and the EFMD-accredited MSc in Management and Leadership, besides the MSc in Business Development, and international doctoral programme.

As a regional business school, UPFBE explicitly recognises contextual constraints and opportunities, and also takes responsibility for supporting the region. The School highlights the historically depressed labour market conditions in the South-Transdanubian region and notes that the regional economy is dominated by domestic SMEs, while the local presence of multinational enterprises is comparatively limited – creating both challenges and a "local impact" rationale for programme development and stakeholder engagement.

4.2. Key Milestones in Internationalisation and Accreditation

UPFBE's internationalisation trajectory is closely tied to its long-standing engagement with English-taught programmes and structured international partnerships. The School launched its first English-language undergraduate business programme in 1996 (BA in Business Administration; predecessor of the current BSc in Business Administration and Management), followed by an English-language master programme in 1999 (MSc Applied Management / MSc in Management and Leadership lineage) and an English-taught doctoral programme in 2004. Notably, when Bologna-structured education became mandatory in Hungary (with implementation at the university level from 2006), UPFBE already had extensive experience running English-taught programmes and quality-assurance routines, which supported its positioning within both national and international contexts.

UPFBE has maintained strong international partnerships since 1989, among which an important long-term partnership milestone is the Pécs-Hagen double degree programme (FernUniversität in Hagen, Germany), operating since 2001. In the 2020s, UPFBE further expanded its double-degree portfolio, with active collaborations with ESDES Business School (France), KEDGE Business School (France), and WOXSEN University School of Business (India). In addition, the School's earlier English-language BA and MSc programmes were validated by Middlesex University London for more than 25 years, reflecting a sustained engagement with international educational standards.

The School's accreditation journey is described as a deliberate, staged pathway designed to strengthen internal standards and benchmarking capacity. UPFBE traces the initial "impulse" for international accreditations to an AACSB workshop held in Zagreb in 2009, which triggered internal strategic discussions. Following this, the School designed a sequence starting with

programme accreditation at bachelor level, progressing to master-level programme accreditation, and ultimately aiming to raise standards at institutional level with AACSB and EFMD EQUIS. UPFBE became an EFMD member in 2016, and it received its first EFMD programme accreditation in 2020 for the BSc in Business Administration and Management, which was later prolonged with a five-year accreditation in 2023. UPFBE was the second in the country and first school outside the capital to gain EFMD programme accreditation, and the only school in Hungary with the full bachelor-master pathway EFMD-accredited. From 2020 onward, UPFBE also formalised its responsible-management orientation through joining the UN Principles for Responsible Management Education (PRME). In 2024, the School received the EFMD BSIS label, signalling an additional layer of international recognition linked to business school impact. In parallel, the School's strategic plan explicitly includes further internationalisation and accreditation ambitions.

4.3. ERS Strategy Initiative and Governance Setting

UPFBE's ERS agenda is anchored in both UP's institutional strategy and the School's own mission-driven strategic framework. At the university level, UP's 2023–2030 Strategy positions sustainability as a flagship objective and explicitly calls for environmental, social, and economic sustainability considerations to be integrated across higher education activities and institutional operations. Within this context, UPFBE frames its "being global, acting local" positioning through a strategic pillar on sustainable development, linking educational, research, and stakeholder-engagement efforts to societal challenges in the regional ecosystem. At the School level, ERS is embedded into formal governance and quality frameworks. UPFBE's Quality Policy (introduced in 2018 and later revised) identifies ethics, responsibility and sustainability as core principles, while behavioural expectations and integrity norms are operationalised through the School's Code of Ethics and relevant student regulations (e.g. disciplinary regulations, study and examination rules). To prevent and manage unethical behaviour, the School applies systematic controls such as Turnitin for plagiarism (including AI detection) and addresses emerging issues of AI usage through policy development and pedagogical integration.

A key institutional step in the ERS strategy initiative was the establishment of the Sustainability Centre in 2021 as a unit within the Centre for Applied Learning (CAL). The Centre was created to coordinate and institutionalise ERS-related activities and to integrate ethical thinking, social responsibility and sustainability across education, research, and co-curricular/extra-curricular initiatives. The Centre's work is organised around three pillars that mirror the School's ERS integration logic: (1) ERS in the curriculum, (2) ERS-related research and knowledge creation, and (3) ERS in the third mission and extra-curricular engagement. In practice, the Sustainability Centre also functions as an operational node for generating structured evidence of ERS-related activities (e.g. events, workshops, course monitoring, guest lectures, campus challenges), which supports the School's measurement and reporting ambitions.

Within education, UPFBE has initiated a school-wide SDG-based assessment of courses across all programmes and levels, creating an SDG matrix intended to support systematic curriculum review and development. The mapping process includes content analysis of course descriptions and uses SDG mappings and keyword sets derived from the Elsevier SDG Research Mapping Initiative and Scopus tagging practices; the resulting SDG map is shared with course leaders for validation and correction. This curriculum-oriented pillar is complemented by a portfolio of ERS-focused courses and certificate programmes (e.g. circular economy and

sustainability/ethics-focused certificates), aimed at strengthening learners' ability to connect ERS content to managerial roles and decisions.

Within research, the ERS initiative is reinforced through both external commitments and internal support mechanisms. When UPFBE joined PRME, it began using the PRME framework as a structured mechanism for reviewing the implementation and efficacy of ERS activities. The School has begun to formalise a governance-and-measurement approach that links ERS to societal impact management.

5. Findings: Embedding ERS Through Three Pillars and Measurement

The findings follow the conceptual framework (Section 2.6) and show how ERS is embedded through three interrelated pillars: (1) curriculum integration, (2) research aligned with regional sustainability challenges, and (3) extra-curricular learning and stakeholder engagement. Across pillars, the case highlights a staged logic in which repeated exposure and authentic contexts primarily support early outcomes (especially awareness), while later attitudinal change and professional usage require longer-term follow-up. The section concludes with the emerging internal ERS data toolkit, which aims to make ERS activities and outcomes more visible and measurable.

5.1. Pillar 1 – Curriculum Integration

ERS curriculum integration at UPFBE is anchored in the School's mission and supported by quality assurance and stakeholder-inclusive programme development. ERS learning is delivered through both dedicated courses and ERS-relevant modules embedded across programmes (e.g. sustainability, responsibility, ethics, CSR-related themes), complemented by recurring ESG/sustainability guest lectures that reinforce exposure across the student journey. To support curriculum-level improvement, sustainability literacy is tracked longitudinally via SULITEST at key stages of the BSc pathway. Overall, this pillar primarily supports early outcomes by ensuring baseline, programme-wide exposure and conceptual grounding, while selected project-based formats provide initial opportunities for application.

5.2. Pillar 2 – Research Aligned with Regional Sustainability Challenges

The case indicates an explicit intention to strengthen sustainability- and responsibility-oriented research within the School's research portfolio. Reporting mechanisms document ERS-related outputs and SDG-linked monitoring (including Scopus-indexed publications mapped to SDGs) and external research partnerships, suggesting an emerging, measurable research stream. Research themes include ESG-related finance and SME-oriented tools, as well as regionally grounded innovation and entrepreneurship topics, reflecting the "being global, acting local" logic of translating global frameworks (SDGs/ESG) into locally relevant research questions. Beyond outputs, the case also highlights efforts to "socialise" research through public events and collaborations, strengthening research–teaching–engagement linkages.

5.3. Pillar 3 – Extra-Curricular Learning and Stakeholder Engagement

The third pillar is implemented through structured partnerships and engagement opportunities that provide authentic contexts for ERS learning. A key partnership is the long-term cooperation with the Pécs Community Foundation, enabling guest lectures, joint non-profit projects and

community-based initiatives. Additional collaborations (including corporate partners) expand the portfolio of engagement formats such as site visits, mentoring, juries, hackathons and challenge-based projects. Overall, these activities extend ERS beyond the classroom and provide recurring touchpoints that support awareness raising and early attitude formation through lived experience and reflection in real stakeholder settings.

5.4. Internal ERS Data Toolkit and Measurement Approach

To make progress visible and to avoid "activity without evidence", ERS implementation is operationalised through an internal measurement toolkit that links the three pillars (curriculum, research, extra-curricular engagement) to staged outcomes in line with the conceptual framework. At the early stage, the toolkit prioritises awareness raising as the most proximal and measurable outcome of repeated exposure across formal learning, research-informed teaching, and engagement-based experiences. Accordingly, SULITEST was introduced as a baseline diagnostic instrument for incoming BSc students (Awareness Test and TASK) and integrated into the programme as a criterion-requirement at multiple points (entry, 1st semester, and 6th semester). In the first implementation wave, participation reached n=216 for the Awareness Test, with n=186 completing TASK; the cohort's average Awareness score was 38.8/100, indicating substantial room for improvement and providing a clear rationale for systematic interventions.

At the process and output level, student-level diagnostics are triangulated with institutional activity indicators generated by UPFBE's applied learning ecosystem. CAL annual reporting documents the Sustainability Centre's ERS-related reach and programming. For 2024/2025, CAL records 4 co-organised Sustainability Centre events, 312 participants involved in two campus challenges, participation in five ERS workshops, 12 ERS-focused courses, and 18 guest lectures on sustainability and ESG. These indicators capture the breadth and intensity of ERS exposure beyond the classroom, complementing curricular and research integration.

For the research pillar, the toolkit draws on annual faculty-level research performance reporting to demonstrate alignment with sustainability challenges and partnerships. The 2024 research report documents 36 Scopus-listed publications mapped to SDGs and shows SDG-linked distribution (e.g., SDG 8, SDG 12, SDG 17), alongside recorded research partnerships with external organisations, supporting the role of research outputs as inputs to teaching and regional engagement.

Together, these measures create a coherent monitoring logic: diagnose baseline awareness, document the intensity and variety of ERS exposures across pillars, and enable follow-up assessments over time to test whether sustained pillar-based implementation is associated with improved awareness (and, in later phases, attitudinal and behavioural proxies).

6. Conclusions, implications and limitations

This case suggests that internationalisation and international accreditation can operate as mutually reinforcing catalysts for embedding ethics, responsibility and sustainability (ERS) when they are connected to mission-driven strategy and translated into routines, roles, and evidence systems. Internationalisation provided sustained exposure to global expectations through long-running English-taught programmes and structured international partnerships, while accreditation provided an externally legible, staged development pathway that

strengthened governance, continuous improvement and performance monitoring. A second conclusion concerns how ERS becomes executable. The School's applied-learning architecture helps stabilise ERS across the three pillars (curriculum, research, engagement) by converting initiatives into repeatable formats and by generating operational evidence that can be tracked over time. This is complemented by an emerging societal impact governance and measurement logic that consolidates diverse data sources into a coherent monitoring approach, which is critical for avoiding "activity without evidence." Third, the case illustrates that "being global, acting local" functions as a translation mechanism: global standards (accreditation, PRME/SDG language, international benchmarking) provide structure and legitimacy, while regional conditions shape priorities and formats. In a context dominated by SMEs and with region-specific labour-market constraints, ERS becomes credible when it is embedded in locally relevant projects, partnerships and engagement opportunities that make sustainability tangible for students and stakeholders.

These conclusions should be interpreted in light of limitations: the analysis is a single-case, document-heavy account, which constrains generalisability and may reflect self-reporting bias; moreover, longer-term outcomes (attitudes and professional usage) require longitudinal tracking beyond the current evidence base. Future studies could strengthen and test the proposed catalyst logic by further tools, e.g. longitudinal designs that follow cohorts over time; comparative multi-case research across regional business schools and accreditation configurations to identify which mechanisms are robust and which are context-dependent; and measurement and stakeholder-interpretation research that examines how employers, SMEs and community partners perceive ERS-related "signals".

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A scientific paper

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LOCAL GOVERNMENT UNITS IN THE FUNCTION OF ABSORBING PRE-ACCESSION FUNDS IN BOSNIA AND HERZEGOVINA

ABSTRACT

The subject of this research paper is local government units (hereinafter: LGUs) in absorbing funds under the Instrument for Pre-Accession Assistance (hereinafter: IPA funds) in Bosnia and Herzegovina (hereinafter: B&H). Candidate countries have access to significant financial resources under the IPA provided by the European Union (hereinafter: EU). The extent to which these funds will be utilized depends partly on the capacity of LGUs, as important actors in the EU integration process.
The research focuses on analysing the existing absorption capacities of LGUs in B&H and identifying possibilities for their improvement, to ensure better utilization of IPA funds in the future. Primary research was conducted using a survey questionnaire targeting LGUs in B&H that are representative in terms of geographical area, budget size and number of employees.
Through research and analysis of three main aspects of LGUs' absorption capacities (human, financial and institutional capacities), it was found that these factors significantly influence the level of utilization of available IPA funds. The findings confirm that most LGUs do not take a proactive role in applying for projects due to a lack of certain specific knowledge required for project preparation and IPA fund management, insufficient experience, and questionable motivation. The research also indicates that many LGUs lack adequate financial capacity to cover their own contribution or to pre-finance projects, as well as that project partnerships necessary for joint applications are insufficiently developed.
In order to improve the absorption capacity of LGUs and achieve better results in the next programming cycles, the paper recommends a systematic strengthening of human resources, establishing financial mechanisms for co-financing and pre-financing, and developing institutional networks and partnerships. In this way, in our view, LGUs in B&H will be more efficient in using available IPA funds and better prepared for utilizing EU structural funds upon accession.

Key words: *Local government units, Instrument for Pre-Accession Assistance, absorption capacities, Bosnia and Herzegovina*

1. Introduction

B&H made certain progress on the path to full membership by obtaining candidate status for EU membership on December 15, 2022. However, B&H's complex constitutional framework significantly hinders and slows this process, and according to Hušić (2017), local self-

government could serve as an effective mechanism for mitigating the negative consequences of slow reactions from higher levels of government.

In accordance with the Law of Principles of local self-government in the Federation of Bosnia and Herzegovina (Official Gazette of the Federation of Bosnia and Herzegovina, No. 49/06), and the Law on local self-government in Republica Srpska (Official Gazette of the RS, No. 97/16, 36/19 and 61/21), local self-government implies the right and ability of local government units to within the limits of the law, regulate and manage certain public affairs, namely public affairs that fall within their jurisdiction based on their own responsibility and in the interest of the local population. A successful accession process to the EU requires that B&H have a high quality, modern administration and local self-government (Kuljaninović, 2017), and its units (municipalities, cities, etc.) play a very important role in absorbing financial resources within the framework of the IPA funds.

The goal of the IPA funds is to provide assistance to accession countries in meeting standards and adopting the community's rules, and to prepare them for competitive participation in the common EU market. B&H's readiness and preparedness to use the funds from these sources will largely determine the pace of fulfilling the prerequisites for its accession to the EU.

The subject of this paper is LGU in the function of absorbing funds from IPA funds. The paper starts from the research hypothesis that the development of LGU's absorption capacities affects the degree of utilization of IPA funds. Accordingly, the central research question posed in the paper is: What is the impact of the existing capacities of LGU on the degree of utilization of IPA funds?

The conditions for obtaining funds from EU funds are very strict, and for the implementation of projects under EU programs, participation from partners in multiple member states is usually required, as well as co-financing of the projects by the proposal submitters. This indicates the importance of developing partnerships with potential project partners in thematic areas that LGU identifies as strategic and priority areas. In addition to developing partnerships and securing co financing for projects, significant factors for the successful use of available IPA funds are adequate human resources for project application and implementation.

The research in this paper focuses on the absorption capacities of LGUs in B&H in the context of IPA funds and the possibilities for increasing them in the future period.

2. Literature review

Previous research on this topic indicates delays in contracting, slow preparation and implementation of projects funded by IPA, which is directly linked to the weaknesses of a complex, fragmented and inefficient executive branch. Among other things, a significant impact on the use of IPA funds is cited as insufficient information and a lack of employed, professional and qualified personnel who are involved in project writing and analysis, especially in public institutions and organizations in all levels of government (Žigić, 2022).

According to the European Court of Auditor evaluation (2016), the absorption of funds was slowed by weak administrative capacities, which resulted in contracts and payments continuing after the end of the IPA I program period. Nezirić's analysis of absorption (2023) further highlights that B&H still has low utilization of available funds, primarily due to the lack of developed necessary sectoral strategies, delays in programming a complex and slow system for

making political and technical decisions, as well as unresolved ownership issues. According to Aćić and Grujić (2023), the absorption of IPA funds depends on several factors, namely the political context of EU enlargement, the readiness of institutions in B&H to meet accession criteria, as well as the institutions potential to absorb the offered funds.

Research in the Republic of Croatia has shown that cantonal actors, together with local government units and educational institutions, are the most successful category of EU program users in terms of the available calls (Puljiz, 2011). To improve the absorption capacities of LGUs in B&H, a reform of the country's local government is necessary, which, according to European commission reports, is progressing slowly. The public administration reform includes, among other things, strengthening the financial and administrative capacities of LGUs, as well as developing institutional capacities. According to the European commission report on B&H (2024), the country is between an early stage and a certain level of preparedness, and some progress has been made in public administration reform.

According to the "Study on progress in regional policy of the WB6[1] and Turkey" (European Commission, 2022), B&H is currently in the initial phase of preparations regarding regional policy and the coordination of structural instruments. This study identifies the insufficient availability of competent personnel to effectively manage EU funds as one of the key challenges in the Western Balkan region. This issue is further exacerbated by a significant staff turnover rate, which is primarily attributed to non-competitive salaries in the public sector. Furthermore, according to the study's findings, this problem is exacerbated by the lack of a comprehensive retention policy, especially for positions involving significant responsibilities, as well as the lack of a merit-based system for public service recruitment, performance evaluation and professional development.

3. Methodology

In order to prove the research hypothesis, the research design of this paper is based on a mixed methods approach that combines quantitative and qualitative research methods. In the empirical part, quantitative methods were used, namely desk research (secondary research). Within this framework, available secondary data sources were collected, such as specialized literature in the fields of international economics, foreign investment management and alike, as well as reports and other documentation on the EU pre accession funds, along with relevant publications on the websites of EU institutions, in compliance with the principles of relevance and timelines. Data was collected on the available and utilized funds for the implementation of projects within the EU's IPA I and IPA 2 funds in B&H, along with the processing of the collected data.

The primary research instrument in this paper is a survey through which primary empirical data on the absorption capacities of LGUs were collected. The total population consists of 80 LGUs from the FB&H from 10 cantons, 64 LGUs from the entity Republica Srpska and 1 LGU from the Brčko District. The data collection process was conducted via an online survey, which ensured greater accessibility and efficiency in the respondent coverage.

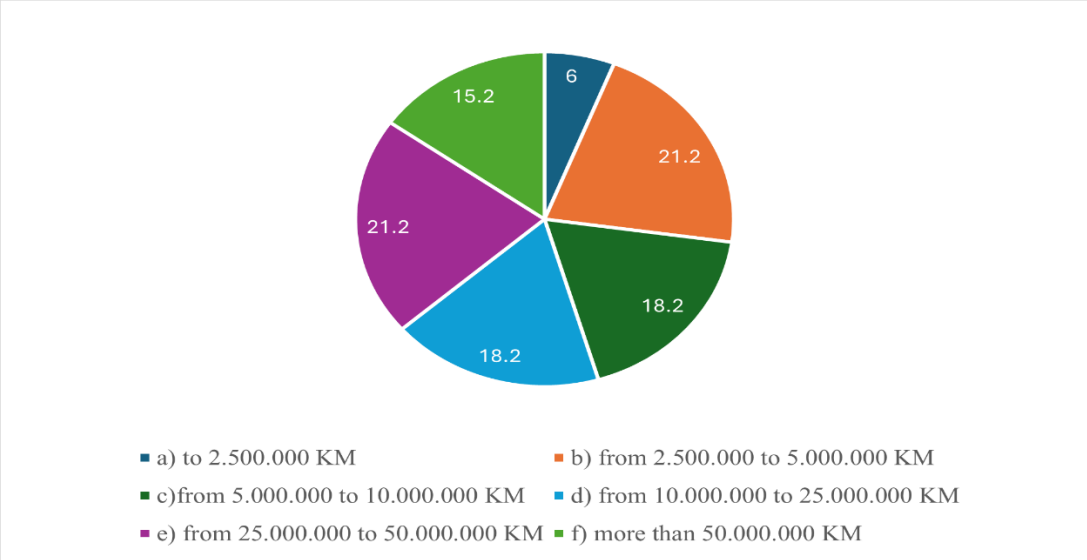
[1] Western Balkan countries: Albania, Bosnia and Herzegovina, North Macedonia, Kosovo, Montenegro and Serbia

The computer program Excel was used for data processing, employing descriptive statistics and correlation analysis, and nonparametric statistical procedures (percentages) were also applied.

The survey questionnaire was composed of four parts, with the introductory section covering general information about LGUs. The questionnaire requested information on the status of LGU in order to compare the absorption capacities of cities and municipalities in B&H and to determine the relationship between LGU status and the capacity to draw funds from IPA funds. The survey covered municipalities and cities from B&H, ensuring a balanced sample in terms of geography, as well as budget size and number of employees, and achieving representation of both entities as well as the Brčko District, i.e., all administrative units. A total of 33 completed questionnaires were received, representing the final sample. This represents a response rate of 22.76% which constitutes an adequate sample.

The majority of the sample consists of municipalities (68.2%), which represents a relevant sample given that the number of municipalities is significantly higher than the number of cities in both entities. Of the total of 145 LGUs in B&H, 35 LGU (24.14%) have city status, namely 8 cities in RS, 26 in FB&H and the City of Brčko District. For the purposes of the research, data on budget size and number of employees are also important, as shown in charts 1 and 2.

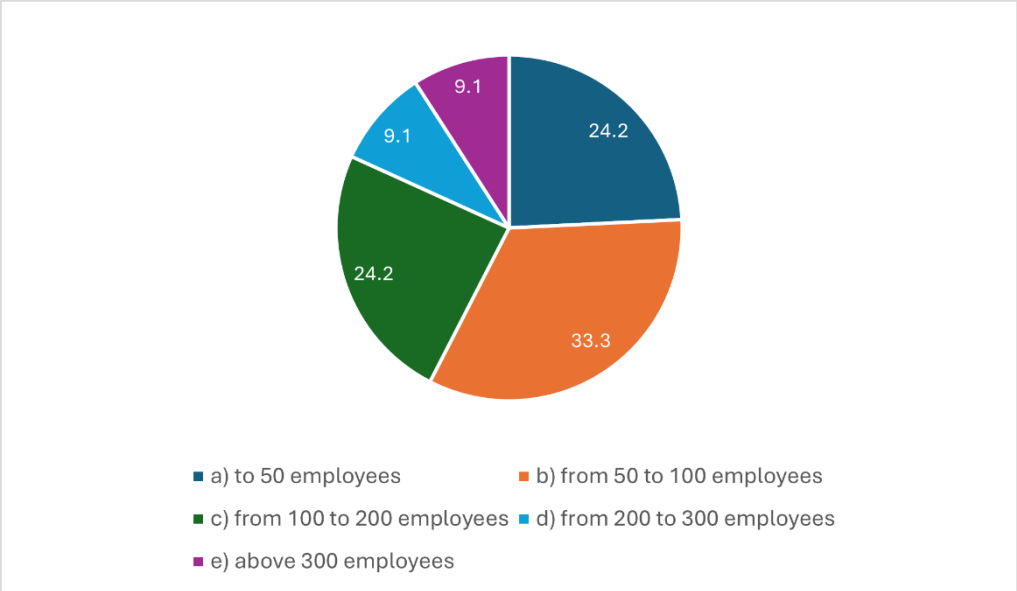
Graph 1: Structure of LGUs by budget size



Source: Authors

According to the results obtained, LGUs with varying budgets, both small and large, are represented, which contributes to obtaining a realistic picture i.e. a representative sample.

Graph 2: Structure of LGUs by number of employees



Source: Authors

Of the total surveyed, the most common LGUs have 50 to 100 employees (33.3%), followed by those up to 50 employees and those with 100 to 200 employees. The survey included a small number of LGUs with 200 to 300 employees (9.1%) and over 300 employee employees (9.1%).
Data obtained from a sample that includes LGUs with different statuses, budget sizes, and number of employees can significantly help in better understanding the needs and capacities of LGU.

4. Results and discussion

In this paper, various procedures and data processing methods were used to achieve the research objective and verify the established hypothesis, namely:

- Descriptive statistical analysis of the research sample as well as the dependent and independent variables of this study:

1. Analysis of data and indicators on available, approved, and utilized funds from the EU's IPA fund for B&H.
2. Quantitative research on LGUs in B&H and EU IPA funds (survey research)

- Correlation analysis (significance of the interrelationship between variables)
- A method of induction for drawing specific conclusions based on individual cases
- A synthesis method for summarizing research results.

To answer the question of how much of the EU's IPA funds B&H utilizes, information was collected by analyzing available databases. The total funds allocated to B&H under IPA I amounted to approximately €660 million, of which B&H received €594 million in the period from 2007-2013 as targeted financial assistance for candidate and potential candidate countries for EU membership (European Commission, 2023). For B&H, the first two of a total of five components were designated, namely:
Component I: Transition and institution building assistance and
Component II: Cross border cooperation.

The following table shows official EU data on the status of implementation of IPA funds for the 2007 to 2013 period as of December 31, 2013, representing the situation at the end of the IPA I programming period.

Table 1: Overview of allocated, contracted and paid funds under IPA I for the period 2007-2013 as of December 31, 2013

IPA I	**Allocated**	**Committed**	**Percentage Committed**	**Paid**	**Percentage Paid**
Component I	516,518,116	340,463,959	65.92%	235,929,768	45.68%
Component II	17,719,302	10,877,769	61.39%	8,300,350	46.84%

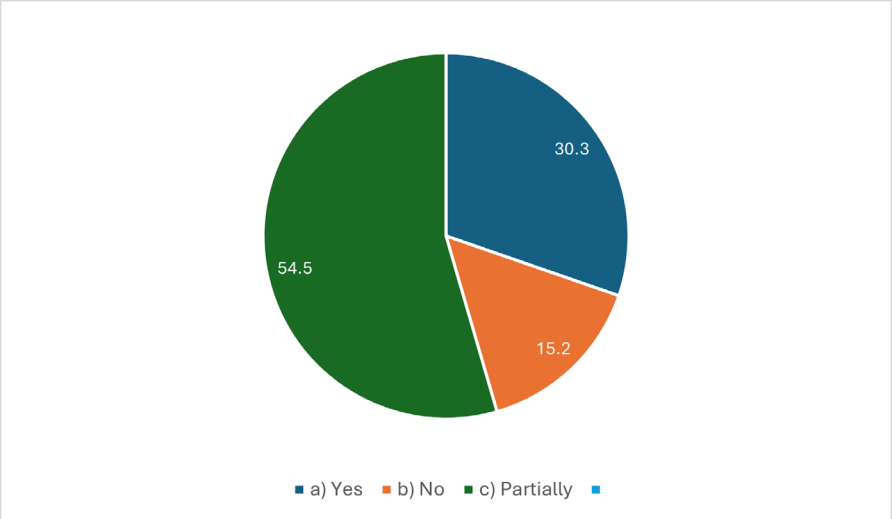
Source: Author's own work based on data from the European Commission's 2013 Annual Reports on Financial Assistance for Enlargement, https://enlargement.ec.europa.eu/2013-annual-report-financial-assistance-enlargement_en as well as the official EU website, www.ec.europa.eu

The data on low absorption and disbursement rates of IPA funds indicate insufficient use of IPA funds in the period up to 2013, which, according to research, was influenced by numerous factors, among other things, delays in contracting assistance under IPA I, which were partly attributed to the complex institutional and political environment in B&H. Data from the EU Delegation to B&H and the Directorate for European Integration also indicate that in the early phases of the IPA II implementation, B&H was slower in drawing down funds, and as of October 11, 2019. of the total of €285.864 million for the 2014 to 2018 period, 143.153 million euros (50%) had been contracted and 86.798 million euros (30%) disbursed. Also, according to the data provided, in 2019, the implementation of IPA I funds for B&H was in its final phase, and 99% of the total IPA I funds were contracted and paid out, which indicates inefficient implementation, as a significant portion of the IPA funds was contracted and paid out long after the programming period (Directorate for European Integration, 2019).

Below, we will present the results of the statistical analysis conducted.

The following chart shows the research results concerning human capacities in the LGUs, namely knowledge, experience, motivation, and familiarity with financing opportunities from IPA funds.

Graph 3: Capacity Building of Surveyed LGUs for Applying to Pre Accession Funds



Source: Authors

As can be seen from the chart itself, in a smaller number of surveyed LGUs (30.3%), human capacities for applying to pre accession funds have been built. In the largest number (54.5%) of surveyed LGUs, human capacities are partially developed, while 15.2% of respondents in the LGUs believe that the administration lacks adequate human resources.

When asked if there is a systematized position for an employee/s who handles/s monitoring calls and preparing project proposals for submission and/or monitoring the implementation of international cooperation projects, which also includes projects from the pre accession funds, 63,6% responded affirmatively, while the remaining 36.4% of LGUs gave a negative answer. Further research and a comparison of the obtained data with the number of employees in the LGUs determined that in LGUs with a smaller number of employees (up to 100), positions related to international or EU projects are not systematized.

The following table shows the results of the survey on the number of employees in LGUs in systematized positions for monitoring calls and preparing project proposals for application and/or monitoring the implementation of international projects, i.e., it shows the existing resources (human capacity) in the surveyed LGUs areas.

Table 2: Number of employed officials in the surveyed LGUs involved in the preparation and implementation of EU projects through job systematization

Number of officials in LGU involved in the preparation and implementation of EU projects	Number of LGUs	%
No employees	1	4.76%
One	4	19.05%
Two	8	38.10%
Three	4	19.05%
Four	1	4.76%
Five	0	0.00%
Six	0	0.00%
Seven or more	3	14.29%
Total	**21**	**100.00%**

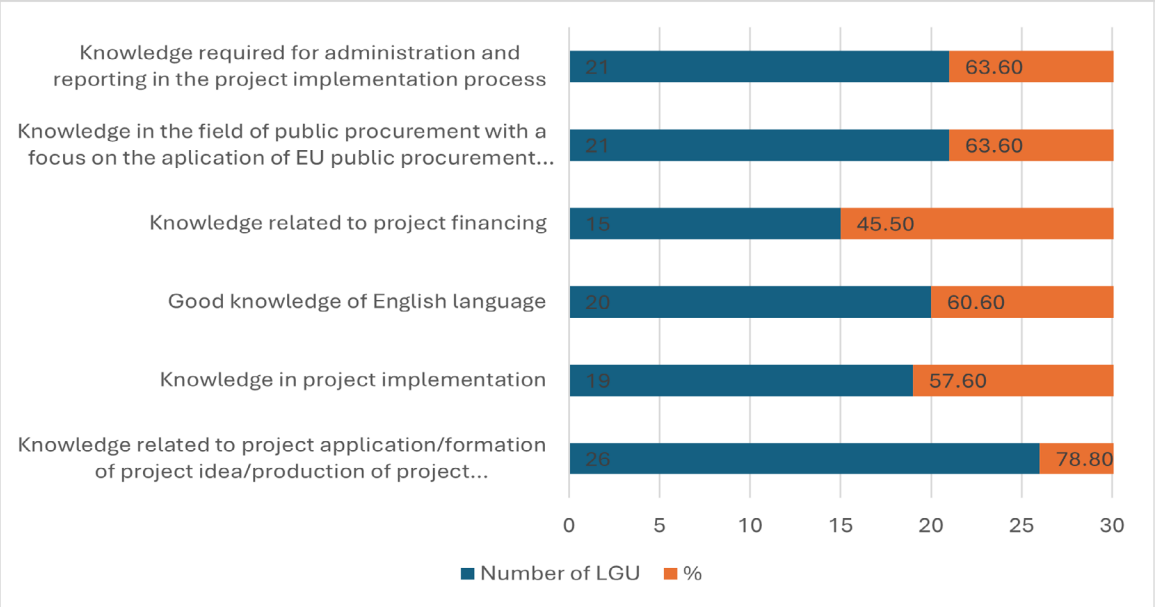
Source: Authors

From the previous table, it is clear that the number of employees in positions related to EU funded projects varies considerably from one LGU to another. The largest number of surveyed LGUs that have the aforementioned positions systematized have between one and four employees, with LGUs having two employees in these roles predominating. In addition to the fact that not all LGUs have systematized positions for officers whose job descriptions include project preparation and/or implementation, there are also situations where such positions are systematized but remain vacant (4.76%). Only a smaller number of LGUs surveyed (14.2%) have significant human capacity for monitoring, preparing, and implementing international projects, which includes projects from pre accession funds. Furthermore, the majority of LGUs surveyed (73.9%) believe that a position for an officer responsible for the preparation and/or implementation of EU projects should be established, while only one LGU (4.3%) believes there is no need for such a position.

When it comes to in house capacity for preparing project applications, just over half of the LGUs surveyed, or 54.5%, believe they can rely on their own capacity to prepare project applications, while the remaining 45. 5% believe they cannot and that it is necessary to engage consulting services when preparing project proposals for IPA funds.

When asked whether in the upcoming period it is necessary to work on enhancing certain specific knowledge of employees in LGUs for applying to pre accession EU funds, the results show that all LGUs surveyed believe that in the upcoming period it is necessary to work on enhancing certain specific knowledge of employees for applying to pre accession EU funds . A further investigation attempted to determine which specific knowledge is needed in the LGU, as shown in the following chart.

Graph 4: Types of knowledge missing in the LGUs for successful application to calls and use of IPA funds



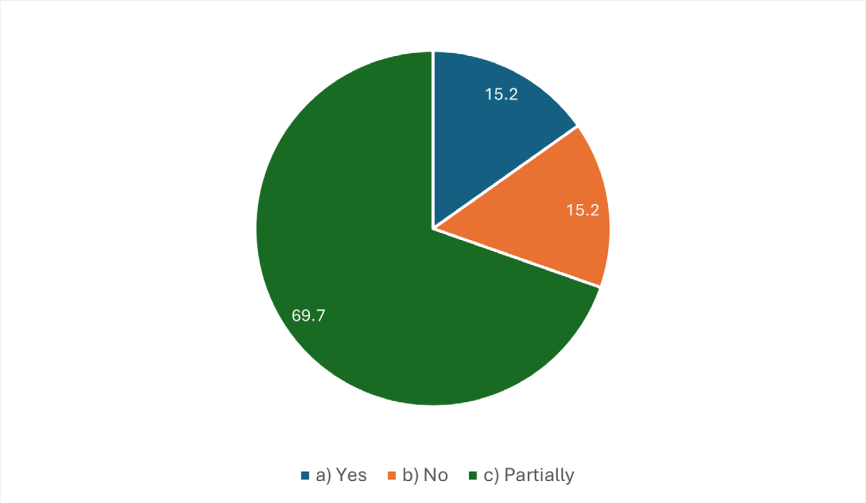
Source: Authors

The previous chart shows that in most of the LGUs surveyed in the territory of B&H, respondents believe that the most lacking are the skills related to project application, project idea formulation, and project documentation preparation, with 78.8% answering in the affirmative. Following that, there is a need for knowledge in the field of public procurement, with a focus on applying EU public procurement rules and the knowledge required for

administration and reporting during the project implementation process (63.6%). A good command of the English language is also a skill lacking among the surveyed LGUs, according to 60.6% of respondents. Additionally, knowledge of project implementation is needed, according to 57.6% of the surveyed LGUs who responded affirmatively. The smallest percentage of LGUs (45.5% or 15 out of a total of 33 LGUs) stated that knowledge related to project financing is needed.

The respondents' views in the surveyed LGUs on whether there are sufficient training programs on the market to enhance specific knowledge among LGU employees for applying to pre accession EU funds are shown in Chart 5.

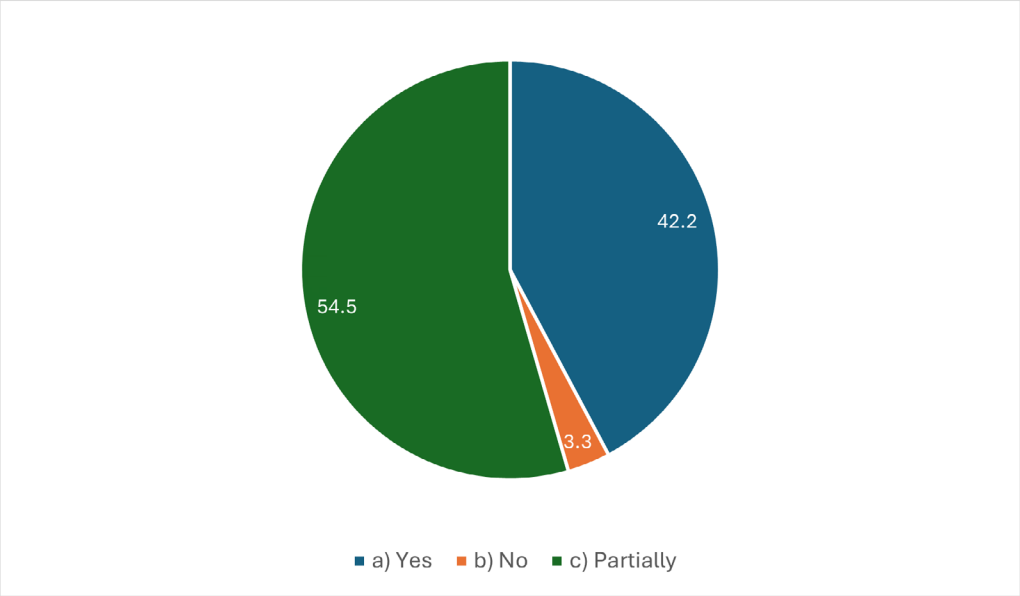
Graph 5: Availability of market based training to enhance the knowledge of employees in the surveyed LGUs for successful application to calls and utilization of IPA funds



Source: Authors

Of the total of 33 LGUs surveyed in BiH, only 5 LGUs (15.2%) stated that there is sufficient training on the market regarding the knowledge needed to successfully apply for calls and use funds from the IPA funds. The remaining LGUs surveyed in B&H (69.7%) consider the existing market based training in the required areas to be partially sufficient, while as many as 5 of them (15.2%) believe there is not enough training in the necessary areas on the market.
For greater use of IPA funds, one of the prerequisites is the availability of information on application opportunities. The research results are shown in the following chart.

Graph 6: Data on the awareness of LGUs respondents about open calls



Source: Authors

According to the results shown in the previous chart, the largest number of LGUs (54.5%) consider their LGU partially informed, while 42.4% of respondents consider it sufficiently informed. Only 3% responded negatively, stating that they are not sufficiently informed about open calls.
The data below show the results of the survey on the trend of applying for projects. When asked whether they apply for calls for proposals available for financing from pre accession funds, a majority of LGUs respondents (65.6%) answered yes, while the remaining 34.4% answered no.

Data on the number of calls to which LGUs applied for funding of projects from IPA funds up to the time of the survey are shown in Table 3.

Table 3: Overview of the average number of LGUs applications to calls for funding from IPA funds

Number of applications to calls	**Number of LGUs**	**%**
From 1 to 3 applications	8	42,1%
From 4 to 8 applications	5	26,3%
A significant number of applications	6	31,6%
Total	**19**	100%

Source: Authors

Based on the survey results, a smaller number of respondents, or 31.6% of them, actively participated in or applied for a significant number of calls for funding from IPA funds. The majority of respondents (42.1%) have submitted a small number of applications to date, between 1 and 3, noting that EU pre accession funds have been available to B&H since 2007.

Table 4 shows how LGUs in B&H obtain information about open calls in order to apply for project funding from pre accession funds.

Table 4: Methods for informing the LGUs about open calls for funding from IPA funds

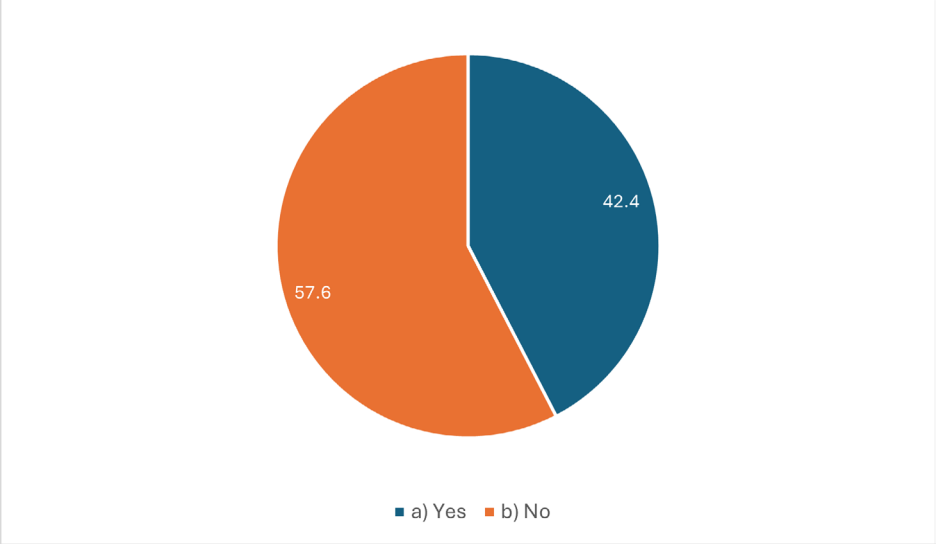
Method of informing about open competitions	Number of LGUs	%
Information via email from potential partners and civil society organizations	25	75,8%
Direct contacts with LGUs and partner institutions	17	51,5%
Conferences, seminars, and workshops	15	45,5%
Social media	13	39,4%
TV and radio programs	2	6,1%
By following up on calls from domestic and international organization	1	3%
By subscribing to websites that provide information on all available calls in one place	1	3%
Directorate for European Integration, INTERREG program pages	1	3%
Notices from the Ministry of Economic Relations	1	3%
Through a specialized agency for monitoring public calls for projects	1	3%
Tracking donor pages	1	3%

Source: Authors

From the data in Table 4, it is evident that the majority of respondents (75.8%) obtain information via email from potential partners and civil society organizations. Based on the above, it follows that networking, i.e., establishing partnerships, is very important in the context of improving the components of LGU absorption capacity.

The following section presents the research results related to LGU's financial capacities. One of the main questions concerned the adequacy of own funds in the budget for financing the implementation of EU projects, and the results are shown in the following chart.

Graph 7: Information on the availability of financial capacity (sufficient funds in the budget) to finance the implementation of EU projects

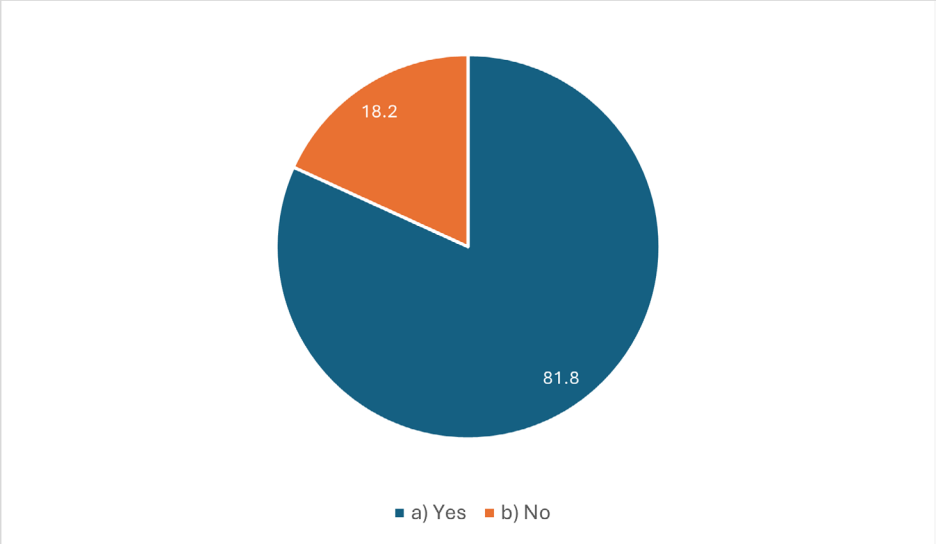


Source: Authors

The results show that 57.6% of LGUs lack sufficient financial capacity to finance the implementation of EU projects, which represents a certain risk of not applying. Based on the above, due to insufficient financial capacity, LGUs would have to resort to some form of borrowing to finance their own contribution in the budget.

Based on the results obtained from the descriptive analysis of the research sample, we can say that there is a need for a second way to finance projects besides funding from budget resources, although not all forms of borrowing were in focus, which could be the subject of further research. Since credit is one of the most common forms of borrowing, the need for a credit line as a specific financial mechanism was examined, and the results are presented in Graph 8.

Graph 8: Information on the need for a credit line or a special financial mechanism to support LGUs in applying for EU funds for co-financing and pre financing of EU projects



Source: Authors

Based on the responses, it can be concluded that there is a significant need (81.8% of respondents) for a special financial mechanism to support LGUs in applying to EU funds for co-financing and pre financing of EU projects.

It is useful to note that in 2023. a credit line for the co-financing and pre financing of EU projects was established within the Development Bank of FB&H in 2023, with interest subsidies from the Government of FB&H, thereby creating the prerequisites for increasing the financial capacities of LGU, i.e., their greater absorption capacities in FB&H.

Considering the possibility of establishing a special fund in the near future, through which LGU could apply for assistance with pre financing or co financing, would certainly be very significant in terms of overcoming or reducing the existing problem.

To determine the effectiveness of using IPA funds in the LGUs, the number of approved and implemented projects from the IPA funds is an important data point.

Table 5: Overview of the results of applying for projects from the EU's pre accession funds for the surveyed LGUs

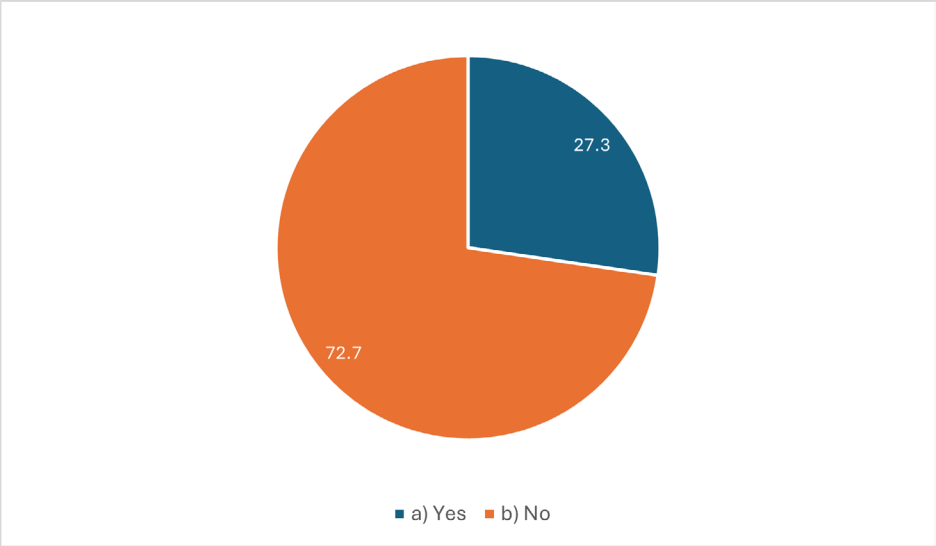
Status LGU	**Number of LGUs**		Total
	Municipality	**City**	
Number of respondents	22	11	33
Successfully implemented projects from the EU's pre accession funds	8 (36.4%)	9 (81.8%)	17 (51.5%)
A significant number of completed projects	1	2	3
Most projects realized from EU pre accession funds per local government unit	from 1 to 2	7	

Source: Authors

It is important to highlight that 51.5% of respondents successfully implemented projects from the EU's pre accession funds, with cities (81.8%) taking advantage of this opportunity more than municipalities (36.4%). LGUs with the status of municipalities most often implemented one to two projects, while cities implemented seven projects from 2007 to mid-2023. Only three LGUs implemented a significant number of projects, which implies that they also utilized a significant amount of funds. We note that regarding the question about the amount of approved and utilized funds, most of the surveyed LGUs did not provide an answer, which made it impossible to determine their success in implementation.

A basic prerequisite for developing LGU's partnership relationships with potential project partners for applying to calls and implementing projects from IPA funds is a database of potential project partners. Such a database is necessary to ensure that the submitted projects are in line with the priorities defined by the Development Strategy and other strategic and development documents of the LGU. For the purposes of this paper, the project management approach was explored from the perspective of developing the LGU's partnership relations, and the research results are presented in the following chart.

Graph 9: The existence of databases of potential project partners, in accordance with the priorities defined by the Development Strategy and other strategic and development documents of the LGUs



Source: Authors

A significant number of respondents (72.7%) do not have a database of potential project partners, in line with the priorities defined by the Development Strategy and other strategic and development documents of the LGU. From this, it can be concluded that there is no systematic project management approach aimed at increasing the implementation of the LGU's strategic and development projects. A further analysis examined the practice of contacting potential project partners, and the results indicate that 57.6% of respondents act proactively in their search for project partners, while the remaining 42. 4% do not have an established practice of contacting project partners, which can be linked to insufficient experience in project application, a lack of a database of potential project partners, or the absence of financial capacity to fund the implementation of EU projects. For the purposes of further analysis, a question was asked about how LGU get in touch with potential partners, which is shown in the following table.

Table 6: The way LGU's get in touch with potential partners

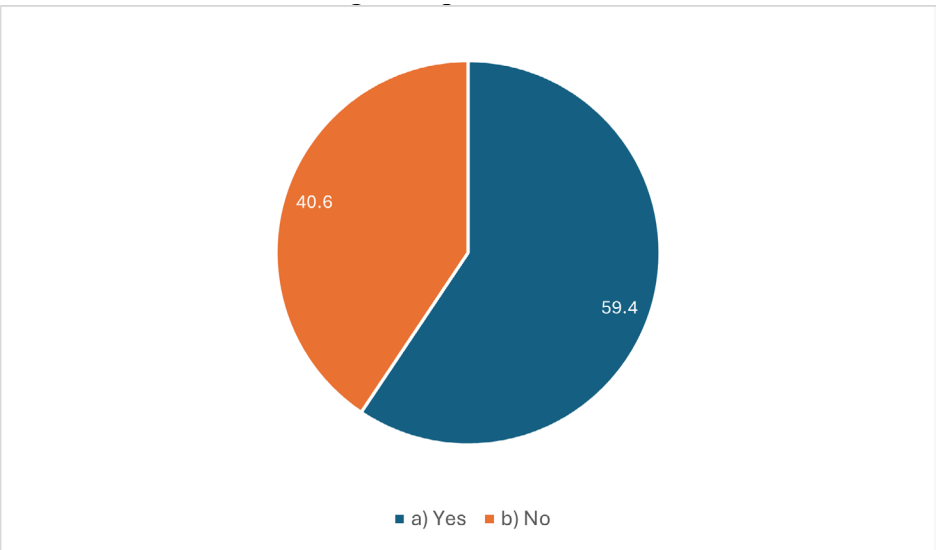
How to get in touch with potential partners	**Number of LGUs**	**%**
We independently analyze potential partners and establish contacts	24	75%
At the organized meetings of the Directorate for European Integration	5	15,6%
Potential partners contact us regarding the relevant experiences of our LGU	17	53,1%
Other: City partnerships, with the support of development agencies	3	9,3%
We have no experience	1	3,1%

Source: Authors

Three quarters of the LGUs surveyed (75%) make contact with potential partners through their own analysis of prospects and by establishing contacts. On the other hand, slightly more than half of the LGUs surveyed (53.1%) with relevant experience are contacted by potential partners. The research showed that a smaller number of respondents (15.6%) get in touch with potential partners at organized meetings of the Directorate for European Integration. Regarding other aspects, 9.3% of respondents highlighted city partnerships and contacting potential partners

with the support of development agencies, while one LGU noted that it has no experience or developed institutional capacity in creating a network of project partnerships.
The prerequisite for using IPA funds is a positively evaluated project application, and the resulting findings are presented in the following chart.

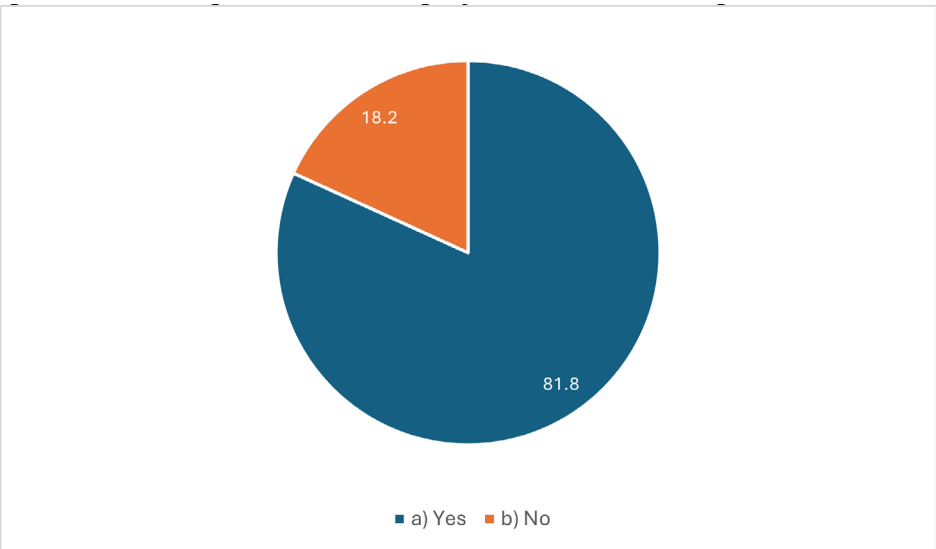
Chart 10: Data on the number of positively evaluated project applications for LGUs project financing from pre accession funds



Source: Authors

More than half of the surveyed LGUs that applied to calls for project funding from EU IPA funds (59.4%) reported that they had a project application positively evaluated for funding from the pre accession funds to date. However, for a significant number of the LGUs surveyed (40.6%) the outcome of the submitted projects was negative. A further investigation attempted to establish a correlation between negative outcomes and absorption capacities. One of these is institutional, and an attempt was made to determine the correlation of the need for institutional support as a potential reason for the negatively evaluated applications.

Chart 11: Need for institutional support (advisory body/expert support) for the LGU in the preparation and implementation of projects from the EU's pre accession funds



Source: Authors

Based on the results obtained, it can be noted that there is a great need for institutional support in the preparation and implementation of projects from the EU's pre accession funds, as well as a need for advice and expert support through an advisory body for LGU in this process. This required a more detailed investigation of the types of services necessary for LGUs, and the results we obtained are shown in the following table.

Table 7: Type of services required as part of institutional support

Type of services	**Number of LGUs**	**%**
Information on Open calls	9	33,3%
Support in preparing project documentation	27	100%
Support in implementing public procurement procedures	13	48,1%
Project implementation support	16	59,3%
Support in implementing promotional activities	5	18,5%
Other: Financial support to ensure participation and revolving fund for financing	2	7,4%

Source: Authors

Regarding institutional support, all surveyed LGUs that require it agree that assistance with project documentation is necessary, which indicates a lack of preparedness of project documentation within the LGU. The second most requested type of service for which institutional support is needed by LGU is assistance with project implementation (59.3%), followed by support with conducting public procurement procedures (48.1%). Additionally, one-third of respondents (33.3%) believe support is needed for information on open calls, while 18.5% of LGUs need institutional support for conducting promotional activities. The surveyed LGUs also highlighted other necessary services within the framework of institutional support, which are related to the financial aspect: financial support for ensuring participation and a revolving fund for financing. From all of the above, a clear correlation is evident between the absorption capacities of LGUs and the more efficient use of IPA funds.

As part of the survey, the LGUs also identified the main challenges and obstacles to using the IPA funds. The most important reason for the underutilization of IPA funds, LGUs highlight the lack of human resources for project application (78.8%). The second most significant problem relates to the lack of knowledge needed for project management and the lack of funds for co-financing their own required contribution. Also noteworthy is the percentage of respondents who cited a lack of financial resources until the expected reimbursement from EU funds (45.5%), a lack of developed relationships with potential partners to collaborate with on project applications, e.g. civil society organizations (42.4%) and a lack of employee motivation and resistance to change (39.4%).

The least important reasons cited by the surveyed LGUs as main challenges and obstacles were the lack of project ideas (15.2%) and insufficient information about project application opportunities (33.3%). From the above, it can be concluded that there is a direct correlation between the absorption capacity of LGUs and the success of using IPA funds, and that human and financial capacities are the main obstacle preventing LGUs from participating sufficiently in calls for project funding from IPA funds.

Regarding LGU's readiness to apply for future calls for project funding from EU IPA funds, it is clear that the LGUs are aware of the importance of the IPA funds and the opportunities they offer by using the available resources through these funds. An extremely high percentage (93.9%) LGUs plans to apply for calls for project funding from EU IPA funds in the future.

The experience gained so far by LGUs that have applied for IPA funds is very significant, and the survey collected comments and recommendations from the LGUs respondents to improve the absorption of funds from the pre accession funds at the LGU level. The responses are grouped into the human and institutional capacities of the LGU.

Within institutional capacities, several LGUs highlighted the need to organize a development or regional agency as direct support for LGU in all activities related to applying for pre accession funds. This was particularly related to assisting less experienced LGUs in project preparation and implementation. One of the recommendations is also to connect with other LGUs in order to exchange knowledge and experience, and to build the capacities of LGU. Additionally, the need to improve relationships with potential partners, as well as pre-arranged partnerships, was highlighted.

The LGUs surveyed particularly highlighted the problem of insufficient readiness of projects with which they could apply when public calls for IPA funds open.

Most of the recommendations from the surveyed LGUs relate to the need to improve human capacity, and emphasize the need to adequately fill established positions, train project reporting officers, and involve a greater number of officers in training. The problem of insufficient understanding among the departments/services within the LGU was also highlighted, which results in the project's implementation being slowed down due to a lack of support from other departments/services.

One of the important recommendations from respondents regarding improving the absorption of funds from pre accession funds at the LGU level is the use of monetary reward mechanisms for officials for successfully completed projects, which would lead to greater motivation for further learning and knowledge enhancement in this area.

5. Conclusion

The paper is based on a research of the existing capacities of LGUs in the context of the utilization of IPA funds as a key instrument for assistance in the European integration process, and an analysis of the possibilities for increasing their utilization rate through the development of more adequate capacities of LGUs in B&H. The focus was on LGUs that are closest to citizens and important in the European integration process.
The research results clearly indicate that there is a lack of human capacity in LGUs, limited financial capacity, and inadequately developed institutional capacities.

Most LGUs lack sufficiently trained personnel and formalized positions for the preparation and implementation of EU projects, especially those with fewer than 100 employees. The complexity of hiring procedures, a lack of specialized knowledge, and insufficient employee motivation further slowdown the project application and implementation process.

Based on an analysis of all factors related to the human capacities of LGUs in B&H obtained from the research, it can be concluded that insufficient information for LGUs about financing opportunities from EU IPA funds is one of the obstacles to using IPA funds, but a less prevalent phenomenon, and that the internal capacities of LGUs in B&H, and above all, knowledge and experience, influence the number of successful project applications and the use of IPA funds.

Research findings show that a large number of LGUs lack funds for their own contribution and for project pre financing, which leads to the withdrawal of applications and a lower number of realized projects. Therefore, it can be concluded that the level of financial readiness of LGUs to co-finance projects affects the absorption of funds from the IPA funds. The establishment of a special fund in the Federation of B&H, which enables LGUs to finance EU projects under favourable credit terms with an interest rate subsidy, represents a good model that should be developed and improved in the coming period.

The lack of developed partnership networks, insufficient cooperation with relevant institutions, and the absence of proactive project planning within partnerships limit opportunities for attracting funds, especially within the framework of cross border and regional cooperation.
Based on the findings, it can be concluded that existing deficiencies in human, financial, and institutional capacities represent a key barrier to the greater use of available funds at LGUs level, while their improvement opens up the potential for better results in subsequent program cycles. In particular, it was noted that LGUs with city status have more completed projects and a higher utilization of funds compared to municipalities, which confirms that the level of capacity development directly impacts the results. On the other hand, based on the fact that 48.5% of the surveyed LGUs did not implement a single project from the IPA funds, it can be concluded that the success of using IPA funds in the LGUs is not satisfactory. The conducted research confirmed the hypothesis that the development of absorption capacities of LGU affects the degree of utilization of funds from IPA funds.

In this regard, it is recommended to systematically strengthen human resources, secure dedicated financial mechanisms for co-financing and pre financing projects, develop institutional networks and partnerships, and transition to a planned approach for project implementation. Only in this way will LGUs in B&H be able to make greater use of IPA funds and be prepared for the use of structural funds after accession to the EU. A major challenge for LGUs is to build adequate capacities to join the EU prepared and to take advantage of the numerous opportunities of the financial package that will be available to B&H as an EU member. For better preparation of LGUs for using of IPA funds, adequate professional training and mentoring support are needed to enable LGUs employees to enhance their knowledge for applying for pre accession EU funds, with primary focus on project writing (from conceiving the project idea, drafting the project proposal, filling out EU required forms to creating budgets), as well as in the area of public procurement (application of EU's PRAG rules for public procurement), and in project management (administration and reporting), along with improving English language skills (business English with focus on specific EU funds terminology).
To improve the use of IPA funds, the active participation of all actors in the European integration process is necessary, as well as the enhancement of the human, financial, and institutional capacities of LGUs that directly and indirectly affect the absorption of the IPA funds. It would be very important to implement the above mentioned recommendations so that the LGUs in B&H can “clip on” to the train of European integration, managed by the EU, and ensure greater utilization of IPA funds and readiness for the structural funds.

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A scientific paper

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PRIMARY SCHOOL POPULATION AS EARLY STRUCTURAL SIGNAL OF REGIONAL DIVERGENCE IN CROATIA

ABSTRACT

Demographic change is one of the key challenges of contemporary economic development and an integral part of the broader societal challenges framework. Its impact is particularly evident in the education system, raising questions about adaptation and the role of educational indicators in assessing social resilience. This paper examines the relationship between demographic dynamics in primary education and the socio-economic development of Croatian counties. Using data from the Ministry of Science and Education (2013–2023) and the official development index of the Ministry of Regional Development and EU Funds, quantitative methods (correlation and regression analysis) were applied to explore the strength and direction of these relationships. The findings demonstrate a strong and statistically significant association. More developed counties show stable or slightly increasing numbers of primary school students, while the least developed experience pronounced negative trends. The results also suggest that the number of primary school students can serve as an early and reliable indicator of regional development, as demographic stability is closely linked with higher development levels. Overall, the study highlights the importance of educational indicators for understanding resilience and underscores the need for territorially differentiated policies, contributing to a deeper understanding of the interlinkages between demographic trends and socio-economic development in Croatia.

Key words: *demographic change, primary school students, regional development, social resilience, socio-economic development, education system.*

1. Introduction

Demographic change represents one of the most profound structural challenges facing contemporary societies. Its regional dimension significantly shapes socio-economic structures, labour market dynamics and long-term development trajectories. This phenomenon is particularly visible across Europe, where many regions are confronted with depopulation, population ageing and a declining working-age population (OECD, 2024; Eurostat, 2025; Szymańska, 2022). These trends do not affect all territories equally; rather, they intensify regional disparities and reshape patterns of economic opportunity and social cohesion.
In this context, Croatia stands out as demographically vulnerable. According to the Croatian Bureau of Statistics (2024), Croatia's population in 2023 amounted to 3.86 million, with a negative natural increase of −13,429. The share of the population aged 65 and over reached 22.9%, while only 19.1% was aged 0–19. Particularly concerning is the sharp decline in live births observed since 2022 (Croatian Bureau of Statistics, 2025), reinforcing a long-term

downward trajectory and signalling implications for the education system, labour market and future human capital formation.

While demographic ageing and migration are widely analysed at the macroeconomic level, less attention has been paid to how these processes are reflected in educational indicators at the regional scale. The number of primary school students represents a particularly sensitive and forward-looking demographic indicator. As primary education is compulsory (Act on Education in Primary and Secondary Schools, 2008), this measure captures almost the entire population aged 7 to 15 and reflects recent fertility trends and migration flows with minimal delay.

Shrinking school cohorts do not merely indicate demographic contraction; they signal a potential reduction in future human capital and labour force capacity, with possible consequences for regional innovation, productivity and long-term competitiveness. In this sense, primary school enrolment can be interpreted as an early structural indicator of regional resilience and vulnerability.

International research confirms that demographic dynamics are closely linked to economic performance. The relationship between working-age population trends, dependency ratios and economic growth is well established (Khachatrian et al., 2023). Empirical evidence highlights human capital erosion in depopulating Polish regions (Bugowski, 2019) and demonstrates how demographic contraction and economic decline reinforce each other in Russian regions (Chernysheva, 2021). In Croatia, Nejašmić and Toskić (2013) argue that the decline in school-age children reflects deeper spatial and social imbalances threatening the sustainability of the "knowledge society." Other studies address operational consequences for school networks and county development capacity (Vuk & Vranković, 2016; Spevec & Vuk, 2012), as well as broader ageing and migration patterns (Tomić, 2020; Živić, 2024).

However, despite this growing body of research, no comprehensive empirical assessment has examined whether changes in primary school student numbers are systematically aligned with regional socio-economic development disparities across all Croatian counties. This gap limits our understanding of how educational demographic indicators reflect territorial divergence. This study therefore addresses the following research question:

To what extent are changes in the number of primary school students associated with the level of socio-economic development of Croatian counties, and can student cohort dynamics serve as an indicator of regional resilience and vulnerability?

The relationship between demographic indicators and development is complex and reciprocal. More developed regions may be better positioned to attract and retain young families, thereby stabilising school cohorts, while stable student numbers may also reflect underlying structural strengths. Rather than assuming strict causality, this study adopts an associational perspective and examines whether systematic alignment exists between educational demographic trends and development disparities.

The empirical analysis is based on administrative data from the Ministry of Science and Education (2024), covering total primary school enrolment in 2013/2014 and 2023/2024, combined with the official county Development Index published by the Ministry of Regional Development and EU Funds (2024). Correlation and regression analyses are applied to assess

the strength and direction of the relationship between demographic dynamics in primary education and socio-economic development levels.

The study contributes in three ways. Empirically, it provides the first comprehensive analysis of the relationship between primary school enrolment changes and regional development levels across all Croatian counties. Conceptually, it positions primary school enrolment as a forward-looking indicator embedded within broader processes of human capital formation and regional resilience. Methodologically, it integrates categorical and continuous measures of development within a quantitative framework. The findings offer insights for policymakers designing territorially differentiated demographic and educational strategies, particularly in regions facing depopulation and labour force contraction.

The paper is structured as follows. Chapter 2 reviews the relevant literature and develops the hypotheses. Chapter 3 presents the materials and methods. Chapter 4 reports the empirical results. Chapter 5 discusses the findings and their implications, and Chapter 6 concludes with policy recommendations and directions for future research.

2. Literature Review and Hypothesis Development

2.1. Demographic Changes and Their Long-Term Development Consequences

Demographic change has become one of the defining structural transformations of contemporary societies. Declining fertility, increasing life expectancy, migration flows and urban concentration are reshaping socio-economic systems across Europe (Eurostat, 2025). Their consequences are particularly pronounced in European countries, where sustained low fertility and ageing populations increasingly affect labour markets, fiscal sustainability and regional development trajectories (Szymańska, 2022; European Commission, 2021).

The economic implications are substantial. A shrinking population reduces labour supply, constrains productivity growth and increases pressure on pension and healthcare systems. Empirical evidence suggests that even a one-percentage-point increase in the working-age population can raise per capita GDP growth by approximately 1.6% (Cruz & Ahmed, 2018). Prolonged demographic contraction may therefore generate a cycle of reduced human capital and weakened regional competitiveness.

The demographic transition model provides the theoretical framework for understanding these processes (Caldwell et al., 2006; Lutz & Skirbekk, 2005). Most European countries have entered the final phase of this transition, characterised by fertility rates below replacement level and sustained ageing. In 2023, the EU fertility rate was 1.53, while Croatia recorded an even lower level (Eurostat, 2023). At the same time, life expectancy in many European countries exceeds 80 years (OECD, 2023).

Demographic decline has direct implications for human capital formation. Smaller birth cohorts translate into smaller student cohorts and a narrower future labour base. Persistent out-migration of young and educated individuals further amplifies regional disparities.

At the policy level, the European Union has integrated demographic concerns into broader social and family policy frameworks aimed at strengthening childcare provision and work–life balance (European Commission, 2017; 2019; 2022). Comparative evidence suggests that

coherent family policies may mitigate demographic decline in certain contexts (Stone & Wingerter, 2024; Ellingsæter, 2014).

The concept of regional resilience provides an analytical lens for interpreting these dynamics. Regional resilience refers to the ability of territories to adapt to structural change and maintain development trajectories (Pike et al., 2010; Dawley et al., 2010; Boschma, 2015). Regions experiencing depopulation may enter self-reinforcing cycles in which shrinking human capital undermines economic performance, accelerating further decline (Ferry & Vironen, 2011). In Croatia, such disparities are particularly visible between dynamic urban centres and less developed eastern and rural regions (Bakić, 2024).

Despite extensive research on ageing, migration and fertility, the empirical link between educational demographic indicators and regional development disparities remains underexplored. This gap motivates the present study.

2.2. The Number of Primary School Students as An Indicator of Future Human Capital

The number of primary school students is one of the most immediate indicators of demographic change. As primary education is compulsory (Act on Education in Primary and Secondary Schools, 2008), enrolment reflects fertility and migration trends with minimal time lag.

Declining school cohorts imply more than reduced enrolment. They signal contraction of the future workforce, narrowing of the tax base and diminished innovation potential. Education represents the foundational stage of human capital accumulation; persistent reductions in student numbers may therefore foreshadow structural labour shortages and weakened regional competitiveness.

Schools also serve as institutional anchors within local communities, contributing to social cohesion and territorial stability. Weak enrolment increases the risk of school closures, undermines local service networks and may accelerate out-migration, particularly in peripheral areas.

Croatian research has mainly addressed operational consequences of declining enrolment (Vuk & Vranković, 2016; Spevec & Vuk, 2012), without systematically linking educational trends to broader regional development indicators. International studies, however, increasingly recognise student numbers as proxies for structural dynamics. Evidence from Poland (Bugowski, 2019) and Russia (Chernysheva, 2021) demonstrates how shrinking cohorts align with regional stagnation and economic decline. Global analyses similarly indicate that stable child cohorts correlate with stronger long-term growth prospects (Cruz & Ahmed, 2018).

In Croatia, many smaller municipalities face fiscal constraints in maintaining educational infrastructure (Bakić, 2024; Joint Research Centre, 2021). Declining enrolment may also create long-term mismatches in teacher supply and demand. Consequently, primary school enrolment should be interpreted not merely as an administrative statistic, but as a forward-looking indicator of regional development capacity and resilience.

2.3. Regional Inequalities and Educational Indicators

Demographic processes unfold unevenly across space, with regional inequalities shaping both their intensity and long-term consequences. More developed regions are generally better

equipped to mitigate depopulation pressures, while less developed areas face accelerated ageing, out-migration and shrinking school cohorts (Batey & Madden, 1999; Joint Research Centre, 2021).

Empirical evidence indicates that institutional and fiscal capacity determine whether regions absorb demographic shocks or enter self-reinforcing cycles of decline (Khachatrian et al., 2023; Kozlovskyi et al., 2020). In this context, primary school enrolment may serve as a measurable reflection of broader structural inequalities and long-term development capacity.

In Croatia, regional disparities are assessed through the official Development Index, calculated in accordance with the Act on Regional Development (2014) and the Regulation on the Development Index (2017). The index is a composite indicator incorporating income levels, unemployment, demographic trends, educational attainment and ageing. Counties are classified into four development groups, ranging from the least developed (Group I) to the most developed (Group IV) (Government of the Republic of Croatia, 2024).

Table 1 presents the 2024 Development Index values for all Croatian counties and their official classification.

Table 1: Development index values and official classification of Croatian counties (2024)

County	Development index	Group
Vukovar-Srijem	72.3	I
Brod-Posavina	75.1	I
Požega-Slavonia	78.4	I
Sisak-Moslavina	80.2	I
Virovitica-Podravina	82.6	I
Osijek-Baranja	85.9	II
Bjelovar-Bilogora	87.3	II
Koprivnica-Križevci	89.1	II
Varaždin	91.5	II
Lika-Senj	93.2	II
Karlovac	94.8	II
Krapina-Zagorje	96.3	III
Šibenik-Knin	97.7	III
Split-Dalmatia	99.1	III
Zagreb	101.4	III
Međimurje	103.2	III
Primorje-Gorski Kotar	105.6	IV
Zadar	107.9	IV
Dubrovnik-Neretva	109.3	IV
Istria	111.7	IV
City of Zagreb	115.2	IV

Source: Author

The differences are pronounced. Counties such as the City of Zagreb and Istria belong to the highest development group, while several counties in Eastern Croatia are classified among the least developed. These disparities suggest that economically stronger regions possess greater capacity to retain and attract young families, potentially contributing to greater stability of school-age cohorts.

Rather than assuming strict causality, this study adopts an associational perspective and examines whether regional development levels are systematically aligned with changes in

primary school student numbers. In this framework, stability of school cohorts is interpreted as a potential structural signal of regional resilience.
Accordingly, the study formulates the following hypotheses:

- H1: There is a statistically significant association between county development level and the percentage change in the number of primary school students.
- H2: Counties belonging to higher development groups exhibit more favourable trends in primary school student numbers compared to less developed counties.

Confirming such alignment would support the interpretation of primary school enrolment as a sensitive indicator of regional resilience and structural stability.

3. Materials and Methods

3.1. Research design and data sources

This study applies a quantitative cross-sectional research design to examine the relationship between regional development and demographic dynamics in primary education across Croatian counties.

The analytical framework combines two complementary statistical approaches. Pearson's correlation analysis assesses the association between official county development groups (I–IV) and the percentage change in primary school student numbers. In addition, a simple linear regression model evaluates the relationship between the continuous Development Index and changes in student cohorts.

The unit of analysis comprises all 21 Croatian counties, including the City of Zagreb, ensuring full territorial coverage.

Data on primary school students were obtained.from official statistics published by the Ministry of Science, Education and Youth (2024), specifically from the digital platform ŠeR – Školski e-Rudnik based on the national information system e-Matica. The total number of students in the school years 2013/2014 and 2023/2024 was used to calculate the percentage change over the ten-year period, which serves as the primary demographic indicator.

Regional development was measured using the official continuous Development Index published by the Ministry of Regional Development and EU Funds (2024). Although counties are classified into four development groups, the regression analysis relies on continuous index values in order to retain full variability of socio-economic differences.

This approach enables both categorical comparison of development levels and estimation of the quantitative relationship between socio-economic development and demographic stability.

3.2. Variables and Analytical Approach

The analysis is based on the assumption that regional socio-economic conditions are associated with demographic dynamics in primary education. However, the study adopts an associational rather than causal interpretation.
The dependent variable is defined as the percentage change in the total number of primary school students between 2013/2014 and 2023/2024.

The independent variable is the continuous Development Index, reflecting composite socio-economic conditions across counties.
To estimate the relationship, the following simple linear regression model was specified:

$$Y = \beta_0 + \beta_1 X + \varepsilon$$

where:

- Y represents the percentage change in the number of primary school students,
- X denotes the Development Index,
- β_0 is the intercept,
- β_1 is the slope coefficient,
- ε is the error term.

3.3. Statistical Processing and Tools

Statistical analysis was conducted using IBM SPSS Statistics 27, while supplementary visualisations were prepared in Microsoft Excel.

The analysis followed three stages. First, descriptive statistics (minimum, maximum, mean and standard deviation) were calculated to summarise regional variation in demographic trends.
Second, Pearson's correlation coefficient was computed to assess the association between official county development groups (I–IV) and the percentage change in primary school student numbers.

Third, a simple linear regression analysis was performed to estimate the relationship between the continuous Development Index and the percentage change in student cohorts.

Model evaluation included the coefficient of determination (R^2), the F-test for overall model significance and t-tests for regression coefficients. Standard diagnostic procedures were applied to verify regression assumptions, including linearity, normality of residuals, homoscedasticity and independence of errors (Janssens, 2008).

Given the cross-sectional design and the composite nature of the Development Index, findings are interpreted as statistically significant associations rather than causal effects.

3.4. Data Overview

Table 2 presents the absolute and percentage changes in the number of primary school students across Croatian counties between 2013 and 2023, together with their official development group classification according to the index.

Descriptive results indicate clear territorial disparities. Counties classified in Group I (least developed) recorded substantial declines in student numbers, exceeding 20% in several cases, with Vukovar-Srijem County showing the largest decrease (−29.36%). In contrast, counties in Group IV (most developed) display greater demographic stability, with positive enrolment trends observed in Istria (+5.16%) and the City of Zagreb (+9.39%).

While descriptive statistics do not establish statistical significance, the observed patterns suggest alignment between development level and demographic stability in primary education.

Table 2: Change in the number of primary school students and classification of counties according to the development index (2013–2023)

County / Region	Change in Number	Percentage Change	Development Group
Vukovar-Srijem	-4,530	-29.36%	1
Brod-Posavina	-3,559	-26.17%	1
Požega-Slavonia	-1,607	-24.63%	1
Sisak-Moslavina	-2,755	-21.63%	1
Virovitica-Podravina	-1,596	-19.99%	1
Osijek-Baranja	-3,130	-18.74%	2
Bjelovar-Bilogora	-1,520	-16.17%	2
Koprivnica-Križevci	-1,310	-14.03%	2
Varaždin	-1,963	-13.78%	3
Lika-Senj	-467	-13.67%	2
Karlovac	-1,328	-12.07%	2
Krapina-Zagorje	-1,121	-11.06%	3
Šibenik-Knin	-853	-11.01%	2
Split-Dalmatia	-2,526	-8.22%	3
Zagreb	-1,697	-6.47%	4
Međimurje	-421	-3.23%	3
Zadar	-316	-2.26%	4
Primorje-Gorski Kotar	-77	-0.40%	3
Dubrovnik-Neretva	+221	+2.35%	4
Istria	+741	+5.16%	4
City of Zagreb	+5,471	+9.39%	4

Source: Author

4. Results

4.1. Results of the Descriptive Statistics

Table 3 presents descriptive statistics for the main variables, including the absolute and percentage change in the number of primary school students and the level of regional development.

On average, Croatian counties recorded a decline of 11.24% in primary school student numbers over the observed period (2013–2023). The percentage change ranged from −29.36% in Vukovar-Srijem County to an increase of +9.39% in the City of Zagreb. In absolute terms, changes varied between a loss of 4,530 students and a gain of 5,471 students.

The mean value of the categorical development level is 2.52 (SD = 1.12), indicating distribution across all four development groups. The continuous Development Index shows a mean of 93.98 (SD = 13.04), with values ranging from 72.3 to 115.0, reflecting substantial territorial variation in socio-economic conditions.

Table 3: Descriptive Statistics of the Main Variables

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Number of students	21	-4,530	5,471	-1,159.19	434.81
Percentage change	21	-29.36	9.39	-11.2376	10.46408
Development (category 1–4)	21	1.00	4.00	2.5238	1.12335
Development Index (continuous)	21	72.3	115.00	93.98	13.04

Source: Author

The above descriptive statistics indicate notable territorial variation in demographic trends. The following section examines whether these differences are statistically associated with regional development levels.

4.2. Correlation Analysis

Pearson's correlation coefficient was used to examine the linear relationship between regional development and demographic change in primary education. The analysis included both the official development categories (Groups I–IV) and the continuous Development Index, as well as the absolute and percentage changes in primary school student numbers. The correlation matrix is presented in Table 4.

Table 4: Pearson Correlation Matrix

Variables	Number of Students	Percentage Change	Development Category (1–4)	Development Index
Number of Students	1	.830**	.641**	.702**
Percentage Change	.830**	1	.910**	.823**
Development Category (1–4)	.641**	.910**	1	.948**
Development Index	.702**	.823**	.948**	1

*Note: Correlation is significant at the 0.01 level (2-tailed)

Source: Author

The results show a statistically significant positive correlation between the continuous Development Index and the percentage change in primary school student numbers ($r = 0.823$; $p < 0.001$). Counties with higher development levels tend to experience smaller declines or positive enrolment trends.

A similarly strong correlation is observed between development category (1–4) and percentage change ($r = 0.910$; $p < 0.001$), indicating alignment between official territorial classification and demographic dynamics.

Correlations involving absolute change in student numbers are lower, although still statistically significant. This difference reflects the influence of county size on absolute values, whereas percentage change provides a more comparable measure of demographic variation across regions.

To further assess this relationship, the following section presents regression analysis using the continuous Development Index.

4.3. Results of the Regression Analysis

Prior to estimating the regression model, standard diagnostic tests were conducted to verify model assumptions. Examination of residual distribution, Cook's distance and residual plots indicated no violations of normality, homoscedasticity, linearity or independence assumptions. The model was therefore considered statistically appropriate for analysis (Laerd Statistics, 2025).

Table 5 presents the regression results examining the effect of the continuous Development Index on the percentage change in primary school student numbers.

Table 5: Results of the regression analysis

Parameter / Indicator	**Value**
R	0.823
R^2	0.677
Adjusted R^2	0.660
Standard Error of the Estimate	6.104
F (1,19)	39.774
p-value (model)	< 0.001
Constant (β_0)	-53.054 ($p < 0.001$)
Development Index (β_1)	0.454 ($p < 0.001$)
Standardized Beta Coefficient	0.823

Source: Author

The analysis reveals a statistically significant positive relationship between the Development Index and the percentage change in primary school student numbers ($R = 0.823$; $p < 0.001$). The coefficient of determination ($R^2 = 0.677$) indicates that approximately 67.7% of the variance in demographic change across counties is associated with differences in socio-economic development levels.

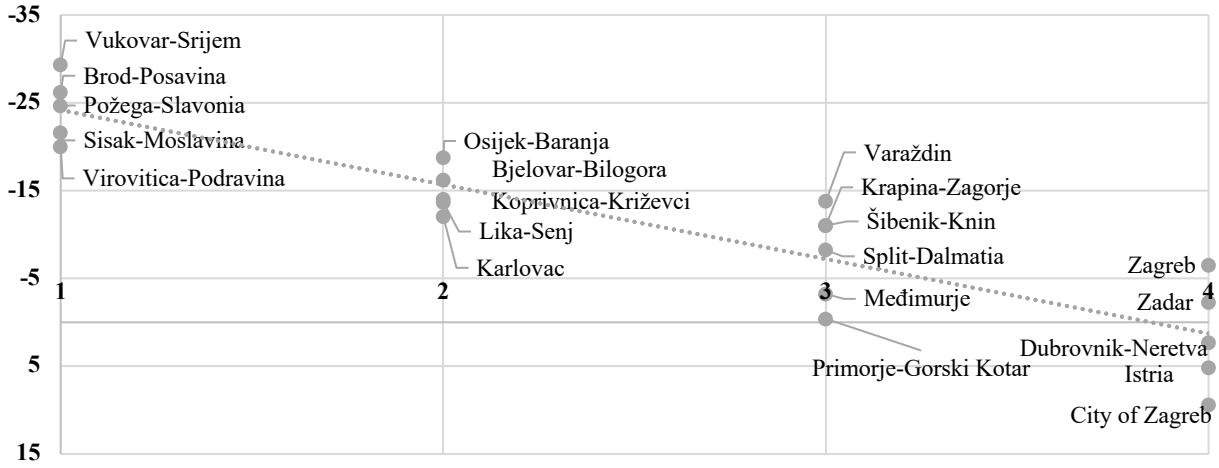
The estimated regression equation is:

$$\textit{Percentage change in student numbers} = -53.054 + 0.454 \times \textit{Development Index}$$

The positive slope coefficient ($\beta_1 = 0.454$; $p < 0.001$) suggests that higher development levels are associated with more favourable demographic trends in primary education. On average, a one-point increase in the Development Index corresponds to a 0.45 percentage-point improvement in the enrolment trend.

In addition,.while the regression model is estimated using the continuous Development Index, Figure 1 provides an additional visual illustration of the relationship across official development categories (Groups I–IV). The graphical representation clearly shows that counties in higher development groups tend to cluster around more favourable enrolment trends, whereas lower development groups exhibit more pronounced demographic contraction.

Figure 1: The relationship between economic development category and percentage change in primary school student numbers



Source: Author

It should also be noted that the Development Index partially incorporates demographic components, which may introduce a degree of structural overlap between variables. Therefore, the findings should be interpreted as evidence of systemic alignment rather than independent predictive causation.

5. Discussion and Conclusion

This study examined whether changes in the number of primary school students are systematically associated with the level of socio-economic development across Croatian counties, and whether educational demographic dynamics can serve as an indicator of regional resilience and vulnerability.

The empirical results provide clear support for both research hypotheses. Hypothesis H1, which assumed a statistically significant association between county development level and the percentage change in primary school student numbers, was confirmed through strong and statistically significant correlation results. Hypothesis H2 was also supported, as counties belonging to higher development groups consistently exhibited more favourable enrolment trends compared to less developed counties. Together, these findings provide an affirmative answer to the research question: changes in primary school student numbers are systematically aligned with regional socio-economic development levels, and student cohort dynamics can indeed function as a meaningful indicator of territorial resilience and vulnerability.

The identified pattern suggests that demographic divergence is not randomly distributed across space, but structurally follows existing socio-economic hierarchies. Counties with stronger labour markets, higher income levels and more favourable institutional conditions demonstrate greater demographic stability in primary education, whereas structurally weaker regions face more pronounced contraction. This finding is consistent with earlier Croatian research emphasising the link between demographic stability and regional development capacity (Nejašmić & Toskić, 2013; Batey & Madden, 1999), as well as international evidence showing that economic strength and institutional quality significantly shape demographic sustainability (Lee, 2012; Kozlovskyi et al., 2020).

Moreover, the results align with theoretical perspectives on regional resilience (Pike et al., 2010; Boschma, 2015), which emphasise the importance of adaptive capacity and human capital in sustaining development trajectories. The observed association between development level and student cohort dynamics suggests that educational demographic indicators are embedded within broader structural processes of territorial adjustment and divergence. In this sense, the Croatian case reflects wider European trends in which economically dynamic regions tend to stabilise or attract younger populations, while peripheral areas experience cumulative decline. Although the analysis is correlational and does not establish direct causality—particularly given that the Development Index incorporates demographic components—the strength and consistency of the statistical relationship indicate systemic alignment rather than coincidence. Educational demographic trends appear deeply intertwined with regional economic structures, institutional capacity and labour market conditions.

The implications extend beyond education policy. Persistent contraction of primary school cohorts implies a gradual narrowing of the future labour force base. In a small open economy increasingly dependent on integration into European value chains and higher value-added production, human capital constitutes a central determinant of productivity growth, innovation performance and export competitiveness. If current demographic trajectories persist, less developed counties may face structural labour shortages, reduced entrepreneurial dynamism and diminished capacity to attract and retain investment.

At the national level, territorially uneven demographic decline may lead to widening disparities in productive potential. Regions experiencing demographic stability are likely to maintain stronger foundations for labour market participation and economic growth, while those facing sustained contraction may encounter cumulative disadvantages. Over time, this dynamic may contribute to the demographic stratification of territory, where socio-economic hierarchies are progressively mirrored in the spatial distribution of future labour force cohorts.

From a strategic perspective, primary school enrolment should therefore be interpreted not merely as an educational statistic, but as an early structural indicator of long-term development capacity. Monitoring trends in school cohorts provides insight into future labour supply constraints, regional competitiveness risks and potential imbalances in human capital formation. Recognising this connection may contribute to more integrated demographic, educational and development strategies aimed at preventing the reinforcement of territorial inequalities.

The study is subject to limitations related to the use of aggregate cross-sectional data and the composite structure of the Development Index. Future research could apply longitudinal designs, spatial econometric modelling or sector-specific labour force projections to deepen understanding of how educational demographic dynamics influence long-term regional and national economic trajectories.

Overall, the findings demonstrate that primary school enrolment reflects broader socio-economic processes and can serve as a sensitive indicator of regional resilience, structural stability and future economic sustainability. Addressing demographic decline is therefore not solely a matter of educational adjustment, but a central challenge for Croatia’s long-term development model, export capacity and competitive positioning within the European economic space.

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A scientific paper

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INNOVATIVE AND SUSTAINABLE HEALTHCARE SYSTEM OF THE REPUBLIC OF CROATIA WITHIN THE EUROPEAN CONTEXT

ABSTRACT

This paper examines the sustainability and efficiency of the healthcare system in the Republic of Croatia within the broader European Union context, with a particular focus on improving Healthy Life Years (HLY) as a key outcome indicator. The main aim of the study is to analyse the interdependence between healthcare resources (medical personnel, hospital capacity, and infrastructure) and HLY, and to develop a model that supports more effective resource allocation and strategic decision-making. In addition, the study seeks to contribute to a better understanding of how structural and organizational factors influence long-term healthcare system performance.
The research is based on Eurostat data for selected EU member states over the period 2015–2019. A combination of hierarchical clustering and an Adaptive Neuro-Fuzzy Inference System (ANFIS) is applied to identify patterns and model complex relationships between demographic and healthcare variables. This methodological approach enables the analysis of nonlinear relationships and provides a more comprehensive insight into the interaction of key determinants of healthcare outcomes.
The findings indicate that HLY is not determined by a single factor, but rather by the balanced interaction of healthcare resources. Efficient allocation and coordination of medical staff, hospital beds, and care capacity are shown to be critical for achieving better health outcomes. The results highlight the importance of integrated and data-driven healthcare planning, as well as the role of digital transformation in improving system resilience and adaptability.
The paper contributes to the literature by providing an innovative methodological framework for evaluating healthcare system performance and offers policy-relevant insights for improving the sustainability and effectiveness of the Croatian healthcare system in line with EU strategies, particularly in the context of demographic change and increasing healthcare demands.

***Key words:** Value-Based Healthcare; Digital Transformation; Health System Resilience; Resource Allocation; Healthy Life Expectancy.*

1. Introduction

Timely recognition of global trends, as well as one's own strengths and weaknesses, is crucial for transforming challenges and new opportunities into development policies. The sustainability of healthcare systems is determined by the quality of the system and by the relationship between healthcare professionals and individuals in relation to health. In response to growing pressures

on national healthcare systems, the European Union (EU) has adopted the comprehensive programme "EU4Health" as a strategic response to the sustainability of healthcare systems in its member states. The objectives of this programme include improving and promoting the health of EU citizens, combating cross-border health threats, ensuring the availability and affordability of medicines and medical products, and strengthening healthcare systems and their resilience through the efficient use of resources. Among the most relevant sub-objectives of the latter, particularly in the context of the digital age and comprehensive EU strategies, are the efficient systematization of health data, the strengthening of digital tools and services, and digital transformation.

The Republic of Croatia is required to align its healthcare system with EU policies while addressing national public health needs. This involves not only formal compliance, but also the effective integration of European priorities into domestic policy frameworks. The modernization of healthcare infrastructure and financial sustainability must be aligned with rapid digitalization and increasingly complex information management, with the aim of improving healthcare quality. These improvements should ultimately lead to an increase in healthy life years and overall quality of life. Accordingly, technological and digital development must be coordinated with healthcare workforce capacities and hospital infrastructure to ensure both sustainability and high-quality healthcare provision.

In this context, healthcare sustainability must be assessed not only through expenditure and efficiency, but also through population health outcomes. Contemporary systems are expected to deliver high-quality, accessible, and resilient care amid demographic ageing, labour shortages, regional disparities, fiscal constraints, and ongoing digital transformation. This is particularly relevant for Croatia, which must address both domestic structural challenges and EU reform requirements. Consequently, strategic healthcare decision-making requires an integrated analytical framework that incorporates demographic and health indicators, system capacities, and long-term health outcomes.

Accordingly, the purpose of this research is to analyse the relationship between healthy life years and key demographic and healthcare variables to support the development of strategic guidelines for a value-based healthcare system. The study examines the impact of healthcare professionals, physicians, hospital beds, and the average length of hospital stay on healthy life years. This enables the identification of the most relevant resources for improving healthcare strategy implementation in Croatia and informing future policy design.

The concept of value-based healthcare is central in this context, as value is increasingly assessed through outcomes relative to resources used rather than service volume alone. This approach aligns with EU strategies and sustainable development goals by emphasizing improved health outcomes, efficient resource use, and system resilience. For Croatia, this implies that healthcare modernization must go beyond infrastructure investment to include the coordinated development of human resources, system capacities, digital tools, and evidence-based public health policies.

Healthy life years (HLY) is a key indicator of healthcare system effectiveness and overall population health, measuring the number of years lived without significant health limitations. It provides a comprehensive view of healthcare outcomes, including prevention, accessibility, and system performance. For Croatia, improving HLY is particularly important as it is closely linked to quality of life, labour market participation, fiscal sustainability, and long-term healthcare system resilience.

The Croatian healthcare system is faced with numerous challenges in this respect. These include unequal regional distribution of healthcare infrastructure, persistent shortages of medical personnel, especially in certain specializations and less developed areas, pressures on hospital capacities, and the need to improve the efficiency of service delivery. In addition, the burden of chronic diseases, population ageing, and rising expectations regarding the quality and accessibility of healthcare further increase the need for more precise and analytically grounded models of healthcare planning. Under such conditions, it is necessary to identify which elements of healthcare capacity are most strongly associated with healthy life years and whether a more balanced allocation of resources could contribute to better outcomes.

The main aim of this paper is therefore to examine the relationship between healthy life years and selected healthcare system determinants in the Republic of Croatia within the broader European context, and to develop a model that may contribute to more effective strategic decision-making in healthcare resource allocation. The object of the research is the analysis of a model for improving strategic decision-making aimed at enhancing healthcare quality and resource allocation. The study is based on selected demographic and healthcare indicators for EU member states comparable to Croatia and uses quantitative and machine learning methods to identify patterns, interdependencies, and implications for healthcare sustainability.

To respond more clearly to the reviewers' remarks and to define the research focus more explicitly, the paper addresses the following research questions:
RQ1: What is the relationship between healthy life years and selected healthcare system resources in the observed EU member states?
RQ2: Which of the selected determinants of healthcare capacity have the strongest impact on healthy life years?
RQ3: How can the findings of the analysis support more effective strategic decision-making and resource allocation in the Croatian healthcare system?
Based on the theoretical framework and the selected empirical indicators, the main research hypothesis set in this paper is as follows:
H1: There is a close and direct relationship between the number of medical personnel, hospital capacities, selected healthcare system indicators, and the population's healthy life years (HLY).
To test this hypothesis, the paper combines a literature-based framework with empirical analysis using Eurostat data and quantitative and machine learning methods. The study contributes to understanding the Croatian healthcare system in a European context and supports the development of strategic guidelines for improving system resilience, resource efficiency, and health outcomes.

The paper is structured into five sections: literature review, methodology, results, and concluding remarks with policy implications and recommendations.

2. Previous Research

The World Health Organization's definition of health is no longer entirely appropriate for the present scenario. This necessitates a shift in existing approaches to value-based healthcare and health outcomes, which must be patient-centred through the development of meaningful metrics tailored to treatment goals and adjusted for measures of overall health status. This is especially applicable with respect to sustainability and resilience in healthcare systems (Card, 2017). As a parallel approach, Badash et al. (2017) suggest that a new conceptualization of health must also include an organizational and value-based system necessary to meet the specific and individual

needs of patients. In this context, the "value-based system" is developed to provide high-quality healthcare at the lowest cost under conditions of limited resources, being a solution to the increasing crisis with health care systems and the disproportionate allocation of resources among demographic groups (Badash et al., 2017). Furthermore, in the era of increased personalization, which means treating patients as per their profiles and utilizing latest information technologies to collect medical data (Celik Ertuğrul and Elçi, 2020), consideration of innovation capacity as a means of reinforcing system resilience is also suggested (Bristow and Healy, 2018). It is essential that these requirements and objectives also be compatible with the paradigm of sustainable development (Lang and Rayner, 2015). Sustainable development goals being adopted by EU member states creates new agenda for public health action both nationally and globally. This is particularly important in the context of countries with low- and middle-income levels that are facing complex demographic transitions (Reddy et al., 2017). The Republic of Croatia, characterized by a narrow scope of healthcare activities and vertical structures often focused on single diseases (Ivčić et al., 2021), faces numerous challenges in transitioning toward modern healthcare systems (Džakula et al., 2021). Effective solutions for functional healthcare systems require a contemporary approach that considers both qualitative and quantitative factors, as well as their implementation into decision-making systems (Brlečić Valčić and Bagarić, 2017).

Healthcare systems of countries throughout Europe have also become increasingly monitored and evaluated in a globalized context. As welfare states attempt to balance population needs with the constraints of scarce resources, novel approaches to sustainability of health service provision have developed (Borgonovi et al., 2018). It is of interest to point out the myriad pressures that contemporary healthcare systems face (Story et al., 2017) such as manpower, finances and quality and safety (Fischer, 2014). All these challenges are not individual in scope, but are indicative of systemic challenges that confronted industrialized societies. From a Croatian perspective, you will be able to gain insights into how flexible these approaches are relative to differing national healthcare system needs and where they can be improved. The "EU4Health" programme is a post-pandemic European Union response, and has affected patients, doctors and health systems around Europe. This programme is not simply a response to a crisis and, as such, has the wider view for building resilience for health systems and preparing them for future challenges. The programme is guided by four general objectives, which are detailed in several specific objectives. It highlights the objective and its sub-objectives, such as strengthening healthcare systems, resilience, efficient resource utilization and health data generation, improving access to healthcare, developing and implementing EU health legislation based on evidence-based decision-making and the integration, collaboration and coordination between national health and care systems for the purposes of this research.
Croatia's challenge related to sustainability is mainly due to financial constraints and demands on the healthcare budget. There is geographic and infrastructural inequality that is problematic. Although parts of Croatia are relatively well served, rural regions or underdeveloped areas are often deprived of medical personnel or some basic form of healthcare infrastructure. And so invest in infrastructure. Without a systematic and long-term plan to shore up these areas, not just financial ones, and without a plan in place for retaining medical staff, with modernizing healthcare institutions, finances are not enough. Strengthening capacity to crisis situations such as the establishment of reserve teams of qualified medical staff could greatly enhance Croatia's capacity to resist future threats to health. Therefore, this topic requires an analytical review of theoretical concepts and investigations into healthcare systems, particularly digital health and its role in modernizing healthcare (Quaglio et al., 2016).

This paper examines the Healthy Life Years (HLY) indicator. It is a vital determinant of the general (i.e., population) health status and the standards of care offered (Gentry and Badrinath, 2017). This is an indicator that evaluates how long a person might live comfortably; it is employed by many European countries to measure how health policy and interventions are working. As a member of the European Union, Croatia also faces the challenge of lengthening its citizens' healthy life years, which is correlated with lower levels of self-perceived health than that found in some other EU countries (Foster and Walker, 2014). Healthy life years for persons aged 65 were below the average for Europe according to Eurostat (2020), indicating the need to improve preventive and curative measures within the healthcare system. Healthy life years do not depend solely on the availability of healthcare services but also on lifestyle, socioeconomic conditions, and education (Marmot, 2017). This, in turn, highlights the need for a public health approach that includes a social view of the larger context.

Socioeconomic health disparities in Croatia are evident with members of the lower income strata and the education strata reporting worse self-evaluations and shorter healthy life expectancy. This trend emphasises the importance in informing public health policies on reducing health inequalities, particularly in terms of promoting healthy lifestyles, improving health education, and widening access to preventive healthcare services (Bandurska, 2022). Strategies by the European Union are also based on the extension of healthy life years as a critical index of the viability of healthcare systems (OECD/European Union, 2018). Moreover, Croatia must further adapt its policies, so as to make people aware that preventive healthcare is important and improve the perception of overall health status. Thus, the burden on budget allocation and human resources (i.e., doctors, or other healthcare personnel responsible for delivering high-quality care) is lowered, and the future of public health in Croatia becomes bright. In Croatia, personalized care is rapidly changing the face of healthcare, and incorporating self-assessed health measures at every stage can help to bring about healthcare reform, improve patient satisfaction for this service or that and raise all levels of medical quality (Kontis et al., 2017). The quality-of-care delivery itself is a crucial aspect of healthcare quality. Healthcare providers must provide the right level and variety of treatment, but also their safety, providing the bedrock on which all other components of quality care are based (Allen-Duck et al., 2017). The success of a healthcare system relies on striking a balance between efficiency and access with security in mind (Ellner et al., 2015). Hence, one of the keys to improving healthcare is the improvement of healthcare resource management, including both human resources and technology (WHO, 2018).

Patient-centered care remains a critical pillar in maintaining high-quality healthcare services. As a paradigm, this places the patient at the heart of the decision-making process, allowing care to be individualized and responsive to the specific needs and preferences of each person. People who participate in making decisions about their care report much higher satisfaction and better health outcomes (Barry and Edgman-Levitan, 2012). It further establishes the importance of skills development for good communication between healthcare providers and providing the resources for continuous education of medical staff, essential for successful models of patient-centered care (Ellner et al., 2015). Given the shortage of healthcare professionals in Croatia, digital education of human resources and the adoption of solutions based on artificial intelligence in hospitals and clinics have significant benefits (Varnosfaderani and Forouzanfar, 2024). Automating administrative tasks and logistical functions can also boost efficiency as healthcare professionals can concentrate on providing personalized care (Pacis et al., 2018).

3. Methodology and Data Overview

The identification of relevant determinants and factors for monitoring healthcare strategies was based on literature sources and available data from the Eurostat database (https://ec.europa.eu/eurostat). Data related to the monitoring of healthcare systems for selected EU member states and for the Republic of Croatia include healthy life years, the number of hospital beds available relative to population, the average number of days patients stay in hospitals, the number of physicians, healthcare nursing and care professionals, and population size. These variables were selected in accordance with the theoretical basis of the study and their relevance for assessing healthcare capacity and health outcomes.

The empirical analysis covers the period 2015–2019. This period was selected to avoid distortions related to the COVID-19 pandemic and to observe healthcare systems under relatively stable conditions. At the same time, it represents a sufficiently long observation period for examining patterns associated with the implementation of modern healthcare strategies in the European Union.

The sample of observed EU countries was defined based on data availability and comparability with the Republic of Croatia, particularly in terms of population size. Countries with populations between 1 and 12 million inhabitants were included to reduce structural heterogeneity and improve comparability in the modelling process. Very large countries and countries with fewer than one million inhabitants were excluded because such differences in system scale could introduce substantial deviations into the analysis. Based on these criteria, a total of 13 member states were selected: Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Latvia, Lithuania, Hungary, Austria, Slovenia, Finland, Sweden, and Croatia. The inclusion of these countries enables a balanced comparison group within the EU context and avoids distortions that may arise from very large or very small healthcare systems.
Table 1 presents the selected parameters used in the analysis.

Table 1: Selected Parameters for Analysis

Variable	Description	Unit
Population	Total resident population	number of inhabitants
Healthy Life Years (HLY)	Expected years lived without severe or moderate health limitations	years
Hospital Beds	Available hospital beds	per 100,000 inhabitants
Number of Physicians	Practicing physicians	per 100,000 inhabitants
Average Length of Hospital Stay	Average inpatient stay	days
Healthcare Nursing and Care Professionals	Nurses and midwives are actively employed in healthcare	per 100,000 inhabitants

Source: Authors' systematization based on data and definitions from the EUROSTAT database

The dataset was compiled from the European statistical network EUROSTAT. In cases where missing data occurred, incomplete observations were excluded from the analysis to preserve the consistency and comparability of the dataset. All selected data were standardized before analysis to ensure equal consistency of all variables and eliminate discrepancies in measurement

scales while maintaining proportionality. Standardization of variables was carried out using the Z-transformation method, whereby a new variable with a mean of 0 and standard deviation of 1 was created (Reyes, 2003).

The first stage of the analysis employed hierarchical clustering. Hierarchical clustering is a powerful unsupervised learning method with a wide range of applications in social science, biology, and computer science (Theodoridis and Koutroumbas, 2009). One of its key advantages is the possibility of constructing a dendrogram, which visualizes relationships between data points and their similarities. The dendrogram is built iteratively by combining the nearest pair, beginning with each object treated separately and gradually forming larger groups based on similarity. In this research, hierarchical clustering was used to group countries according to similarities in selected healthcare indicators and to identify comparable patterns among healthcare systems.

The second stage of the analysis applied the Adaptive Neuro-Fuzzy Inference System (ANFIS). ANFIS is a hybrid computational intelligence approach that combines the modelling capabilities of fuzzy logic with the learning ability of artificial neural networks (Singh et al., 2009; Mathur et al., 2016). Fuzzy logic provides a structured way of dealing with uncertainty and imprecision, while neural networks are effective in learning from data and modelling complex nonlinear relationships. This is particularly important in healthcare research, where relationships between resources and outcomes are rarely strictly linear. For that reason, ANFIS was selected as an appropriate method for modelling the interdependence between healthcare resources and healthy life years.

The created ANFIS model in this research consists of 78 nodes and includes 108 linear parameters and 27 nonlinear parameters, resulting in a total of 135 parameters. The model was trained using 65 data pairs, and a total of 27 fuzzy rules were defined within the system. The minimum training root mean square error (RMSE) achieved by the model is 0.0467248.

Given the limited sample size, a separate checking dataset was not used during the training process. However, model reliability was assessed through the stability of the obtained relationships and the consistency of results across the analysed dataset. In this sense, the model should be understood primarily as an exploratory analytical tool that supports the interpretation of complex interactions between healthcare capacity indicators and healthy life years.

To improve readability, Table 2 reports average values for the period 2015–2019, while the full annual dataset was used in the modelling procedure.

Table 2: Summary Data for Analysis and Modelling (average values, 2015–2019)

Country	Population	Healthy Life Years (HLY)	Hospital Beds	Avg. Length of Stay (days)	Physicians	Nursing & Care Professionals
Belgium	11,350,845	63.48	568.79	7.29	309.35	1,191.22
Bulgaria	7,101,583	65.10	745.37	5.24	415.68	482.23
Czech Republic	10,586,159	62.48	663.15	9.36	402.60	868.95
Denmark	5,740,601	59.78	258.78	5.62	409.67	1,037.73
Estonia	1,318,080	55.50	463.57	7.66	345.84	651.25
Croatia	4,150,387	57.30	557.45	8.34	334.99	684.58
Latvia	1,951,903	52.68	557.95	8.28	323.73	473.23
Lithuania	2,852,162	57.52	659.92	7.65	450.60	803.71
Hungary	9,806,949	60.38	697.46	9.53	330.21	674.64
Austria	8,747,861	57.26	735.70	8.31	519.26	779.14

Country	Population	Healthy Life Years (HLY)	Hospital Beds	Avg. Length of Stay (days)	Physicians	Nursing & Care Professionals
Slovenia	2,068,549	57.56	447.98	6.91	307.61	985.66
Finland	5,498,681	57.42	371.31	8.38	345.17	1,374.25
Sweden	9,988,790	72.92	223.89	5.76	425.72	1,167.20

Source: Authors' systematization based on EUROSTAT data

Using quantitative methods and machine learning techniques, the interdependence of the selected factors was examined regarding the nature of the variables and their relationships. The models created in this analysis were used to assess the effect of the variables on healthy life years, with the aim of evaluating healthcare systems in the selected countries. Based on the performed analysis, a conceptual model was established to support decision-making on investment in the healthcare system of the Republic of Croatia, considering available resources and the perspective of EU healthcare strategies.

4. Results and Discussion

As part of this research and the objectives have been set, it is urgent that the interrelationships among the major factors shaping healthcare systems are examined and analysed. Building a conceptual model that reflects the specific challenges and opportunities in Croatia will require an understanding of the complex relationships between variables such as the availability of healthcare resources and professionals in achieving high-quality healthcare under modern conditions. During this section of studies, the goal is to examine the impact and interdependence of these factors, lay down a strong methodological underpinning for constructing a conceptual model, and provide guidelines for further research. This will facilitate the development of strategic decision-making tools for the benefit of healthcare and its management and ultimately for the health of the population of Croatia, supporting the goals of the European Union in a strategic sense.

4.1. Analysis of the Interdependence of Demographic and Health Indicators in Relation to Healthy Life Year Outcomes

Table 3: Indicators Used in the Analysis of the Interdependence of Demographic and Health Variables

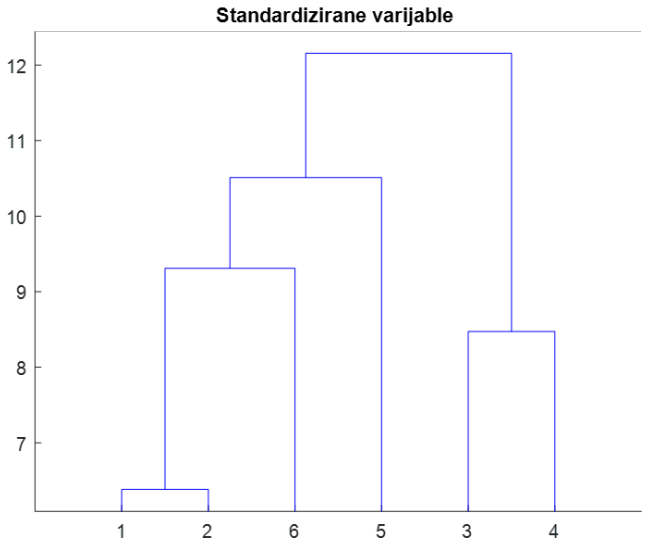
No	Name
1	Population
2	Healthy Life Years
3	Number of Hospital Beds per 100.000 Inhabitants
4	Average Length of Hospital Stays (in Days)
5	Number of Physicians per 100.000 Inhabitants
6	Healthcare Nursing and Care Professionals per 100.000 Inhabitants

Source: Authors' systematization

The choice of variables is justified by the fact that they underpin the assessment of healthcare system capacity and of population health outcomes. Population size is an important demographic variable in healthcare resource allocation, as larger populations are more likely to require investment, and smaller populations may be affected more by demographic trends and

migration. Healthy life years, defined as years of life in which people live without significant health limitations, reflect critical indicators of health care system performance. It has been reported compared to other leading EU countries that Croatia ranks below the EU countries and needs to improve on the strategies of healthcare. Hospital beds per 100,000 people reflect the resources and capacity of hospital care, whereas international comparisons indicate that increased bed numbers do not lead to improved outcomes, given that prevention and enhanced care may mitigate demand. The average length of hospital stay represents the average time spent in the hospital as a measure of the efficiency of the system; shorter hospital stays reflect successful treatment and management, whereas longer hospital stays reflect more complex demands of the patient. The number of doctors is a key variable for assessing access to healthcare and the likelihood of timely intervention, with higher physician density associated with successful health outcomes. Nursing and care providers are instrumental in the recovery, rehabilitation, and comprehensive care of health care recipients and are known to influence the quality of life and healthy life years overall. Together, these factors create an extensive foundation to analyse healthcare functioning and to identify opportunities for policy development.

Figure 1: Results of the Analysis Conducted Using Hierarchical Clustering



Source: Authors' systematization in the MATLAB software package

The analyses elucidated the interconnectedness of fundamental demographic and healthcare variables associated with healthy life years in each country and uncovered that population dynamics, healthcare resources, hospital capacity, and more general socio-economic conditions were closely related. The results suggest that the number of healthy life years depends upon the size of the population and number of healthcare providers, in particular health workers including nurses and doctors, which are likely under pressure due to the growth of population which can limit access to care and in turn, for other vital services. While the number of nurses is not directly proportional to healthy life years, more staff leads to a better quality of care and better health, and the number of doctors is more related (through its role in prevention, timely treatment, and recovery). This is a clear reflection of a third dimension, and it also relates in turn to service excellence and the complexity of patient needs: hospital capacity, defined in relation to bed availability and length of hospital stay. Although the number of beds alone does not directly determine healthy life years, it allows access to care and ensures adequate treatment.

Taken together, the results underscore the interdependence of healthcare resources on population health and lay the groundwork for health system strategic planning, digital transformation, and optimization in Croatia and the EU. These insights are also a premise for further modelling through ANFIS, with variables defined for further model analysis.
The chosen variables for the ANFIS model are listed in Table 4.

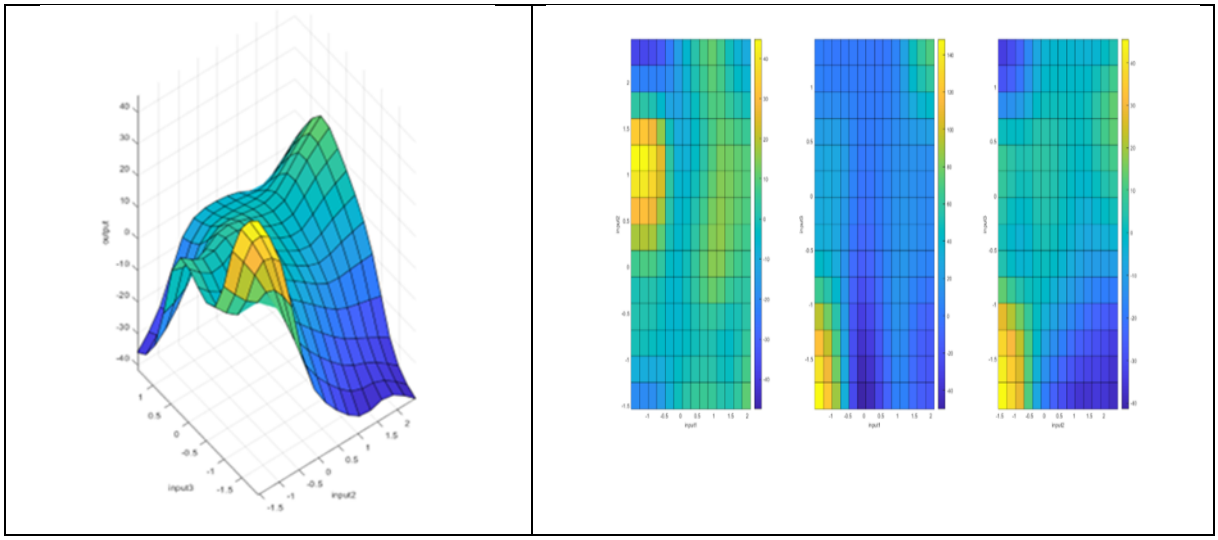
Table 4: Variables for the ANFIS Model

Input 1	Healthcare professionals per 100,000 inhabitants
Input 2	Number of physicians per 100,000 inhabitants
Input 3	Number of hospital beds per 100,000 inhabitants
Output	Healthy life years

Source: Authors

Figure 2 presents the results of the created ANFIS model analysis in 3D and 2D.

Figure 2: Results of ANFIS 1 Analysis – 3D, 2D



Source: Prepared by the authors in the MATLAB software package

According to the ANFIS model, healthy life years depend highly on health resource balance and interactions and not on a single factor. High values of healthy life years can occur even when there is a reduction in resources available to one area when they are offset by strengths available to other areas, indicating that good allocation of resources and utilization of resources in a more optimal manner is imperative. Higher and medium values often correlate to a balanced mix of nurses, physicians, and hospital capacity, demonstrating that stable and sustainable resource balances are key to providing consistent quality care. Very low healthy life years, on the other hand, are associated with obvious imbalances, such as simultaneous shortfalls of healthcare personnel or staff-to-hospital capacity problems. These situations drive inefficiency and lead to worse health outcomes, showing that increasing one resource will not compensate for deficits in others. From a strategic standpoint, the research highlights that long-term healthcare policy must prioritize an increase in healthy life years through investments into research, digital transformation, and education of the populations. That will enable efficient use of resources. In the near-term, balance between healthcare personnel and hospital capacity must be brought in place to stabilize systems and improve outcomes, especially in countries suffering underperforming healthcare provision. Overall, analysis finds that optimal health outcomes are

best achieved by a proper and balanced management of health resources, combining measures to repair and balance healthcare resources, and the appropriate balance and support for immediate needs in both long and medium-term sustainable options.

5. Concluding Remarks

This paper examined the sustainability and efficiency of the healthcare system of the Republic of Croatia within the broader European context, with particular emphasis on healthy life years (HLY) as an important indicator of healthcare outcomes. Starting from the assumption that healthcare system performance depends not on a single resource, but on the interaction between human resources, hospital capacity, and the organization of healthcare delivery, the study analysed the interdependence between selected demographic and healthcare indicators in a comparative sample of EU member states.

The results of the analysis indicate that healthy life years are closely related to the balance and coordination of healthcare resources. More specifically, the findings suggest that the availability of physicians and healthcare nursing and care professionals has a strong association with HLY, as these factors directly influence access to healthcare, prevention, timely treatment, and recovery. At the same time, hospital capacity, expressed through the number of beds and the average length of hospital stay, remains an important element of healthcare system functioning, although its effect depends on the efficiency with which these resources are used. The analysis therefore confirms that better health outcomes cannot be achieved through isolated increases in individual resources, but through their balanced and strategically aligned management.

For the Republic of Croatia, these findings are particularly important. The Croatian healthcare system continues to face challenges related to shortages of healthcare personnel, regional inequalities in access to care, and pressures on hospital capacity and organizational efficiency. In that context, the results of this study point to several priority directions for healthcare policy. First, it is necessary to strengthen the availability and territorial distribution of healthcare professionals, particularly in underserved areas. Second, improving hospital efficiency, including the reduction of unnecessarily long hospital stays, should be regarded as an important component of healthcare reform. Third, stronger use of data, digital tools, and analytical models in healthcare planning could significantly improve resource allocation and support evidence-based decision-making. Finally, long-term healthcare sustainability requires an integrated approach that combines human resources development, capacity planning, digital transformation, and a stronger focus on health outcomes.

The contribution of this paper lies in linking Eurostat-based comparative analysis with hierarchical clustering and ANFIS modelling to provide an analytical framework for understanding the relationship between healthcare resources and healthy life years. In this way, the study contributes to the discussion on sustainable and value-based healthcare systems and offers policy-relevant insights for Croatia within the EU context.

At the same time, several limitations should be acknowledged. The analysis covers the period 2015–2019 and therefore does not include changes related to the COVID-19 pandemic and post-pandemic recovery. In addition, the model is based on a selected set of indicators and a limited sample of EU countries comparable to Croatia by population size. Future research could therefore expand the analysis by including additional variables, such as healthcare expenditure,

digital health readiness, regional disparities, or indicators of preventive care, as well as by extending the time horizon and testing the model on broader comparative samples.

Overall, the study confirms the main hypothesis that healthy life years are significantly related to healthcare system capacity and the balanced management of available resources. For Croatia, the results suggest that improvements in health outcomes and system sustainability depend on a coordinated policy approach aimed at strengthening human resources, improving efficiency, and making greater use of data-driven and digitally supported healthcare management.

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A scientific paper

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THE EU LEGISLATIVE AND ACADEMIC FRAMEWORK FOR THE RESOLUTION OF CREDIT INSTITUTIONS AND INSURANCE UNDERTAKINGS

ABSTRACT

The resolution framework for financial institutions represents a central pillar of financial stability policy in the European Union, aiming to mitigate systemic risk and limit the adverse spillover effects of institutional failures on the real economy. Against this background, the primary objective of this paper is to provide a comprehensive overview and critical analysis of the key regulatory acts and selected academic literature governing the resolution of credit institutions and insurance undertakings within the European Union. The paper seeks to assess the extent to which existing regulatory frameworks contribute to market stability and the protection of depositors and policyholders, while identifying potential areas for further regulatory refinement. The research adopts a qualitative doctrinal and comparative methodology. It involves an in-depth analysis of the most relevant European legislative instruments, with particular emphasis on Directive (EU) 2014/59 establishing a framework for the recovery and resolution of credit institutions and investment firms (BRRD), as well as Directive (EU) 2025/1 establishing a framework for the recovery and resolution of insurance and reinsurance undertakings (IRRD). In parallel, paper reviews and synthesizes selected scientific articles that address both theoretical and empirical aspects of resolution regimes. A comparative perspective is applied to examine approaches adopted in other jurisdictions, allowing for the identification of best practices and transferable lessons for the European context. The analysis demonstrates that, while the EU resolution framework for credit institutions is relatively mature and well-integrated, the regulatory architecture for insurance undertakings is still evolving. The findings highlight persistent challenges related to cross-border coordination, proportionality, and practical implementation. Moreover, the study reveals a growing convergence in resolution principles across financial sectors, underscoring the importance of harmonization and continued academic inquiry to enhance the effectiveness and credibility of EU resolution mechanisms.

Key words: *resolution, financial institutions, credit institutions, insurance undertakings, European Union.*

[1] The authors express their own views in this paper, which do not necessarily reflect the views of the institutions with which they are affiliated.

1. Introduction

During the initial years following the worldwide financial crisis that affected most global markets, including the European Union (EU), in the period 2007-2009, European regulatory bodies launched series of initiatives aimed at examining the reasons for the crisis and devising solutions to the identified weaknesses. The main source for shaping the new regulatory framework were the results of different research and reports, such as:

1) De Larosière Report (De Larosière, 2009);
2) Basel III: A global regulatory framework for more resilient banks and banking systems (BCBS, 2010);
3) Reducing the Moral Hazard Posed by Systemically Important Financial Institutions (FSB, 2010); and
4) A Roadmap towards a Banking Union (EC, 2012).

According to lessons learned in the crisis and recommendations given by the above-mentioned documents, EU decided to create a framework to manage failing banks in an orderly manner, without resorting to taxpayer-funded bailouts. In that respect, in June 2012 the European Commission (EC) published its initial proposal of the BRRD that was officially adopted on 15 May 2014. Upon entry into force of this directive, resolution framework for credit institutions and investment firms in EU was established. In short, it implies the following:

- BRRD introduces the concept of resolution as "a process of a centralized, legal (but out-of-court) and operational mechanism of carrying out the restructuring or orderly liquidation of financial institutions while maintaining their critical functions, protecting deposits covered by deposit guarantee schemes, preserving public funds, and avoiding a negative impact on the financial stability by preventing the domino effect" (Kozińska, 2018).

- In accordance with Binder (2020) "resolution action is reserved to cases where it is ‘in the public interest’ that the relevant bank, or group of banks, should not be allowed to enter traditional forms of insolvency liquidation. Article 32 (5) of BRRD prescribes that "a resolution action shall be treated as in the public interest if it is necessary for the achievement of and is proportionate to one or more of the resolution objectives referred to in Article 31 and winding up of the institution under normal insolvency proceedings would not meet those resolution objectives to the same extent".

- Under Article 3 of BRRD, Member States (MS) were required to designate one or more resolution authorities “empowered to apply the resolution tools and exercise the resolution powers” (D’Ambrosio & Fromage, 2025). In that respect, BRRD introduces into EU regulatory framework the use of resolution tools prescribed by Article 37(3), namely, the sale of the business tool, the bridge institution tool, the asset separation tool and the bail-in tool (Alexander, 2017).

- A fundamental principle of bank resolution under the BRRD, aimed at ensuring the continuation of the whole bank's operations or some of its parts, is that losses and recapitalisation costs must be borne first by shareholders and subsequently by creditors through the bail-in tool, in accordance with the liability hierarchy set out in Articles 48 and 108 of BRRD. However, as stipulated in Article 34 of BRRD, creditors must not incur higher losses in resolution compared to those in ordinary insolvency proceedings. Subject to this, the bail-in tool according to Article 43 of BRRD facilitates the write-down or

conversion into equity of specified creditors' claims (Best & Read, 2017). In accordance with Alexander (2017) the main goal of bail-in provisions was "to address the moral hazard problem of so-called too-big-to fail financial institutions and the unfairness of having taxpayers subsidize excessive private sector risk-taking".

- In accordance with BRRD, systemically important banks in the EU are required to maintain "at all times an entity-specific minimum amount of own funds and eligible liabilities (MREL) of the bank in order to facilitate a bail-in" (Best & Read, 2017). In addition, global systemically important banks are obliged to meet the requirements of the Financial Stability Board (FSB) on Total Loss-Absorbing Capacity (TLAC). In essence, the function of TLAC is like that of MREL since both aim to ensure that banks have enough equity and debt instruments available at any time to absorb losses and provide a recapitalization (Best & Read, 2017).

- "The bail-in tool, MREL and TLAC provide suitable instruments that will potentially allow authorities to pass on the cost of resolution of systemic banks to their owners and creditors while preserving public funds (bail-in instead of bail-out)" (Best & Read, 2017).

It is evident that BRRD creates a legal and regulatory framework to reduce the likelihood that public funds will be used to bailout a failing financial institution (Alexander, 2017).

The same principles of resolution action prescribed within BRRD, along with the establishment of the Single Resolution Mechanism (SRM), Single Resolution Board (SRB) and the Single Resolution Fund (SRF), were introduced with the Regulation EU/806/2014 for the euro area.

Likewise, at the beginning of 2021, Regulation EU/23/2021 (CCP RRR) entered into force, establishing a legal and operational framework for the recovery and resolution of central counterparties (CCPs) and at the beginning of 2025, Directive 2025/1/EU (IRRD) entered into force establishing a framework for the recovery and resolution of insurance and reinsurance undertakings.

Throughout the post-crisis period, the EU has been consistently developing a resolution framework for the entire financial industry. However, the question arises whether all elements of the resolution framework thus established, especially in relation to credit institutions and insurance undertakings, are adequately prescribed by all the regulatory and legislative acts, i.e., to such an extent that they would be enforceable and efficient in practise. The question also arises whether and to what extent the academic community has investigated advantages and disadvantages of all the most important elements of this framework(s): degree of actual feasibility of envisaged resolution tools, primarily of the bail-in instrument, its constitutionality, efficiency of the MREL requirement, protection of rights of creditors and depositors, criteria for determining public interest for resolution of both credit institutions and insurance undertakings, establishment of financial arrangements and insurance guarantee schemes, etc.

Against this background, the primary objective of this paper is to provide a comprehensive overview and critical analysis of the key regulatory acts and selected academic literature governing the resolution of credit institutions and insurance undertakings within the EU. The paper seeks to assess the extent to which existing regulatory framework contribute to market stability and the protection of depositors and policyholders, while identifying potential areas for further regulatory refinement.

2. Methodology

The research adopts a qualitative doctrinal and comparative methodology. It involves an in-depth analysis of the most relevant European legislative documents, with particular emphasis on BRRD and IRRD. In parallel, the paper reviews and synthesizes selected scientific articles that address both theoretical and empirical aspects of resolution regimes for credit institutions and insurance undertakings.

In the process of selecting academic papers to be included in this paper, the research was conducted in the period from 28th December 2025 to 15th January 2026 in the following databases: Scopus, Web of Science, EBSCO and Google Scholar using the following keywords: bank resolution, insurance undertakings resolution, resolution tools, MREL and BRRD.

The focus was placed on scientific articles and books published in the period 2015-2025 that are generally related to any dimension of the resolution framework in the EU, following the above-mentioned keywords. Several older papers were also included, primarily because they deal with the causes of the crisis that preceded the establishment of the EU resolution framework. Scientific articles with an explicit connection to a particular MS or to a specific resolution case carried out in the same period were excluded from this research.

Taking all the above into account, this paper explores the following research question:

Is the resolution framework for insurance undertakings at the same stage of development as the resolution framework for credit institutions?

3. Analysis of the current EU legislative and academic framework

3.1. Review of the main legislative documents

One of the first global conferences following the crisis to focus on the consolidation of the financial markets was the Pittsburgh G20 meeting in September 2009 (Zoltan, Kalmar & Lentner, 2018). Shortly after, in accordance with conclusions of the G20 meeting, the European Parliament (EP) published a cross sectoral analysis outlining recognized causes of the crisis and proposed reform measures. In this report EP highlighted, among others, the following reasons for the crisis: global imbalances, absence of proper regulation and robust supervision, complete lack of instruments for contingency management in the event of a banking crisis and in particular the absence of a cross-border bankruptcy mechanism (EP Report, 2010).

Research into the causes, consequences and extent of the crisis continued in the years that followed. Several years later, the BCBS Report (BCBS, 2015) presented a far more comprehensive list of vulnerabilities in the financial system exposed by the global financial crisis:

- excessive leverage, with lack of sufficient high-quality capital to support banks' assets;
- rapid credit expansion, partly driven by weak underwriting practices and the underestimation of credit and liquidity risk;
- elevated systemic risk, including strong interconnections among financial institutions and shared exposures to similar shocks;
- insufficient capital buffers to mitigate the procyclical nature of financial markets and to sustain lending to the real economy during periods of stress; and

- inadequate liquidity reserves and significant exposure to both direct and indirect liquidity risks (e.g., through the shadow banking system).

In order to adequately address all identified shortcomings, a series of legal acts were adopted at the EU level, which implemented a comprehensive reform of business operations and crisis management of the entire financial sector. The most important legislation which regulates the resolution framework in EU is given in a Table 1.

Table 1: Overview of the most important legislation establishing the EU resolution framework

Year	Act	Aim
2010	Regulation EU/1092/2010	establishes macroprudential supervision of the EU's financial system and the European Systemic Risk Board (ESRB)
2010	Regulation EU/1093/2010	establishes the European Banking Authority (EBA), supervisory authority in charge of credit institutions sector
2010	Regulation EU/1094/2010	establishes the European Insurance and Occupational Pensions Authority (EIOPA), supervisory authority in charge of the insurance and occupational pension sector
2010	Regulation EU/1095/2010	establishes the European Securities and Markets Authority (ESMA), supervisory authority in charge of credit rating agencies, trade repositories and securitisation repositories
2012	Directive 2002/47/EU (FCD) & Regulation EU/648/2012 (EMIR)	affects resolution by defining rules for collateral and derivatives
2013	Regulation EU/1024/2013	confers specific tasks on the European Central Bank (ECB) and establishes the Single Supervisory Mechanism (SSM)
2013	Directive 2013/36/EU (CRD IV) & Regulation EU/575/2013 (CRR)	set capital and liquidity standards (Basel III implementation) to make banks more resilient and less likely to fail
2014	Directive 2014/49/EU (DGSD)	ensures depositors are protected up to 100,000 euro if a bank collapse
2014	Directive 2014/59/EU (BRRD)	establishes a framework for early intervention, recovery and resolution of credit institutions and investment firms
2014	Regulation EU/806/2014 (SRMR)	establishes the Single Resolution Mechanism (SRM) and the Single Resolution Board (SRB)
2021	Regulation EU/23/2021 (CCP RRR)	establishes a framework for the recovery and resolution of central counterparties (CCPs)
2025	Directive 2025/1/EU (IRRD)	establishes a framework for the recovery and resolution of insurance and reinsurance undertakings

Source: Authors

Following the adoption of above-mentioned legal acts, the EBA received numerous mandates to develop various secondary legislation in order to more precisely define individual segments of the new resolution framework for credit institutions. The aforementioned secondary legislation for credit institutions will not be listed within this scientific paper, simply because it is very extensive, but since the IRRD was adopted in 2025, and the development of the resolution framework for insurance undertakings began much earlier, the most important

standards and guidelines for insurers that preceded the adoption of the IRRD will be highlighted below.

Although the resolution framework for insurance undertakings was officially established in 2025, it should be noted that European regulators recognized the risks to which this sector was exposed long before and began developing this framework almost in parallel with the development of the resolution framework for banks and investment firms. In November 2011 FSB endorsed *Key Attributes of Effective Resolution Regimes for Financial Institutions,* as the new international standard for orderly resolution of failing financial institutions. Additionally, in 2013, nine insurance companies were identified as systemically important by the FSB, after which it initiated the development of industry-wide systemic regulation with support from the International Association of Insurance Supervisors (IAIS). The framework developed by the FSB for insurers largely mirrors its approach to banks, particularly in the development of capital standards and the calibration of capital surcharges. Similar parallels between banks and insurers are also evident in several influential academic studies on systemic risk (Thimann, 2014).

FSB continued its work and issued in 2014 an additional guidance supplementing on specific Key Attributes from 2011 in relation to the process of sharing necessary information for resolution purposes and giving specific guidance on how the Key Attributes should be applied for insurers, financial market infrastructures (FMIs) and the protection of client assets in resolution (FSB, 2014).

Additionally, in June 2016, the FSB released complementary guidance on developing effective resolution strategies and plans for systemically important insurers which should assist home and host authorities in meeting the recovery and resolution planning requirements under the FSB Key Attributes (FSB, 2016).

In parallel, in November 2019 the IAIS adopted *Insurance Core Principles and Common Framework for the Supervision of Internationally Active Insurance Groups,* a document which prescribes standards for recovery planning and actions required when an insurance or reinsurance undertaking needs to exit the market and enter into resolution (IAIS, 2019). In addition to the above-mentioned document, aiming to provide guidance with respect to supervisory materials related to recovery planning in 2019 the IAIS has developed an *Application paper on recovery planning* and in 2023 an *Application Paper on Resolution Powers and Planning* with the aim to provide supporting material on supervisory practices related to resolution.

In the period immediately following the crisis, the EU insurance market lacked a coordinated framework for guarantee schemes comparable to those in other financial sectors, such as Deposit Guarantee Schemes (DGS) or Investor Compensation Schemes (ICS). Nevertheless, in numerous countries, insurance guarantee schemes already existed to partially cover obligations of insolvent insurers.

One of the first works that systematically deals with those issues was a Working Paper issued in 2013 by the OECD, which investigates policyholder protection schemes in OECD member countries and selected non-OECD countries. The central conclusion of the document is that, given the heterogeneity of products in the insurance sector, applying uniform coverage and funding arrangements across all lines may inadequately reflect line-specific risks and social considerations. Accordingly, aspects such as social objectives, contract maturity, and savings components warrant consideration (OECD, 2013).

In 2019, the EC requested that EIOPA provides some advice on IGSs. In its response, EIOPA took the position that each MS should establish a national guarantee scheme to protect policyholders in the event of insurer failure, incorporating a minimum set of harmonised features while respecting the principle of proportionality. In this regard, it emphasised the importance of maintaining flexibility in the schemes' legal structure and design. (EIOPA, 2019).

Despite these efforts, the harmonization of IGSs was ultimately omitted from the final version of the IRRD, which entered into force following its publication in the Official Journal on 28th January 2025.

3.2. Review of the main academic literature

For the purposes of identifying academic literature related to the EU resolution framework for credit institutions and insurance undertakings, a database search using selected keywords was performed.

Specifically, using the keywords " bank resolution" articles dealing with the following topics are identified:

a) ineffectiveness of EU bank resolution rules in general (Asimakopoulos & Howarth, 2022; Walther & White, 2020; Avgouleas & Goodhart, 2019),
b) comprehensiveness of EU bank resolution framework (Binder, 2014; Maddaloni & Scardozzi, 2023),
c) hierarchy of claims (Binder, 2016),
d) public interest assessment (Stopczyński, 2025), and
e) process of making resolution decisions (Lintner, 2017).

In this part of the research, one of the latest published books of Professor Christos Gortsos was identified, i.e.: "*The European Banking Regulation Handbook, Volume II*", in which several chapters are devoted to various resolution issues such as: resolution planning, resolution action, MREL, resolution funding, etc. (Gortsos, 2025).

Since in the early stages of its development and implementation resolution framework for banks provoked various, often very negative reactions, effectiveness and comprehensiveness of the EU bank resolution framework was often set up as the research topic. This research identified one of the most recent scientific work that aimed to determine whether the EU regulatory framework for the resolution of significant banks established in the EU is valid under EU constitutional law. That is the doctoral dissertation of Jolien Timmermans which showed that, although certain breaches of EU constitutional law were found, the SRM can be considered legally valid under EU constitutional law (Timmermans, 2025).

A need to review credibility and/or constitutionality of the resolution framework certainly stems and from the application of the bail in tool which implies as a first step in its implementation a "dispossessing" of the existing shareholders and "assigning" ownership of the new shares of the failed institution to the new owners.

So, using the keywords "Resolution tools", most of the results obtained were related to bail in tool. Specifically, the following topics were found:

a) studying arguments that speak in favour of bail in (Berg & Bjerre-Nielsen, 2020),

b) proving deficiencies of bail in (Alexander, 2017; Tröger, 2018; Berg & Bjerre-Nielsen, 2020),
c) questioning the compatibility of bail in with the rest of the EU legal framework (Grünewald, 2017),
d) discretionary exclusion of certain types of liabilities from the application of bail-in (Tröger, 2018),
e) examining the influence of bail in on stock prices (Fiordelisi et.al., 2020),
f) the use of sale of business and bridge institution tools (Binder, 2014), and
g) advantages of bridge institution tool (Freitas & Garcia Rolo, 2025).

When it comes to feasibility of bail in, and generally of resolution tools, it is worth of mentioning the research made by Kozińska (2018) in which the author on the basis of the analyses made among 29 EU resolution authorities[2] concluded that the resolution tools are better at solving problems related to capital than ones related to liquidity and that the most effective resolution tool is "bad bank". In this research bank liquidation was rated as the least appropriate. Besides Kozińska (2018), Binder (2014) and Freitas & Garcia Rolo (2025) who investigated bridge institution tool, this research did not result in finding of other scientific papers that dealt with resolution tools other than bail-in.

Apart from bail-in, there is another segment of the new resolution framework for credit institutions that has caused a lot of debates in the first years of the resolution framework in EU and as such has provided scientists with a reason for deeper researches. This is the MREL requirement, one of the prerequisites for the implementation of the bail-in instrument. Using the keyword "MREL", following articles were found:

a) Best & Read (2017) carried out a pro-forma analysis of 23 systemically important EU banks, concluding that new and existing regulations overlap and that unnecessary complexity could be reduced without altering overall capital and MREL requirements,
b) Martino & Parchimowicz (2021) concluded that the current institutional architecture doesn't allow to MREL requirements to fulfil its positive preventive potential,
c) Tröger (2020, 1) specifications for MREL requirement finds highly detailed and discretionary and thus unable to fully alleviate the predicament of investors in bail-in debt,
d) Hasenclever (2020) studied implications of MREL on internal liquidity risk management and funding and advises optimising the balance sheet structure and the resolution strategy,
e) Psaroudakis (2023) elaborates the structure of MREL under current law and the basic features of its calibration, as well as further legislative measures that support the MREL mechanism in practice.

And, finally, using the keyword "BRRD", this search resulted in finding following articles:

a) Aarnio (2015) researched different types of rules in CRD IV, BRRD and Markets in Financial Instruments Directive 2 (MiFID 2) and concluded that these three directives have a common regulatory structure consisting of a combination of minimum requirements, discretionary assessment and explicit rules and that, of the three directives discussed, BRRD is perhaps the one most obviously based on discretion.
b) Zoltan, Kalmar & Lentner (2018) offer a thorough summary of the major worldwide developments in financial markets and banking regulation following the financial crisis,

[2] 28 national resolution authorities and the Single Resolution Board as the resolution authority for the Banking union

based on a systematic analysis of published materials, directives, and international regulatory frameworks. Attention is given to both newly established and existing financial authorities in the United States, Europe, and Ukraine. The analysis suggests some indications that the updated regulations have contributed to greater stability, particularly in countries with more rigorous supervisory systems.

Research using the same keywords in the same databases was also conducted for the purposes of identifying academic literature related to the resolution framework for insurance undertakings. Keywords "resolution tools", "MREL" and "BRRD" did not identify any scientific articles, and the keyword "insurance undertakings resolution" identified the following scientific articles related to resolution of insurance undertakings:

Thimann (2014) aims to establish a clear conceptual differentiation between banking and insurance in the context of systemic regulation. He identified four differences and two similarities between banking and insurance, that are presented in the table below:

Table 2: Banking and insurance - differences and similarities

	Banking	**Insurance**
Similarities	financial intermediaries	financial intermediaries
	large-scale investors	large-scale investors
Differences	institutionally connected with each other through the interbank market	stand-alone operators
	engage in maturity transformation	aim to match the duration of assets and liabilities
	inherently liquidity-short	inherently liquidity-rich
	create money, credit and handle the payment system	-

Source: *Authors according Thimann*

Visnovsky (2023) based on French insurance sector explains that the preparation of resolution plans consists of the main three steps: determining the critical functions, assessing how easily those functions can be separated, and defining resolution strategies applicable to the entities or groups responsible for carrying out those functions. Based on these elements, ACPR as French national resolution authority for banks and insurance undertakings has adopted the first resolution plans for 13 French insurers.

In parallel, Nemes (2018) gives the comprehensive overview of the resolution framework for insurers in Romania on the example of Romanian laws and from the perspective of Romanian Financial Supervisory Authority.

Siri & Van den Hurk (2022) give an overview of the relevant actions provided in the resolution framework for the recovery, preservation and possibly resolution of the insurance undertakings, from the perspective of the management staff. They concluded that, under ordinary circumstances, directors are required to consider and balance the interests of both shareholders and regulators; however, when the company's condition worsens, this balance shifts more strongly toward safeguarding the interests of policyholders.

4. Discussion

To drawing conclusions, a detailed overview of the documents and papers identified within this research is given in Table 3.

Table 3: A comparative overview of the identified legislative and academic literature on the EU resolution framework for banking and insurance

	Key words	Credit institutions	Insurance Undertakings
Representation of the topic in the literature			
a) Legislative literature (total score)	-	High	Moderate
1st level (directives, regulations)	-	High	Low
2nd level (standards, guidelines)	-	High	Moderate
b) Academic literature (total score)	-	High	Low
Thematic diversity of research			
General topics in relation to the framework (feasibility, effectiveness, constitutionality, public interest, hierarchy of claims)	Resolution, BRRD	High	Low
MREL	MREL	Moderate	Low
Bail in tool (Solvent Run Off)	Resolution tools	High	Low
Sale of business tool		Low	Low
Bridge institution/undertaking tool		Low	Low
Asset (and Liability) separation tool		Low	Low
Write down and Conversion tool		Low	Low

Source: *Authors*

Score scale interpreter:

High = more than 10 acts
Moderate = between 5 and 10 acts
Low = less than 5 acts

This research showed that looking from the perspective of the representation of the topic in legislative literature, 1st level of the legislative literature (directives, regulations) is significantly much more developed in relation to credit institutions (High representation) than in relation to insurance undertakings (Low representation). This arises from the fact that BRRD1 entered into force on 1st January 2015 and has been amended and supplemented two times until today (2017 and 2019). Additionally, in parallel with those amendments, the SRMR came into force, establishing the SRM and complementing BRRD at Banking Union level (euro area), as well as some other directives and regulations prescribing in details some segments of the resolution framework (Table 1). On the other side, IRRD has been just published in January 2025 and in this moment represents the only Level 1 document relevant for the resolution of insurance undertakings.

When it comes to the 2nd level of the legislative literature (guidelines, standards), situation is a little bit different. Namely, 2nd level of the legislative literature for credit institutions remains

High represented since EU regulators issued in last 10 years a significant number of guidelines and standards to complement and/or prescribe in detail the main cornerstones of the resolution framework for credit institutions. On the other side, 2nd level of the legislative literature for insurance undertakings is classified as Moderate represented, since EU regulators issued a series of standards and guidelines in the same period to bridge a gap before the formal adoption of the IRRD.

When it comes to thematic diversity of research in relation to credit institutions, this research showed that general topics in relation to the resolution framework (feasibility, effectiveness, constitutionality, public interest, hierarchy of claims) and bail in tool are currently Highly represented in selected databases. MREL requirement as research topic is classified as Moderate and the rest of the topics in relation to credit institutions are found as Low represented in academic literature.

And finally, when considering thematic diversity of research in relation to insurance undertakings, this research showed that there are currently relatively few scientific papers on topics related to the resolution framework for insurance undertakings and therefore both the individual grades and the overall grade for academic literature in relation to insurance undertakings is Low.

Consequently, in relation to the research question posed, this research proved that resolution framework for insurance undertakings is not at the same stage of development as the resolution framework for credit institutions as the process of transposition of IRRD into national regulatory frameworks in the EU is underway and the academic debate on its essential provisions (such as resolution tools, PIA assessment, implementation of the valuation process, design of financing arrangements, treatment of creditors and policyholders in resolution, especially from a cross-border aspect, etc.) will intensify with its full implementation from January 2027.

EU regulatory institutions have invested enormous efforts over the years in developing a resolution framework for both sectors, however, this research showed from a regulatory and scientific perspective, resolution framework for credit institutions is at a much higher level of maturity than the one for insurers. Moreover, the study reveals a growing convergence in resolution principles across financial sectors, underscoring the importance of harmonization and continued academic inquiry to enhance the effectiveness and credibility of EU resolution mechanisms in general.

5. Conclusions

This scientific review has shown how broad and intensive the EU reform of the financial sector was in a period after the crisis. Primarily, enormous progress has been made in the development of the resolution framework and crisis management in the banking sector. This is evidenced not only by numerous reforms in terms of establishing new supervisory and regulatory agencies at the EU level, and issuing numerous directives, regulations, guidelines, opinions, advices and instructions for the banking industry, but also by numerous academic scientific papers that have accompanied each activity carried out and innovation introduced. The general conclusion from this research can be reduced to the fact that in the last 10 years, i.e., in a period since the new resolution framework came into force in the EU, significantly more legal acts and academic papers have been issued regarding the resolution framework for credit institutions than

regarding the resolution of insurance undertakings. The bail-in instrument, MREL and the different perspectives of credibility of the entire resolution framework for credit institutions have been mostly the subject of numerous researches, from almost every possible angle. Most of the authors included in this research concluded that the bail-in instrument and the MREL requirement have their limitations and do not enable the implementation of resolution *per se*, but at the same time, the same resolution framework as such is assessed as constitutional and enforceable. The existing regulatory framework for the resolution of credit institutions at the current level of development can represent a significant and stable axis which contributes to market stability and the protection of depositors and policyholders. When considering which areas should be further researched in relation to the resolution framework for credit institutions, this research has shown that there is a lack of scientific work related to resolution tools other than bail-in as well as practical dimensions of the feasibility of resolution proceedings (for example, liquidity in resolution and operational continuity in resolution).

In the EU insurance sector, there have also been many legislative initiatives and reform measures conducted in the period after the crisis, however, in accordance with the results of this research, resolution framework for insurance undertakings is not at the same level of development as it is for credit institutions. Despite numerous legislative acts, the academic community has not explored the resolution framework for insurers to any significant extent. In accordance with the selected criteria, this research identified only 4 scientific papers on this topic. Consequently, when considering the development of the resolution framework for insurance industry, further scientific research is needed in general, but particularly in the application of resolution tools especially when choosing the most appropriate resolution tool for specific insurance undertakings and its impact on liquidity in the process of resolution. The findings of this research also highlight lack of research related to cross-border coordination, proportionality, and practical implementation of resolution tools.

Limitations of this research are reflected in the following three dimensions: first, considering all the above-mentioned arguments, it is clear that the EU resolution framework is complex and as such includes various mechanisms, institutions and a huge number of regulatory acts, so it was very difficult to systematically include all these elements in a single synthesis without simplification. Precisely because of the complexity of this topic and the wide volume of literature, particularly in relation to credit institutions, it was challenging to cover all relevant aspects of the EU resolution framework within the limited scope of the text. Second, resolution framework for credit institutions and resolution framework for insurance undertakings, although they have the same root and many similarities, each has its own specificities (Table 2), which makes comparative analysis difficult to some extent. And finally, third, in this scientific research, the authors chose the criteria for selecting papers and including them in this paper, which means that there is a certain amount of subjectivity and bias in the selection and there is a possibility that not all relevant papers were included.

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A scientific paper

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FROM MEMORY TO METAHUMANS: RETHINKING CULTURAL HERITAGE FOR SUSTAINABLE REGIONAL DEVELOPMENT

ABSTRACT

This conceptual paper examines how metahumans, understood as cultural actors (custodians and communities) mediating between tradition and innovation, can support the preservation and transmission of cultural heritage, with relevance for living and intangible practices, while also enabling regional innovation and sustainable development. Responding to documented risks of knowledge loss due to globalisation and demographic change, the paper positions digitally environments (e.g., AI-enabled interfaces, extended reality, and metaverse-related applications) as infrastructures through which heritage can be curated, experienced, taught, and co-created. Methodologically, the paper proposes a structured global case review protocol to identify and synthesise documented implementations of digital/virtual humans and related agentic interfaces used for heritage interpretation, craft know-how transmission, and community storytelling. The results are used to derive a framework that links design choices and psychological mechanisms (e.g., social presence, perceived authenticity, trust, inclusivity, cognitive and affective burden) and outcomes (e.g., learning, engagement, visitation intention, creative entrepreneurship, and regional identity strengthening) as well as governance and ethical concerns. The paper concludes with a set of propositions and a future research agenda suitable for empirical approaches in tourism, creative and cultural industries, and regional development.

Key words: *metahumans; heritage custodians; intangible cultural heritage; extended reality; regional development.*

1. Introduction

Intangible cultural heritage (ICH) encompasses living practices, expressions, skills, and knowledge systems that are continuously recreated by communities and transmitted across generations (Meskell, 2014). Unlike tangible heritage assets, ICH is inherently processual and relational, relying on embodied know-how, social interaction, and shared meaning. As such, it is particularly vulnerable to structural transformations associated with globalization, demographic ageing, rural depopulation, and economic restructuring. Empirical research consistently shows that the erosion of ICH is often accompanied by the weakening of place-based identity, social cohesion, and localized cultural economies (Aplin, 2007; ICOMOS, 2022; Messenger & Smith, 2010).

Digital transformation introduces a paradoxical dynamic for ICH safeguarding. On the one hand, the accelerated consumption cycles and standardized digital content may marginalize localized practices and reduce the temporal and relational conditions required for intergenerational transmission. On the other hand, digital infrastructures offer unprecedented opportunities to expand access to heritage, support experiential and situated learning, and enable new forms of cultural participation that transcend spatial and temporal boundaries (Sylaiou & Fidas, 2022). Museums, heritage organizations, destination management entities, and creative industries increasingly deploy immersive media, extended reality (XR), conversational interfaces, and artificial intelligence to interpret, communicate, and valorize cultural heritage (De Paolis et al., 2022; Spadoni et al., 2022). Within this evolving landscape, we proposed that metahumans have emerged as a salient socio-technical phenomenon. This paper does not adopt a narrow technological definition restricted to high-fidelity digital avatars or photorealistic virtual characters. Metahumans are conceptualized as cultural actors and knowledge custodians, who mediate between tradition and innovation through digitally networked environments, shaping how heritage is produced, transmitted, and augmented. This broader framing encompasses virtual museum guides, digitized representations of craftspeople and practitioners, and community-mediated narrative systems governed collaboratively by heritage stakeholders.

Despite the growing visibility of metahuman-enabled heritage initiatives, the academic literature remains fragmented across human–computer interaction (HCI), information systems (IS), museum studies, tourism research, and cultural heritage research. Existing studies frequently emphasize technological performance, interface design, or short-term user experience outcomes, while issues of custodianship, legitimacy, governance, and regional development remain under-theorized (Duguleană et al., 2020; Sylaiou et al., 2025). The potential of metahumans to act not merely as interfaces but as custodians of living heritage, supporting cultural continuity while enabling innovation, has not yet been systematically conceptualized. In this paper, the term "metahumans" is used in a conceptual rather than restrict technological sense. Metahumans are defined as socio-technical mediators that combine digital human representations (e.g., avatars, embodied conversational agents, or AI-driven virtual characters) with the cultural knowledge and narratives of heritage custodians. Unlike conventional virtual guides or digital avatars whose role is primarily informational or assistive (e.g. Machidon et al., 2018), metahumans are conceptualised as interfaces capable of supporting interpretation, participation, and intergenerational transmission of intangible cultural heritage (ICH). This distinction allows the concept to move beyond human–computer interaction functionalities toward a custodianship logic grounded in heritage governance and community participation (Hou et al., 2022).

Addressing these gaps, the present study pursues three objectives. First, it maps and systematizes existing academic evidence on virtual and digital humans in cultural and intangible heritage contexts. Second, it identifies recurring custodianship configurations, design choices, and governance conditions shaping experiential and socio-economic outcomes. Third, it proposes a testable conceptual framework linking metahuman-enabled heritage mediation to cultural sustainability and regional innovation, thereby providing a foundation for future quantitative and mixed-method research.

2. Theoretical background

2.1. Immersive technologies in cultural heritage: from representation to experience

Immersive technologies, especially Virtual Reality (VR) and Augmented Reality (AR), have become central to contemporary cultural heritage mediation, shifting emphasis from static digitisation toward experience design. A survey of multisensory VR/AR applications documents how cultural heritage deployments increasingly integrate multimodal interaction to support engagement and interpretation, while also foregrounding challenges of implementation, evaluation, and user experience management (Marto et al., 2022). In parallel, evidence from VR exhibit design shows that the success of immersive heritage is strongly dependent on user-centred design processes that integrate visitor needs, interpretive goals, and contextual constraints, particularly in archaeological museums and comparable heritage settings (Barbieri et al., 2017).

Beyond individual experiences, the field is also moving toward platforms and infrastructures that enable institutions and communities to create and curate immersive exhibitions. For instance, user-centric systems for building interactive 3D/VR exhibitions illustrate an infrastructural turn in digital heritage, where authoring, collaboration, and reuse become critical for scaling cultural experiences beyond one-off prototypes (Zidianakis et al., 2021). This shift matters for ICH-oriented agendas because it positions immersive environments as evolving cultural infrastructures rather than merely representational interfaces.

2.2. Digital storytelling, usability, and cognitive burden in heritage AR/VR

A second cluster of studies argues that the value of immersive heritage experiences depends less on "having XR" and more on how interaction is orchestrated, including narrative design, interface clarity, and workload management. In mobile AR-based cultural heritage storytelling, the interplay among usability, user experience, and mental workload is empirically examined, showing that AR storytelling can enhance experiential outcomes, but only when interaction does not impose excessive cognitive burden (De Paolis et al., 2022). This is particularly relevant when positioning metahuman-enabled experiences as educational or custodial systems: custodianship cannot be achieved if users are overloaded, disoriented, or unable to sustain engagement due to interface complexity (De Paolis et al., 2022).

Related work on immersive exhibitions suggests that gamification can increase engagement and motivation by structuring exploration through interactive goals, feedback, and playful mechanisms; however, it also reinforces the need to ensure that playful mechanics do not eclipse cultural meaning or encourage superficial consumption of heritage content (Wang et al., 2024). In science museum contexts, AR systems designed to promote interactive engagement further demonstrate that meaningful outcomes (e.g., curiosity, exploratory behaviour) are tightly linked to the alignment among exhibit content, interaction design, and interpretive scaffolding (Spadoni et al., 2022). Collectively, these studies consolidate a core premise, which is immersive heritage effectiveness emerges through a balance of interpretation, interaction, and experiential manageability, which provides a concrete foundation for later framework development.

2.3. AR as interpretive augmentation: deep learning and specialised museum tours

A more application-oriented stream demonstrates how AR can enhance museum experience through advanced computational techniques. In the Taxila Museum context, AR combined with deep learning is used to enrich visitor experience and interpretation, illustrating how heritage

augmentation can incorporate intelligent recognition and context-aware overlays (Khan et al., 2018). Similarly, AR has been applied to specialised museum tours (e.g., medical specimen collections), evidencing that AR can support interpretive depth, visitor orientation, and educational value in sensitive or technically complex exhibition settings (Sugiura et al., 2019). These studies highlight that AR can function as an interpretive layer capable of enhancing access to expertise, yet they also reveal a conceptual limitation for ICH: augmentation is often content-delivery oriented and not necessarily designed for sustained cultural transmission or community-authorised custodianship.

2.4. Virtual agents in museums: natural interaction, embodiment, and credibility

An important bridge toward metahumans lies in research on virtual assistants and embodied agents in museum environments. A virtual assistant designed for natural interactions in museums demonstrates that agentic interfaces can support conversational access to interpretive content and improve interaction naturalness, thereby shaping the visitor journey in ways that extend beyond static labels or menus (Duguleană et al., 2020). Experimental work further shows that the representation of both the virtual agent and exhibited objects influences visitors' experience of artefacts; embodied guides can foster higher presence and credibility, with downstream implications for engagement and learning (Schmidt et al., 2019). However, while these studies offer robust evidence on social presence, credibility, and user experience, the agent's role is predominantly conceptualised as a guide or interface rather than as a culturally legitimate mediator embedded in heritage governance. This gap is pivotal for moving from "agent-as-interface" to "metahuman-as-custodian" and requires theoretical grounding not only in human-computer interaction constructs (presence, credibility, workload) but also in heritage logics of legitimacy, continuity, and community authority. Beyond usability and presence, immersive heritage is increasingly linked to deeper interpretive outcomes such as empathy, reflection, and socio-cognitive engagement. VR applications have been shown to support perspective-taking in cultural contexts, suggesting that immersive environments can help users inhabit alternative viewpoints and thereby foster deeper engagement with cultural narratives and meanings (Lucifora et al., 2023). For an ICH custodianship agenda, perspective-taking is not merely an "experience outcome"; it can be conceptualised as a mechanism that supports cultural understanding, respect, and potentially intergenerational transmission when coupled with narrative and community-based meaning-making.From a regional development perspective, immersive heritage mediation may also function as a driver of place-based cultural economies An & Tong, 2025). By enabling new forms of storytelling, participation, and digital access to local traditions, immersive heritage infrastructures can contribute to tourism competitiveness, cultural entrepreneurship, and the strengthening of regional identity (Meng et al., 2025; Rong et al., 2021). These dynamics align with broader debates on regional innovation ecosystems, where digital technologies, cultural institutions, and creative industries co-evolve to generate new economic and social value.

2.5. Inclusion, accessibility, and audience diversity: older adults and comfort constraints

A custodianship framing also demands attention to inclusion. VR adoption among older adults indicates both strong potential (e.g., engagement, novelty, psychosocial benefits) and meaningful barriers linked to usability, comfort, and accessibility (Brown, 2019). Complementarily, research on perceptual optimisation for comfortable VR-based telepresence underscores that user comfort is a non-trivial design constraint, shaped by perceptual and motion planning considerations in immersive contexts (Becerra et al., 2020). Together, these contributions reinforce a critical point for metahuman/ICH systems, custodianship-oriented

designs must accommodate diverse bodies and abilities, minimising discomfort and ensuring that immersive participation does not become exclusionary by default (Brown, 2019; Becerra et al., 2020).

Although not heritage-specific, metaverse research provides transferable constructs for understanding immersive experience mechanisms relevant to the proposed framework. Experimental work comparing metaverse virtual nature experiences with a virtual museum experience indicates that immersive environments can influence affect, connectedness, and behavioural intentions, highlighting how "metaverse experiences" can shape attitudes and real-world engagement through psychological mediators (Chan et al., 2023). In addition, conceptual work on "metaleisure" frames the metaverse as a domain that reconfigures leisure practices and participation logics, pointing to broader socio-cultural shifts in how people spend time, engage socially, and attach meaning to virtual environments (Bayram, 2022). For cultural heritage and ICH, these studies do not provide direct custodianship models, but they inform how immersive environments may cultivate attachment, intention, and sustained participation, elements that become relevant when heritage mediation is relocated into networked digital contexts.

2.6. Toward metahumans as custodians of ICH

The literature provides strong evidence on (i) immersive heritage experience design (Barbieri et al., 2017; Marto et al., 2022), (ii) platformisation and scalable creation of virtual exhibitions (Zidianakis et al., 2021), (iii) usability and cognitive burden in heritage storytelling (De Paolis et al., 2022), (iv) interpretive augmentation through advanced AR (Khan et al., 2021; Sugiura et al., 2019), (v) agentic mediation and social presence in museums (Duguleană et al., 2020; Schmidt et al., 2019), (vi) socio-cognitive mechanisms such as perspective-taking (Lucifora et al., 2023), and (vii) inclusion, comfort, and adoption barriers (Brown, 2019; Becerra et al., 2020). Yet, this evidence remains largely organised around experience, interaction, and engagement, with limited explicit theorisation of custodianship, that is, how metahuman custodians could mediate culturally legitimate transmission of living practices, negotiate authority and representation, and support continuity while enabling innovation.

This conceptual gap motivates the present study, rather than treating metahumans as high-fidelity avatars or museum "helpers", metahumans are positioned as agentic mediators and potential custodians whose roles must be understood through the joint lens of (a) immersive design choices and psychological mechanisms and (b) heritage governance concerns linked to legitimacy, inclusion, and ethical safeguards. This synthesis directly informs the framework proposed later, which systematises design–mechanism–outcome pathways and specifies where custodianship conditions must be introduced to move beyond interface-level interventions.

The development of a meta-human case-study could be considered in traditional craft practices that are increasingly at risk of disappearing due to demographic change and industrialisation. Practices such as traditional embroidery in Madeira (Portugal), artisanal boat construction in the Ria de Aveiro (Portugal), or traditional coastal fishing techniques illustrate forms of intangible cultural heritage that rely on the transmission of tacit knowledge between generations. In such contexts, metahuman representations of master artisans or heritage custodians could guide visitors through immersive environments where techniques, narratives, and cultural meanings are interactively demonstrated. By digitally documenting and interpreting these practices, immersive systems could support the preservation and transmission of local knowledge while simultaneously strengthening cultural tourism and regional creative economies.

3. Methods

3.1. Research design

This paper adopts a conceptual and exploratory research design, grounded in a focused narrative literature review combined with a structured global case review protocol. The methodological objective is not to provide an exhaustive synthesis of the digital heritage field, but rather to support theory building and framework development regarding the emerging role of metahumans as custodians of Intangible Cultural Heritage (ICH). This approach is particularly appropriate for the proposed objectives, where conceptual integration, analytical clarity, and applicability take precedence over systematic coverage or statistical aggregation (Stebbins, 2001; Edmondson & McManus, 2007). The methodology is therefore designed to ensure analytical rigor, transparency, and coherence with the paper's theoretical aims, while remaining feasible within the scope and constraints of the study.

3.2. Evidence base and scope definition

To contextualize the research field, an initial mapping of the literature was conducted using a Web of Science–indexed dataset (n = 91), compiled in the project database. This dataset served exclusively as an evidence universe, allowing the authors to situate the study within the broader research landscape on immersive technologies, virtual agents, and cultural heritage. Importantly, no full-text coding or systematic analysis was conducted on this broader dataset, and no claims of exhaustiveness are made. The initial dataset was compiled through keyword combinations including "virtual humans", "virtual agents", "immersive heritage", "extended reality", "augmented reality cultural heritage", and "digital heritage". Titles, abstracts, and keywords were screened to identify studies focusing on immersive mediation in cultural heritage contexts. The screening process reduced the dataset to a smaller analytical corpus from which the 15 core articles were purposively selected according to the relevance criteria described below.

The core analytical corpus of the study consists of 15 peer-reviewed journal articles, purposively selected. These articles were chosen based on:

(a) citation prominence and academic impact;
(b) direct relevance to immersive cultural heritage applications (e.g., VR, AR, XR, metaverse-related environments);
(c) explicit engagement with virtual agents, embodied interfaces, or agentic digital representations; and
(d) conceptual or empirical relevance to heritage interpretation, engagement, learning, or transmission processes.

This purposing sampling strategy is consistent with focused narrative reviews and conceptual framework papers (Ahmad & Wilkins, 2025), where depth of analysis and theoretical relevance are prioritized over breadth. Within the selected articles, a structured global case review protocol was applied. In this study, cases are defined as documented implementations or applications of immersive technologies or virtual/digital human agents in cultural heritage contexts, including museums, exhibitions, and heritage-related educational environments. Cases were identified through explicit descriptions within the selected articles, including system deployments, experimental settings, or applied demonstrators. Only cases sufficiently

documented in the academic sources were retained, ensuring that all empirical references are fully traceable to the cited literature and that no external or undocumented cases are introduced.

3.3. Analytical procedure

A qualitative, theory-oriented coding process was applied to the 15 articles and their documented cases. Coding focused on identifying recurring patterns and relationships across six analytical dimensions: Type of agentic representation (e.g., virtual guide, embodied assistant, narrative agent); Heritage domain (with particular attention to implications for intangible cultural heritage); Technological configuration (e.g., VR, AR, mobile AR, conversational interfaces); Experiential and cognitive mechanisms (e.g., social presence, authenticity, trust, perspective-taking, cognitive workload); Reported outcomes (e.g., engagement, learning, memorability, intention to revisit); Ethical and governance-related considerations (e.g., credibility, representation, accessibility). The synthesis emphasized conceptual convergence rather than frequency, allowing the identification of explanatory mechanisms and design–outcome linkages relevant to custodianship-oriented heritage mediation. Coding focused on three analytical dimensions: (1) technological configuration and type of agentic representation; (2) experiential and cognitive mechanisms associated with immersive interaction; and (3) heritage-related outcomes, including engagement, learning, interpretation, and potential custodianship implications. Cross-case comparison enabled the identification of recurring design patterns and conceptual relationships across the analysed studies.

3.4. Framework development

Insights derived from the focused review and case analysis were integrated through conceptual synthesis, resulting in the development of an integrative framework that links design choices, mediating mechanisms, and heritage-related outcomes. The framework is explicitly grounded in the reviewed literature and does not introduce constructs or relationships unsupported by the evidence base. Methodological rigor is ensured through transparent scope definition, explicit sampling criteria, and clear acknowledgment of limitations. While the study does not claim comprehensive coverage of the field, it provides a foundation for conceptual advancement and future empirical testing, which is appropriate for knowledge dissemination and early-stage theory development.

4. Results

The results of this study derive from the structured synthesis of the selected core articles and the documented immersive heritage cases identified therein. It articulates conceptual patterns, configurations, and relationships that emerge across studies, aligned with the three objectives of the paper.

4.1. Objective 1: Mapping metahuman-related configurations in cultural heritage contexts

The first objective aimed to identify how virtual and digital human representations are currently configured and deployed within cultural heritage environments. Across the reviewed literature, no study explicitly labels these agents as “metahumans” in a custodial sense; however, multiple

configurations functionally approximate this role. Three dominant configurations were identified:

First, virtual guides and assistants are the most common form of agentic representation. These are conversational or embodied interfaces designed to support navigation, interpretation, and information access within museums and exhibitions (Duguleană et al., 2020; Schmidt et al., 2019). Their primary role is mediational rather than authoritative, positioning them as facilitators of experience rather than holders of cultural legitimacy.

Second, narrative and interpretive agents appear in immersive VR and AR environments, often embedded within storytelling structures or guided exhibition flows. These agents contribute to experiential immersion, perspective-taking, and emotional engagement, particularly in cultural and archaeological contexts (Barbieri et al., 2017; Lucifora et al., 2023). While these representations engage users more deeply with heritage narratives, they remain largely scripted and institutionally controlled.

Third, platform-based and system-level representations emerge in studies focused on infrastructure and authoring environments for virtual exhibitions. Here, digital human representations are not isolated interfaces but part of broader systems that enable curators, educators, or institutions to construct immersive heritage experiences (Zidianakis et al., 2021). This configuration signals a shift from individual agents to ecosystems of mediation, creating conceptual space for custodianship-oriented roles.

Overall, the results indicate that current agentic representations in heritage contexts are technologically sophisticated but conceptually under-theorized in terms of cultural governance, continuity, and community involvement.

4.2. Objective 2: Identifying experiential and cognitive mechanisms underlying immersive heritage mediation

The second objective focused on identifying the mechanisms through which immersive agents and environments influence user experience and engagement. Across the reviewed studies, several recurring mechanisms were identified.

Social presence and perceived credibility emerge as central mechanisms shaping user trust and engagement with virtual agents. Embodied representations that simulate human-like interaction patterns enhance perceived authenticity and attentional focus, particularly when agents are visually coherent with exhibited artefacts (Schmidt et al., 2019; Duguleană et al., 2020).

Perspective-taking is identified as a higher-order cognitive mechanism enabled by immersive VR environments. Studies demonstrate that immersive cultural experiences can support users' ability to adopt alternative viewpoints, fostering deeper interpretive engagement and empathetic understanding (Lucifora et al., 2023). This mechanism is especially relevant for intangible cultural heritage, where meaning is embedded in practice, memory, and lived experience rather than static objects.

Cognitive and affective workload consistently moderates the effectiveness of immersive experiences. AR and VR applications that impose excessive mental effort or interaction complexity undermine engagement and learning outcomes, regardless of technological novelty

(De Paolis et al., 2023). Conversely, carefully designed interaction flows support sustained attention and experiential continuity.

Finally, inclusivity and comfort function as enabling or constraining conditions. Research on older adult populations and VR comfort optimization highlights that immersive heritage systems must accommodate diverse physical, perceptual, and cognitive capacities to avoid exclusion (Brown, 2019; Becerra et al., 2020).

Collectively, these mechanisms indicate that immersive agents can support meaningful heritage engagement only when experiential design, cognitive load, and user diversity are carefully aligned.

4.3. Objective 3: Linking immersive design to heritage-related outcomes and the custodianship potential of metahumans

The third objective examined the outcomes associated with immersive heritage mediation and their implications for custodianship-oriented models.

Across the reviewed studies, short-term experiential outcomes are consistently reported, including increased engagement, enjoyment, memorability, and learning (Spadoni et al., 2022; Wang et al., 2024). In some cases, immersive experiences also influence behavioural intentions, such as intention to revisit, recommend, or further explore cultural content (Chan et al., 2023). However, results indicate a clear conceptual gap between these outcomes and longer-term heritage objectives. While immersive systems can enhance access, interpretation, and emotional connection, few studies explicitly address cultural continuity, intergenerational transmission, or legitimacy of representation, all critical to ICH safeguarding.

Platform-oriented studies suggest that scalable, user-centric infrastructures may enable broader participation and co-creation, indirectly supporting heritage sustainability (Zidianakis et al., 2021). Yet, governance conditions, such as community involvement, consent, attribution, and ethical safeguards, are rarely operationalized within the analyzed systems.

As a result, the findings suggest that immersive agents currently function primarily as interfaces and experience enhancers, rather than as culturally authorized custodians. This gap underscores the need for an integrative framework that explicitly links immersive design choices to custodianship conditions and long-term heritage outcomes.

4.4. Summary of results

Taken together, the results reveal that:

1. Existing immersive heritage agents approximate metahumans functionally but lack custodial framing;
2. Experiential mechanisms (presence, credibility, perspective-taking, workload) are well documented and robust;
3. Heritage-related outcomes remain predominantly experiential and short-term, with limited engagement with governance and continuity concerns.

These findings directly inform the proposed conceptual framework presented in the following section, which systematizes the relationships among immersive design, mediating mechanisms, and custodianship-oriented outcomes.

5. Proposed Conceptual Framework: Metahumans as Custodians of Intangible Cultural Heritage

5.1. Rationale and scope of the framework

Building on the patterns identified in the results section, this paper proposes an integrative framework that explains how immersive technologies and agentic digital representations (including metahuman-like configurations) may evolve from "agent-as-interface" toward "metahuman-as-custodian" in cultural heritage contexts. While the reviewed evidence strongly supports experiential and cognitive mechanisms such as social presence, credibility, perspective-taking, and workload management (Schmidt et al., 2019; Duguleană et al., 2020; Lucifora et al., 2023; De Paolis et al., 2023), it also indicates that heritage applications remain predominantly oriented to short-term engagement outcomes (Spadoni et al., 2022; Wang et al., 2024). The proposed framework addresses this gap by systematizing the pathways through which immersive design choices and agent configurations can support heritage-relevant outcomes, including those aligned with ICH continuity. Importantly, the framework is designed as a conceptual and testable model suitable for future empirical research.

5.2. Core constructs and levels of analysis

The proposed framework (Figure 1.) is structured across four layers: contextual antecedents, design and agent configuration, mediating mechanisms, and outcomes.
(A) Contextual antecedents. Context shapes what kinds of immersive experiences and agentic roles are feasible and meaningful. The reviewed literature indicates that heritage settings vary in interpretive goals, audience needs, and infrastructural capacity (Barbieri et al., 2018; Marto et al., 2022; Zidianakis et al., 2021). Accordingly, antecedents include:

- Heritage domain (tangible vs. ICH-oriented mediation).
- Institutional setting (museum, exhibition, educational environment, platform-based virtual exhibition).
- Audience profile and inclusion constraints, including older users and accessibility needs (Brown, 2019).
- Comfort and perceptual constraints in immersive contexts, which condition participation and sustained engagement (Becerra et al., 2020).

These antecedents influence both design choices and the plausibility of custodian-like roles.

(B) Design and agent configuration. This layer captures how immersive experiences and agents are built and embedded. The literature supports the relevance of:

- Technology configuration (AR/VR/XR; mobile vs. headset-based environments) (Marto et al., 2022; De Paolis et al., 2023).
- Interaction architecture (storytelling, gamification, guided exploration) (De Paolis et al., 2023; Wang et al., 2024).
- Agent configuration (virtual assistant, embodied guide, narrative agent, system-level representation) (Duguleană et al., 2020; Schmidt et al., 2019; Zidianakis et al., 2021).
- Computational augmentation (e.g., deep learning–enabled contextual overlays) where relevant (Khan et al., 2021).

This layer represents the controllable "design levers" through which institutions and designers shape heritage mediation.

(C) Mediating mechanisms. Three mediating mechanisms recur and jointly explain how design/configuration translates into outcomes:

- Social presence and credibility: Embodied or agentic representations influence perceived realism and credibility, shaping engagement with exhibits and interpretive content (Schmidt et al., 2019; Duguleană et al., 2020).
- Perspective-taking: Immersion can enable users to adopt alternative viewpoints, fostering deeper interpretive engagement (Lucifora et al., 2023).
- Cognitive workload and comfort constraints: The usability and mental workload imposed by immersive systems condition whether engagement can be sustained and inclusive (De Paolis et al., 2023; Brown, 2019; Becerra et al., 2020).

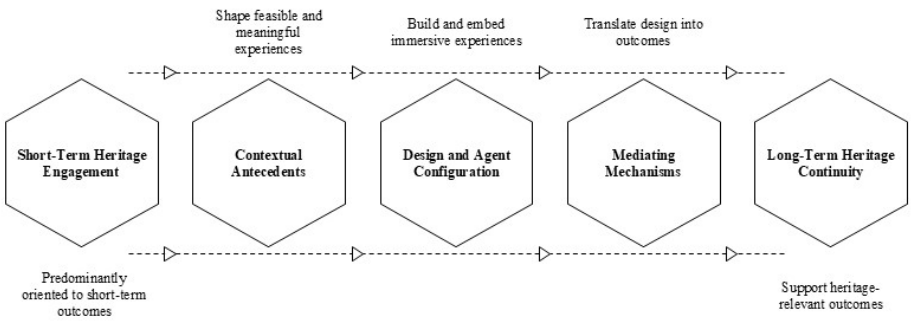
These mechanisms are framed as mediators because they translate design decisions into meaningful user responses and behavioral outcomes.

(D) Outcomes. The reviewed literature primarily documents outcomes such as engagement, enjoyment, learning, and intention-related behaviors (Spadoni et al., 2022; Wang et al., 2024; Chan et al., 2023). The framework distinguishes between:

- Immediate experiential outcomes: engagement, satisfaction, enjoyment.
- Interpretive outcomes: learning, memorability, reflective engagement, perspective-taking.
- Behavioral outcomes: intention to revisit, recommend, or further explore cultural content (Chan et al., 2023).

For custodianship-oriented applications, these outcomes constitute necessary, but not sufficient, conditions. The framework therefore conceptualizes custodianship potential as an emergent, higher-order outcome that becomes plausible when immersive systems and agent configurations support sustained meaning-making, inclusive participation, and credible mediation.

Figure 1: Metahumans as Custodians of Intangible Cultural Heritage



Source: Authors

5.3. Framework Rationale: From "Agent-as-Interface" to "Metahuman-as-Custodian"

The proposed model posits that the transition from interface-level agents toward custodial metahuman roles depends on three cumulative shifts.
First, systems must move from mere novelty-driven immersion toward purposeful interaction architectures grounded in storytelling, guided exploration, and interpretive scaffolding (De Paolis et al., 2023; Wang et al., 2024). Second, agentic representations must move beyond informational guidance toward credible, socially present mediation, shaping how users relate to heritage narratives and cultural meaning (Schmidt et al., 2019; Duguleană et al., 2020). Third, immersive mediation must remain inclusive and sustainable, requiring careful attention to workload, comfort, and audience diversity (Brown, 2019; Becerra et al., 2020). Under these conditions, metahumans can be conceptualized as custodial mediators: not because they "contain" heritage, but because they support sustained engagement with heritage knowledge, facilitate interpretive meaning-making within the community, and enable participation across diverse audiences.

The framework offers a structured tool for heritage institutions and designers to evaluate whether immersive implementations are likely to remain at the "experience-enhancement" level or whether they can credibly evolve toward custodianship-oriented mediation. It also provides a roadmap for future empirical research to operationalize constructs and test the proposed pathways in specific cultural heritage and ICH contexts.

6. Conclusions and implications

6.1. Conclusions

This paper set out to explore how immersive digital technologies and agentic representations can move beyond an interface-oriented role toward a custodianship-oriented mediation of Intangible Cultural Heritage (ICH). Findings indicate that existing applications of AR, VR, and virtual agents in cultural heritage contexts are primarily designed to enhance experience quality, including engagement, enjoyment, learning, and memorability (Barbieri et al., 2018; De Paolis et al., 2023; Spadoni et al., 2022). While these outcomes are valuable, they remain largely short-term and interaction-focused, offering limited support for longer-term heritage objectives such as continuity, legitimacy, and intergenerational transmission, core principles of ICH safeguarding.

Across the reviewed studies, immersive design choices consistently operate through mediating mechanisms such as social presence, perceived credibility, perspective-taking, and cognitive workload management (Schmidt et al., 2019; Duguleană et al., 2020; Lucifora et al., 2023). These mechanisms explain how immersive systems influence user experience, but they do not, by themselves, guarantee custodianship-oriented outcomes. Instead, the results suggest that custodianship potential emerges only when immersive mediation is embedded within broader logics of cultural meaning, inclusion, and legitimacy. To address this gap, the paper proposed an integrative conceptual framework that links contextual antecedents, immersive design and agent configuration, mediating mechanisms, and multi-level outcomes. The framework reframes metahumans not as repositories of heritage knowledge, but as mediating actors whose custodial potential depends on their ability to support sustained engagement, interpretive depth, and inclusive participation. In doing so, the study advances the conceptual vocabulary available to scholars and practitioners working at the intersection of immersive technologies and ICH.

6.2. Theoretical implications

From a theoretical perspective, this study contributes to cultural heritage and HCI-related research in three main ways. First, it advances existing immersive heritage research by reconceptualizing agentic digital representations. Whereas prior studies largely treat virtual agents as functional interfaces or guides, this paper introduces a custodianship-oriented framing that foregrounds questions of legitimacy, continuity, and cultural authority. This move complements established HCI constructs, such as presence, credibility, and workload, by embedding them within heritage-specific logics.

Second, the study contributes to the emerging dialogue between immersive experience research and ICH studies. By explicitly engaging with ICH as a living, relational, and practice-based form of heritage, the paper highlights the limitations of experience-centric models and calls for conceptual integration that accounts for governance, inclusion, and ethical mediation.

Third, the proposed framework offers a theory-building scope for future empirical research. By specifying mediating mechanisms and boundary conditions, it enables scholars to move from descriptive accounts of immersive applications toward explanatory and testable models of custodianship-oriented digital heritage mediation.

6.3. Managerial and policy implications

The findings of this study have several implications for heritage managers, designers, and policymakers. For heritage institutions and museums, the results suggest that investments in immersive technologies should be guided not only by experiential objectives but also by long-term heritage considerations. Virtual agents and metahuman-like representations should be designed to support interpretive depth, inclusivity, and sustained engagement, rather than functioning solely as novelty-driven interfaces.

For designers and technology developers, the framework highlights the importance of aligning interaction architectures with cognitive and perceptual constraints. Managing workload, ensuring comfort, and supporting diverse audiences, particularly older users, are critical for enabling inclusive participation and avoiding the exclusionary effects of poorly designed immersive systems (Brown, 2019; Becerra et al., 2020).

From a policy and governance perspective, the custodianship framing underscores the need for guidelines that address representation, legitimacy, and ethical mediation in digital heritage initiatives. As immersive technologies become increasingly integrated into heritage strategies, policymakers should consider how digital agents are authorized, attributed, and governed to align with broader cultural sustainability objectives.

6.4. Limitations and future research directions

Several limitations should be acknowledged. First, the study adopts a focused narrative review rather, prioritizing conceptual depth over exhaustive coverage. While appropriate for the paper's aims and scope, this approach limits generalizability. Second, the analysis is based on documented cases within the selected literature. Future research would benefit from encompassing other empirical studies, including experiments, field deployments, and participatory research with heritage-bearing communities, to test the proposed framework and propositions.

Future research could also explore comparative studies across cultural contexts, examine co-creation models involving communities and practitioners, and investigate how custodianship-oriented metahumans perform over time in supporting ICH transmission. Quantitative and mixed-method approaches may further operationalize key constructs and assess their impact on heritage-related outcomes.

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A scientific paper

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DIGITAL TRANSFORMATION, PERCEIVED BENEFITS, AND INVESTMENT INTENTIONS IN MICRO AND SMALL ENTERPRISES IN EASTERN CROATIA

ABSTRACT

Technological progress requires enterprises to adapt their business models to new realities. Successful digital transformation involves system integration and optimisation, strengthening employees' digital skills through education, and developing new digital business models.
The aim of this paper is to present the results of an analysis of the state of digital transformation among micro and small enterprises in eastern Croatia. The authors seek to determine the level of implementation of digital technologies, the existence of digital strategies within these entities, and the key obstacles hindering the digital transformation process.
The research was conducted using a survey. The questionnaire was distributed online to enterprises in three counties in eastern Croatia: Brod-Posavina, Osijek-Baranja, and Vukovar-Srijem. The survey consisted of 19 questions grouped into three parts: demographic data, current level of digital transformation, and future plans. Responses were collected from 72 enterprises. The data were analysed using statistical methods.
The results suggest a moderate level of digital transformation in the observed enterprises, with clear differences across business functions and a continued reliance on basic digital tools. A significant proportion (38.9%) of the surveyed enterprises do not have a designated person responsible for digital transformation. High investment costs and a lack of specific knowledge and skills among employees were identified as primary obstacles. Nevertheless, the findings indicate a willingness to invest in more advanced digital solutions. Overall, financial support and education emerge as two key conditions for accelerating the region's digital transformation.

Key words: *Digital transformation, Eastern Croatia, Micro and small enterprises.*

1. Introduction

Digital transformation is not a temporary technological trend but a structural change in how businesses operate. Digital technologies are reshaping how firms create products and services, manage value chains, and collect and use data in decision-making. For micro and small

enterprises, digital transformation presents both opportunities and risks: it enables them to reach new markets, reduce costs, and improve efficiency with limited resources, but it also requires investment, organisational change, and new skills. From a regional perspective, digital transformation becomes even more important, as digital technologies reduce geographical barriers, improve access to knowledge, and connect small businesses with markets beyond their immediate environment.

Eastern Croatia provides a relevant setting for examining this topic. The region faces several development challenges but also holds strong potential in agriculture, manufacturing, logistics, and services. Micro and small enterprises form the backbone of the local economy, and their digital transformation can generate multiplier effects for regional development– from retaining the workforce and increasing productivity to strengthening the entrepreneurial ecosystem. At the same time, regions like this often experience a "digital divide" between urban and rural areas, which can lead to slower adoption of advanced solutions and weaker institutional support.

Based on these considerations, this paper has three main objectives:

- to determine the level of digitalisation across business functions in micro and small enterprises in Eastern Croatia;
- to examine organisational readiness for digital transformation, including the presence of a dedicated digital role, clearly defined digitalisation goals, and the use of public funding;
- to quantitatively test the relationship between these factors and both the perceived benefits of digitalisation and investment intentions.

The study combines a descriptive approach (frequencies and means) with econometric modelling (OLS, ordered logit, Poisson, and negative binomial regression), allowing for a deeper understanding of digital transformation patterns.

In this study, enterprise development is operationalised indirectly through perceived digitalisation benefits and investment intentions rather than through objective performance indicators such as revenue growth, productivity, or exports. This approach reflects the practical difficulty of obtaining reliable firm-level performance data from micro and small enterprises and is intended to capture developmental outcomes in an exploratory and perception-based way.

The paper addresses the following research questions:

IP1 – What is the level of digitalisation across business functions?
IP2 – To what extent do firms have a responsible digital role and defined digitalisation goals, and do they use public funding?
IP3 – Which technologies do firms use, which barriers do they report, and when do they plan to invest?
IP4 – Which variables best explain perceived benefits and investment intentions?

2. Theoretical Framework

Digitalisation typically refers to the conversion of analogue data into digital form and the use of digital tools to automate tasks. Digital transformation represents a broader process that includes the redesign of business processes, changes in business models and organisational culture, and the development of new competencies. In other words, digital transformation does not simply mean "introducing IT," but rather a strategic shift that aligns technology with

business objectives and customer needs. The literature emphasises that, through digital transformation, organisations create new forms of value, adopt data-driven decision-making, and develop more agile ways of working (Verhoef et al., 2021).

The digital transformation process can be described in several stages:

- analysis and planning, which involve assessing digital maturity and defining objectives;
- technology selection and implementation (for example, cloud solutions, BI, and automation);
- process and operational change through the redesign of workflows;
- continuous improvement, which includes measuring outcomes and making iterative adjustments.

In micro and small enterprises, these stages often lack formal structure and instead reflect pragmatic managerial decisions. As a result, firms frequently follow a hybrid pattern: they adopt individual solutions (such as contactless payments) without an overarching strategy, while a more coherent strategy sometimes emerges only after initial experience.

Digital maturity refers to an organisation's ability to continuously use digital technologies to achieve business objectives. Empirical studies commonly measure it through a combination of:

- the level of digitalisation across business functions,
- the breadth and depth of technologies in use,
- the existence of a strategy and clear responsibility,
- the organisation's capacity to manage change and develop employee skills.

In this study, digital maturity is measured using the DT_INT index (the average digitalisation score across business functions), while technological breadth is captured by the TECH variable (the number of technologies in use).

In micro and small enterprises, objective performance indicators of digital transformation (such as revenue growth or productivity) are often difficult to obtain, and entrepreneurs frequently hesitate to share such data. For this reason, this study uses perceived benefits (BENEFIT) as a proxy measure of "development outcomes". Perceived benefits matter because they shape investment decisions: firms that recognise greater benefits are more likely to invest, expand their technology portfolio, and develop digital competencies. Nevertheless, perception may be biased– either optimistic or pessimistic– so the results require cautious interpretation.

Digital transformation now takes place within a strong European Union policy framework. The "Path to the Digital Decade" sets targets for 2030 across four areas: digital skills, business digital transformation, digital infrastructure, and digital public services. The policy places particular emphasis on ensuring that most SMEs achieve at least a basic level of digital transformation and increase their use of cloud computing and artificial intelligence (European Commission, 2021). At the same time, the Digital Economy and Society Index (DESI) monitors EU countries' progress in digitalisation and frequently highlights challenges faced by SMEs. For regional policy, this context is important because incentives, vouchers, and recovery and resilience instruments can provide financial support for the digital transformation of micro and small enterprises (European Commission, 2022).

Existing research confirms that digital transformation (DT) goes beyond the simple digitalisation of individual activities and represents a broader organisational and strategic

process that encompasses technology, business processes, management practices, and culture. Authors therefore stress the need to distinguish between adopting digital tools (digitalisation) and transforming business models and value creation logic (digital transformation). In practice, effects tend to emerge gradually and heterogeneously, especially among micro, small, and medium-sized enterprises (SMEs) (Kraus et al., 2021; Konopik et al., 2022; Eller et al., 2020).

In the SME context, studies show that key enablers of digital technologies relate to firm resources and capabilities, particularly IT resources, digital skills, learning capacity, and the ability to reconfigure resources (dynamic capabilities). Empirical findings suggest that IT resources and digital skills can drive higher levels of digitalisation, while the role of a formal digital strategy often depends on implementation capacity and context and does not always act as a universal success factor (Eller et al., 2020; Sousa-Zomer et al., 2020; Konopik et al., 2022).

Systematic literature reviews further structure the success factors of digital technologies in SMEs. An integrative review identifies three interrelated managerial dimensions:

- digital infrastructure and processes with active managerial involvement,
- the introduction of new organisational and governance mechanisms,
- top management responsibility for orchestrating change.

These findings confirm that digital technology requires change management, not just technological investment (Ben Slimane et al., 2022; Sagala & Őri, 2024).

Research also recognises leadership, organisational roles, and culture as critical implementation mechanisms. Studies emphasise that managerial coherence and alignment with the firm's mission facilitate advanced stages of digital technologies by reducing uncertainty and resistance to change. At the micro level, SMEs often lack formal roles such as a Chief Digital Officer; instead, they implement digital technologies through informal change agents and peer-mentor approaches. This increases the importance of clearly defined responsibilities and internal digital "champions" (Porfírio et al., 2021; Zoppelletto et al., 2023).

Recent research further shows that dynamic capabilities can foster digital leadership and digital culture as distinct yet complementary levers of digital technologies, with potentially non-linear transmission mechanisms between leadership and culture. This helps explain why firms of similar size in the same sector achieve different digital outcomes. Related information systems research indicates that digital leadership can enhance innovation outcomes through platform-based digital capabilities, highlighting the need to integrate "soft" (people and culture) and "hard" (platforms and processes) components of transformation (Held et al., 2025; Benitez et al., 2022).

Barriers to digital transformation in SMEs consistently fall into four groups: financial (costs), human (skills shortages), organisational (resistance to change), and technological (infrastructure, interoperability, and security). Quantitative studies confirm that organisational and technical barriers, along with skill gaps, significantly affect digital outcomes. Recent literature places particular emphasis on cybersecurity: digitalisation expands the attack surface and increases exposure to threats, making cyber resilience essential for sustainable transformation outcomes (Brink & Packmohr, 2023; Annarelli & Palombi, 2021).

Similarly, research on business resilience highlights that the digital era increases both the frequency and complexity of crises, requiring firms to build resilience through a combination

of technological solutions, management practices, and security measures (Sigurnjak & Knežević Kušljić, 2025; Amankwah-Amoah et al., 2021).

Studies typically present the outcomes of digital technologies in SMEs in terms of operational, financial, and strategic benefits. A systematic review on digitalisation returns identifies verified value added in efficiency, cost reduction, productivity growth, customer satisfaction, and competitive advantage. Qualitative studies emphasise SMEs' need for measurable indicators (such as ROI) due to limited resources and higher investment risk (Pfister & Lehmann, 2023a; Pfister & Lehmann, 2023b).

Empirical innovation research confirms heterogeneous effects: digitalisation can stimulate product and process innovation, but outcomes depend on the type of digital solutions and firm context (for example, internal R&D capacity). Under crisis conditions, prior knowledge and collaboration networks increase the likelihood of digital investment, while IT capabilities enhance agility, which can mediate positive performance effects (Radicic & Petković, 2023; Holl & Rama, 2024; Bai et al., 2023).

At the level of business processes and information infrastructure, relevant studies show that digital investment decisions involve cost–security trade-offs. In the context of the Internet of Things (IoT), firms often accept higher costs and security risks in exchange for the benefits of remote monitoring and control. Research on business process outsourcing further suggests that firms frequently implement digital transformation through a mix of internal and outsourced elements, which requires clear decision criteria (Cobović, 2023; Cobović, 2022).

Finally, regional analyses of infrastructure costs and ICT service availability indicate that local conditions– such as prices, fees, and service access– can shape competitiveness and help explain differences in investment intentions and perceived barriers (Cobović et al., 2014).

Overall, the literature points to the need for an integrated research approach that simultaneously captures organisational readiness (roles, leadership, skills, and strategy), barriers (finance, competencies, security), transformation intensity and maturity (technology breadth and depth), and outcomes (perceived benefits, performance, and investment intentions). Such an approach offers a more realistic explanation of heterogeneity in SME digital transformation and improves the practical and policy relevance of research findings (Ben Slimane et al., 2022; Sagala & Őri, 2024; Feliciano-Cestero et al., 2023).

3. Regional Context of Eastern Croatia

In Eastern Croatia, micro and small enterprises often operate with limited access to capital, a smaller pool of skilled professionals, and weaker local support infrastructure. These constraints can slow digital transformation, but they also increase the relative benefits of digital solutions that reduce costs and improve market access. Service-sector firms (such as tourism, retail, and services) can quickly implement digital sales and payment channels, while manufacturing firms typically require more complex investment in automation and maintenance.

Based on the theory of internal and external digitalisation, market-facing functions (marketing and sales) and functions with widely available standard digital services (finance and accounting) are expected to show higher levels of digitalisation. In contrast, production and maintenance– functions that require specialised technologies and system integration (such as

IoT, CMMS, and industrial ERP)—are likely to lag behind. This expected pattern is directly tested using the DT_INT index and department-level averages.

The regional entrepreneurial ecosystem includes development agencies, chambers of commerce, universities, and advisory service providers. Their role in digital transformation can be crucial, as micro and small enterprises often lack internal IT capacity to assess and select appropriate solutions. In practice, support institutions can provide guidance, expertise, and access to information that help firms make informed digital investment decisions and reduce the risks associated with transformation:

- diagnostics of digital maturity,
- training programmes and workshops focused on specific digital tools,
- assistance with applications for funding programmes,
- networking opportunities that connect firms with technology providers and experts.

This aspect is important for interpreting findings related to the FUND variable.

4. Model and Hypotheses

The empirical model links four groups of variables:

- organisational readiness (ROLE, STRAT, FUND);
- transformation intensity (DT_INT and TECH);
- barriers (BARR, COST, SKILL);
- outcomes (BENEFIT and INV_INTENT).

Hypotheses H1–H5 test the effects of readiness and transformation intensity on outcomes, as well as the potential moderating role of barriers.

H1: Firms that appoint a person responsible for digitalisation (ROLE) exhibit a higher level of digital maturity (DT_INT).
H2: Firms with defined digitalisation goals (STRAT) and/or those that use public funding for digitalisation (FUND) exhibit a higher level of digital maturity (DT_INT).
H3: Greater digital transformation intensity (higher digital maturity DT_INT and broader technological scope TECH) is associated with a higher number of perceived digitalisation benefits (BENEFIT).
H4: Broader technological scope (TECH) is associated with earlier planned investment in digitalisation (INV_INTENT).
H5: Barriers to digitalisation (BARR, including typical barriers such as COST and SKILL) moderate the relationship between digitalisation strategy (STRAT) and perceived benefits (BENEFIT). In other words, the benefits of having a strategy diminish as barriers increase.

5. Methodology

5.1. Research Design and Instrument

The study employs a survey questionnaire comprising demographic questions (gender, age, education), firm-level information (county, industry, firm size, and revenue), and questions on digital transformation. These address organisational arrangements for digitalisation, the existence of digital goals, use of public funding, digitalisation ratings by business function,

technologies in use, investment plans, barriers, and perceived benefits. The questionnaire combines closed-ended and multiple-choice questions, enabling precise descriptive analysis and the construction of composite indices.

5.2. Data Preparation and Cleaning

To ensure consistency with the conference abstract, the analysis is based on 72 valid responses. All observations in the final sample contain complete values for the key variables. Multiple-choice responses (technologies, barriers, and benefits) are converted into numerical counts.

5.3. Measurement Validity and Limitations

The constructs used in this study demonstrate clear content validity, as they directly reflect core concepts of digital transformation. DT_INT captures the level of digitalisation across business functions, TECH measures the breadth of the technology portfolio, ROLE and STRAT represent managerial and strategic dimensions, FUND reflects access to financial support, and BARR captures barriers to digitalisation. However, several limitations should be noted:

- DT_INT is based on subjective ratings and may vary with respondents' perceptions;
- STRAT is a binary measure and does not capture the quality or scope of the strategy;
- BENEFIT reflects perceived benefits rather than objective performance;
- multiple-choice items may depend on how respondents interpret the provided options.

5.4. Models and Interpretation of Coefficients

The BENEFIT variable represents a count of selected benefits. In this instrument, the minimum value is 1, which implies truncation because the value 0 is not observed. For this reason, OLS results for BENEFIT serve only as a comparative benchmark, while Poisson and negative binomial regressions provide the primary basis for inference. In addition, the high correlation between ROLE and STRAT may lead to multicollinearity and unstable partial coefficients. The results for ROLE and STRAT therefore require cautious interpretation and robust checks.

Given the sample size (N = 72), the study is well suited for descriptive analysis and for estimating parsimonious multivariable models, but it has limited statistical power for detecting more complex effects, particularly interaction terms. This issue is especially relevant for H5, which tests whether barriers moderate the relationship between digitalisation strategy and perceived benefits. Because moderation effects typically require larger samples than main effects, the absence of statistically significant interaction terms in the present study should not be interpreted as conclusive evidence that moderation is absent. Rather, the estimates should be treated as indicative and interpreted with caution.

The OLS models use robust standard errors (HC3) to account for potential heteroskedasticity. The ordered logit model uses the ordinal dependent variable INV_INTENT, where positive coefficients indicate a higher probability of earlier investment. Poisson and negative binomial regressions model the count outcome BENEFIT; results are interpreted using incidence rate ratios (IRR = $\exp(\beta)$), which allow direct percentage-based interpretation. For example, IRR = 1.10 implies an approximately 10% higher expected count per one-unit increase in the predictor.

The study uses the following variables and codings:
DT_INT – digital maturity index: average digitalisation rating across seven functions (1–5).
TECH – number of technologies in use: count of selected technologies (0–8).

ROLE – 1 if a person, team, or department is responsible for digitalisation; 0 otherwise.
STRAT – 1 if digitalisation goals are defined; 0 otherwise.
FUND – 1 if public funding has been used; 0 otherwise.
BARR – number of barriers (1–5); BARR_c – centred value of BARR.
COST – 1 if the barrier "High costs" is reported; 0 otherwise.
SKILL – 1 if the barrier "Lack of investment in learning and skills development" is reported; 0 otherwise.
BENEFIT – number of perceived benefits (1–6).
INV_INTENT – ordinal investment intention: 0 = no plans; 1 = more than 4 years; 2 = 2–3 years; 3 = 1 year.

Model specifications (with controls for firm size, revenue, industry, and county):
Model A (OLS):

$$DT_INT = \beta_0 + \beta_1 ROLE + \beta_2 STRAT + \beta_3 FUND + \beta_4 TECH + Controls + \varepsilon.$$

Model B (OLS):

$$BENEFIT = \alpha_0 + \alpha_1 DT_INT + \alpha_2 ROLE + \alpha_3 STRAT + \alpha_4 FUND + \alpha_5 TECH + \alpha_6 BARR_c + \alpha_7 (STRAT \times BARR_c) + Controls + u.$$

Model C (ordered logit):

$$INV_INTENT = f(ROLE, STRAT, FUND, TECH, Controls).$$

Robustness checks: Poisson and negative binomial regressions for BENEFIT, with IRR = $\exp(\beta)$

6. Results

6.1. Descriptive Results

The sample (N = 72) consists predominantly of female respondents (46), with 26 male respondents. The largest age group is 31–40 years (33 respondents), followed by 41–50 (22), 18–30 (14), and 51–60 years (3).

Average digitalisation scores by business function (Table 1) confirm the expected pattern. Finance and accounting, as well as marketing and sales, rank highest, while production and maintenance rank lowest. This finding has clear practical implications: during the transformation planning phase, firms and support institutions can focus their programmes on the more challenging functions (production and maintenance), which require higher investment and more specialised expertise.

Table 1: Descriptive statistics of key measures (N=72)

Measure	Mean	SD	Min	Max
DT_INT (average across 7 functions; 1–5)	3.048	1.029	1.0	5.0
TECH (count of technologies)	2.194	1.607	0.0	8.0
BENEFIT (count of perceived benefits)	3.319	1.685	1.0	6.0
BARR (count of barriers)	1.583	0.852	1.0	5.0
ROLE (0/1)	0.361	0.484	0.0	1.0
STRAT (0/1)	0.306	0.464	0.0	1.0
FUND (0/1)	0.181	0.387	0.0	1.0

Measure	Mean	SD	Min	Max
INV_INTENT (0–3 ordinal)	1.528	1.186	0.0	3.0

Source: Authors

Table 2 presents the technologies used by firms. Payment and cloud solutions predominate, aligning with the global shift towards cloud infrastructure and digital payments. Adoption rates for more advanced technologies, such as BI and AI, remain lower but are evident, suggesting an early stage of adoption. Notably, TECH, measured as the number of technologies in use, varies across the sample (Min = 0, Max = 8), enabling analysis of broader portfolio effects.

Table 2: Technologies used (multi-select)

Technology	Count	Share_%
Contactless payments	34	47.2
Cloud-based business	28	38.9
Cloud computing	25	34.7
Revenue management software	25	34.7
PayPal or similar online payments	21	29.2
Artificial intelligence (ChatGPT)	11	15.3
Business intelligence software	8	11.1
Channel manager (auto price/availability updates)	6	8.3

Source: Authors

Barriers to digitalisation (Table 3) indicate that costs and human factors play a central role. High costs are the most frequently reported barrier, followed by employee resistance and insufficient investment in skills. This result aligns with the theoretical view that digital transformation is a socio-technical process rather than a purely technological implementation. Investment plans (Table 4) further reveal a "two-speed" structure: some firms plan to invest in the short term, while a substantial share currently has no investment plans.

Table 3: Barriers to digital transformation (multi-select)

Barrier	Count	Share_%
High costs	36	50.0
Employee unpreparedness	27	37.5
Insufficient investment in learning and skills	21	29.2
Resistance to change	20	27.8
Management not sufficiently interested	10	13.9

Source: Authors

Table 4: Planned digital investment horizon

Investment horizon	Count	Share_%
Within 2–3 years	25	34.7
No investments planned currently	23	31.9
Within 1 year	18	25.0
More than 4 years	6	8.3

Source: Authors

6.2. Modelling: Digital Maturity, Benefits, and Investment Intention

Descriptive statistics for the constructed measures are presented in Table 1. The analysis therefore proceeds directly to the hypothesis tests using three groups of models: (A) determinants of DT_INT, (B) determinants of BENEFIT with moderation effects, and (C) determinants of INV_INTENT.

Table 5: Model A (OLS, HC3): Determinants of digital maturity (DT_INT)

Variable	Coefficient	Robust SE	p-value
Dedicated digital role exists (ROLE=1)	0.186	0.492	0.705
Digitalization goals defined (STRAT=1)	-0.420	0.404	0.298
Public funding used (FUND=1)	0.536	0.480	0.264
Number of technologies used (TECH)	0.304***	0.111	0.006

Notes: R^2=0.505. Controls included (size, revenue, sector, county). Significance: *** p<0.01, ** p<0.05, * p<0.10.

Source: Authors

Table 6: Model B (OLS, HC3): BENEFIT with STRAT×BARR_c

Variable	Coefficient	Robust SE	p-value
Dedicated digital role exists (ROLE=1)	2.103***	0.614	0.001
Digitalization goals defined (STRAT=1)	2.145**	0.862	0.013
Public funding used (FUND=1)	1.234**	0.627	0.049
Number of technologies used (TECH)	0.348*	0.206	0.091
Barriers count (centered) (BARR_c)	0.613*	0.363	0.092
Interaction STRAT×BARR_c	0.774	0.736	0.293

Notes: R^2=0.469. BARR_c is centered. Controls included. Significance stars as above.

Source: Authors

Model A shows that TECH is a statistically significant and positive predictor of DT_INT, while ROLE, STRAT, and FUND are not significant once controls are included. This result suggests that digital maturity in the sample mainly varies according to the breadth of implemented technologies, whereas the effects of formalised roles, defined goals, and funding may operate indirectly (for example, through TECH) or emerge over time in ways that a cross-sectional design cannot capture. The findings for ROLE, STRAT, and FUND should therefore be interpreted as a lack of additional explained variance at this point in time and within this sample, rather than as evidence that these mechanisms are unimportant in the digital transformation process.

H1 is not supported, as the coefficient for ROLE in Model A is positive but statistically non-significant.

Table 7: Poisson GLM (HC3): BENEFIT with STRAT×BARR_c (IRR)

Variable	Coef. (log)	SE	p-value	IRR	95% CI (IRR)
Dedicated digital role exists (ROLE=1)	0.557***	0.125	0.000	1.745	[1.365, 2.230]
Digitalization goals defined (STRAT=1)	-0.624***	0.165	0.000	0.536	[0.388, 0.741]
Public funding used (FUND=1)	0.341***	0.119	0.004	1.406	[1.114, 1.775]
Number of technologies used (TECH)	0.101**	0.045	0.025	1.106	[1.013, 1.208]
Barriers count (centered) (BARR_c)	0.192***	0.073	0.009	1.212	[1.050, 1.399]
Interaction STRAT×BARR_c	0.116	0.130	0.373	1.123	[0.870, 1.448]

Notes: AIC=297.257. IRR=exp(β). Controls included.

Source: Authors

Table 8: Negative binomial GLM (HC3): BENEFIT with STRAT×BARR_c (IRR)

Variable	Coef. (log)	SE	p-value	IRR	95% CI (IRR)
Digital maturity index (DT_INT)	-0.023	0.077	0.768	0.977	[0.840, 1.137]
Dedicated digital role exists (ROLE=1)	0.567***	0.126	0.000	1.763	[1.377, 2.256]
Digitalization goals defined (STRAT=1)	-0.651***	0.172	0.000	0.521	[0.372, 0.730]
Public funding used (FUND=1)	0.337***	0.128	0.008	1.401	[1.090, 1.801]
Number of technologies used (TECH)	0.111**	0.053	0.036	1.117	[1.007, 1.239]
Barriers count (centered) (BARR_c)	0.207**	0.082	0.011	1.230	[1.048, 1.444]
Interaction STRAT×BARR_c	0.155	0.147	0.292	1.168	[0.875, 1.559]

Notes: AIC=377.907. IRR=exp(β). Controls included.

Source: Authors

Table 9: Robustness: Poisson with COST/SKILL interactions (IRR)

Variable	Coef. (log)	SE	p-value	IRR	95% CI (IRR)
Digital maturity index (DT_INT)	-0.020	0.058	0.734	0.980	[0.874, 1.099]
Dedicated digital role exists (ROLE=1)	0.533***	0.138	0.000	1.704	[1.300, 2.233]
Digitalization goals defined (STRAT=1)	-0.689***	0.223	0.002	0.502	[0.324, 0.778]
Public funding used (FUND=1)	0.304***	0.117	0.009	1.356	[1.079, 1.704]
Number of technologies used (TECH)	0.091*	0.049	0.064	1.095	[0.995, 1.205]
Barrier: high costs (COST=1)	0.069	0.132	0.602	1.072	[0.827, 1.389]
Barrier: insufficient investment in learning/skills (SKILL=1)	0.132	0.154	0.391	1.141	[0.843, 1.545]
Interaction STRAT×COST	-0.117	0.286	0.683	0.890	[0.508, 1.558]
Interaction STRAT×SKILL	0.333	0.285	0.243	1.395	[0.798, 2.440]

Notes: AIC=303.705. COST=high costs; SKILL=skills investment barrier.

Source: Authors

Table 10: Robustness: Negative binomial with COST/SKILL interactions (IRR)

Variable	Coef. (log)	SE	p-value	IRR	95% CI (IRR)
Digital maturity index (DT_INT)	-0.004	0.070	0.955	0.996	[0.869, 1.141]
Dedicated digital role exists (ROLE=1)	0.513***	0.133	0.000	1.671	[1.288, 2.168]
Digitalization goals defined (STRAT=1)	-0.685***	0.245	0.005	0.504	[0.312, 0.814]
Public funding used (FUND=1)	0.285**	0.126	0.023	1.330	[1.039, 1.701]
Number of technologies used (TECH)	0.096*	0.054	0.078	1.100	[0.989, 1.223]
Barrier: high costs (COST=1)	0.068	0.143	0.633	1.071	[0.809, 1.417]
Barrier: insufficient investment in learning/skills (SKILL=1)	0.148	0.160	0.357	1.159	[0.847, 1.586]
Interaction STRAT×COST	-0.158	0.292	0.588	0.854	[0.482, 1.512]
Interaction STRAT×SKILL	0.358	0.285	0.210	1.430	[0.818, 2.503]

AIC=382.492; IRR=exp(β).

Source: Authors

Robust specifications (Tables 7–10) confirm the stability of the main findings. In the Poisson models, the IRR for ROLE is approximately 1.75, indicating a 75% higher expected number of perceived benefits among firms with a designated digital role. FUND also increases expected

BENEFIT (IRR around 1.35–1.41), while TECH raises BENEFIT by roughly 9–11% for each additional technology. The interaction terms (STRAT × BARR_c, STRAT × COST, STRAT × SKILL) are not statistically significant, indicating that the moderating effect of barriers cannot be confirmed, even when barriers are operationalised as specific dominant constraints.

Although STRAT is positive in the benchmark OLS specification, the interpretation of this relationship relies primarily on the Poisson and negative binomial models, which are more appropriate for the count nature of the BENEFIT variable. Accordingly, the sign reversal between OLS and count specifications should be interpreted as model-sensitive and reinforces the need to prioritise count-model inference for BENEFIT.

H5 is not supported in the present sample, although this result should be interpreted cautiously given the limited statistical power for interaction testing.

Table 11: Model C (Ordered logit): Investment intention (INV_INTENT)

Variable	Coefficient	SE	p-value
Dedicated digital role exists (ROLE=1)	-0.017	0.760	0.982
Digitalization goals defined (STRAT=1)	-0.064	0.891	0.943
Public funding used (FUND=1)	-0.216	0.756	0.776
Number of technologies used (TECH)	0.520**	0.230	0.024

Notes: AIC=207.366. Higher INV_INTENT indicates earlier investment.

Source: Authors

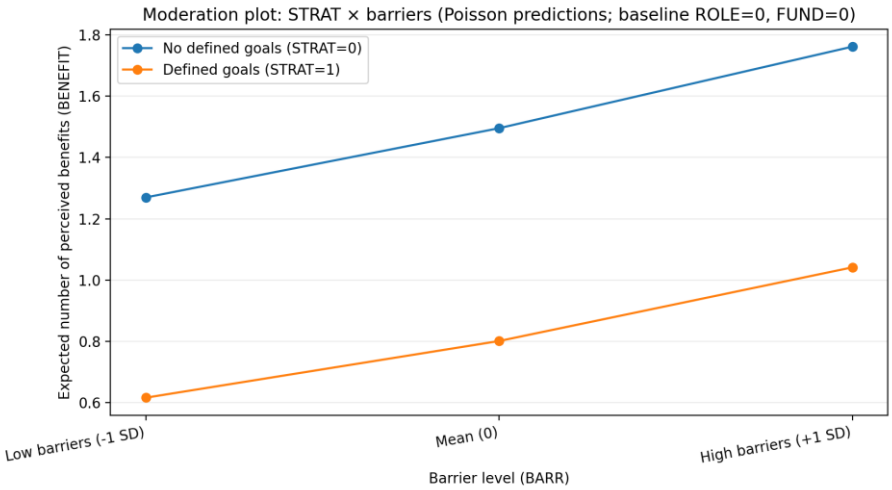
Table 12: Pearson correlations of key constructs

	DT_INT	TECH	BENEFIT	BARR	ROLE	STRAT	FUND	INV_INTENT
DT_INT	1.0	0.363	0.145	-0.248	0.353	0.264	0.175	0.215
TECH	0.363	1.0	0.226	-0.043	0.361	0.467	-0.012	0.381
BENEFIT	0.145	0.226	1.0	0.28	0.237	0.072	0.234	0.217
BARR	-0.248	-0.043	0.28	1.0	-0.108	-0.03	0.018	-0.03
ROLE	0.353	0.361	0.237	-0.108	1.0	0.694	0.098	0.228
STRAT	0.264	0.467	0.072	-0.03	0.694	1.0	0.159	0.317
FUND	0.175	-0.012	0.234	0.018	0.098	0.159	1.0	-0.057
INV_INTENT	0.215	0.381	0.217	-0.03	0.228	0.317	-0.057	1.0

Source: Authors

The ordered logit model (Table 11) shows that TECH is a positive and statistically significant predictor of earlier investment in digitalisation (higher INV_INTENT). The coefficient of 0.520 corresponds to an odds ratio of exp (0.520) ≈ 1.68, meaning that, holding other factors constant, each additional technology increases the cumulative odds of moving to an earlier investment category by approximately 68%. In other words, firms that already use a broader set of technologies are more likely to invest sooner, which is consistent with the argument that prior experience reduces uncertainty and strengthens implementation capacity.

Figure 1: Illustrative predicted values from the Poisson model



Source: Authors

Note: Predictions are based on the Poisson model with controls; the baseline assumes ROLE = 0 and FUND = 0, while DT_INT and TECH are set to their sample means. Barriers are shown at −1 SD, 0, and +1 SD around the mean of BARRIERS. The figure is presented for illustrative purposes only. Because the estimated interaction effect is not statistically significant, the plotted differences should not be interpreted as evidence of a statistically supported moderation effect.

7. Discussion

The results provide several important insights for both theory and practice regarding the digital transformation of micro and small enterprises. First, the distinction between DT_INT and TECH is conceptually significant. Digital maturity across business functions (DT_INT) reflects the depth of process digitalisation, while TECH indicates the breadth of the technology portfolio. In this sample, portfolio breadth shows more stable associations with outcomes (BENEFIT and INV_INTENT). This pattern suggests that firms in the early stages of transformation tend to expand their set of tools incrementally before fully integrating and redesigning processes.

Second, ROLE emerges as the strongest predictor of perceived benefits. This finding supports the argument that digital transformation requires ownership and coordination. Without a clearly responsible role, firms implement solutions in a fragmented manner, making benefits harder to identify and leverage.

It is important to note that this study uses a cross-sectional design. The results therefore indicate associations rather than causality. It remains possible that more digitally mature firms are simply more likely to introduce digital roles and adopt additional technologies, rather than these mechanisms causing higher maturity.

The negative and statistically significant coefficient for STRAT in the count models is counterintuitive and should be interpreted with caution. One possible explanation is that the binary strategy indicator captures formalisation rather than the quality, coherence, or implementation capacity of digital strategy. In smaller firms, strategic digitalisation goals may be introduced reactively, that is, after firms have already encountered difficulties, inefficiencies,

or pressures to formalise their digital activities. A second explanation relates to the relatively strong association between STRAT and ROLE, which may generate unstable partial coefficients when both predictors are included in the same model. In that case, the negative STRAT coefficient may reflect overlap between formal planning and implementation ownership rather than a robust negative substantive effect of strategy itself. This interpretation is also consistent with the broader literature, which suggests that the value of digital strategy depends not only on its formal existence but also on implementation capacity, organisational roles, leadership coherence, and the ability to translate strategic intent into operational change. Accordingly, the present result should not be read as evidence against digital strategy as such, but rather as an indication that formal strategy without sufficient implementation support may not translate into stronger perceived benefits.

Third, the positive association between FUND and perceived benefits in the count models highlights the importance of financial support, especially in environments where high costs are the dominant barrier. In the regional context of Eastern Croatia, this finding has strong policy implications. Support programmes can act as a catalyst, helping firms move from basic digital solutions (payments, cloud services) towards more advanced applications (system integration, business intelligence, and security).

Fourth, the finding that barriers do not moderate the relationship between strategy and benefits should be interpreted cautiously. The interaction terms are not statistically significant; therefore, H5 is not supported in the present sample. However, this result may reflect the limited power of a relatively small sample to detect moderation effects, particularly when several predictors, controls, and interaction terms are estimated simultaneously. A brief post-hoc reflection suggests that the study is better positioned to detect main effects than interaction effects. Accordingly, the absence of a statistically significant interaction cannot be treated as conclusive evidence that barriers play no conditional role in shaping perceived benefits.

The descriptive results by business function (Table 1) also help identify the main transformation bottlenecks: production and maintenance receive the lowest scores. For regional development, this implies that interventions such as training programmes and incentives should target specific sectors and functions. For example, manufacturing firms require Industry 4.0–oriented projects (sensors, machine monitoring, predictive maintenance), while service firms can focus more on digital sales channels and customer relationship management.

8. Limitations and Future Research

The findings should be interpreted in light of several limitations. Most importantly, the cross-sectional design does not allow causal conclusions, and the reported estimates should therefore be understood as associations. In addition, although the sample of 72 firms is adequate for descriptive purposes and exploratory regression analysis, it constrains statistical precision and is less suitable for reliably detecting interaction effects. This is particularly relevant for H5, where the absence of significant moderation may reflect limited power rather than the true absence of a moderating relationship. The analysis is also based on perceived benefits rather than objective firm-level performance indicators, and the sample is confined to three counties without stratified sampling, which may limit external validity. Finally, binary measurement of variables such as STRAT and FUND reduces the ability to distinguish between different levels of strategy quality or funding intensity.

This post-hoc interpretation is also supported by the relatively wide confidence intervals of the interaction estimates, which suggest limited precision in detecting small or moderate moderation effects.

Future research should expand the sample to include all five Slavonian counties and stratify it by industry, use longitudinal or panel data to track the effects of digital investments over time, incorporate objective indicators such as revenue, productivity, exports, or the number of digitalised processes, and develop more nuanced measures of digital strategy and digital culture. It would also be useful to examine how digital transformation differs between manufacturing and service firms, as well as the extent to which regional infrastructure, including high-speed internet and the availability of experts, shapes the transformation process.

9. Conclusion

This study examined digital transformation among micro and small enterprises in Eastern Croatia by linking organisational readiness, transformation intensity, barriers, and perceived outcomes. The results suggest that the breadth of technologies in use (TECH) and the presence of a designated digital role (ROLE) are the factors most consistently associated with stronger perceived benefits of digitalisation, while broader technological portfolios are also linked to earlier investment intentions. At the same time, the findings should be interpreted with caution. The analysis is based on a relatively small cross-sectional sample and on perceived rather than objective indicators of enterprise development, which limits the strength of causal and generalisable conclusions. In particular, the non-significant moderation results do not allow firm conclusions regarding the conditional role of barriers and should be revisited in future studies based on larger samples and more detailed measures of digital strategy and organisational capability.

Even with these limitations, the study indicates that digital transformation in smaller firms is shaped less by abstract strategic intent alone and more by concrete technological adoption, implementation ownership, and access to financial support. Coordinated financial incentives, targeted education, and institutional support can help firms move from basic digitalisation towards more integrated forms of transformation with measurable gains in competitiveness and regional resilience.

For regional policymakers and support institutions, these findings point to three priorities: strengthening firms' implementation capacity, expanding access to targeted financial support, and improving employee digital skills through practical training programmes.

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A scientific paper

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CAN ENTREPRENEURIAL ATTITUDES BE BOOSTED THROUGH HACKATHONS? EVIDENCE FROM A UNIVERSITY-BASED EXPERIMENTAL STUDY

ABSTRACT

This study investigates the impact of university-hosted hackathons on students' entrepreneurial attitudes and spirit, examining the moderating roles of MBTI personality types, gender, and parental entrepreneurial background. It evaluates the educational effectiveness of short-term idea competitions in fostering an entrepreneurial mindset and contextualises hackathon-based learning within broader institutional competence development efforts.

Employing a quasi-experimental design, the research utilised the Simonyi Hackathon as the intervention framework. Data were collected from 131 international and Hungarian students across six faculties via pre- and post-event online surveys. Quantitative analyses, including descriptive statistics, paired samples t-tests, and one-way ANOVA, were used to assess shifts in entrepreneurial attitudes and competencies. Furthermore, MBTI profiling was applied to explore differential student responses to the intervention. To deepen the analysis, the empirical results were complemented with a competence development model, allowing the findings to be interpreted not only as isolated behavioural changes but also as elements of a wider educational ecosystem.

The results indicate that hackathon participation positively influences entrepreneurial attitudes and skills, specifically regarding innovation, risk-taking, opportunity recognition, and decision-making. The most significant attitudinal improvements were observed in students with "Diplomat" and "Analyst" MBTI profiles. Contrary to expectations, neither gender nor parental background showed a strong correlation with increased entrepreneurial propensity. While the intervention improved self-perceived readiness, attitudinal shifts did not guarantee immediate entrepreneurial action. These results support integrating hackathons into entrepreneurship curricula to enhance employability and practical readiness for future endeavours.

Key words: *Entrepreneurship education, Hackathon, Entrepreneurial attitude, Employability, MBTI.*

1. Introduction

Regional business development increasingly relies on universities to supply entrepreneurs, foster innovation, and strengthen local economic relations. The "entrepreneurial university" extends beyond technology transfer, shaping students' entrepreneurial mindset (Peris-Ortiz, 2017; Battaglia et al., 2022). Business development at the regional level becomes particularly tangible when educational institutions, local companies, mentors, and financial actors work together in a shared space on common problems.

In Hungary, research into entrepreneurial motivations and perceived opportunities also indicates that entrepreneurial activity is driven by both livelihood and opportunity-driven patterns, and that these patterns are sensitive to the economic environment, role models, and the available support infrastructure (Csákné Filep et al., 2023). International comparative data (e.g., the GEM database) also indicate that the "gap" between entrepreneurial intention and actual business start-up is a persistent phenomenon, and that education and the support ecosystem can play a key role in bridging this gap (Global Entrepreneurship Monitor, 2024; Tessényi & Kun, 2022).

Entrepreneurial attitude and entrepreneurial intention can be considered the precursors to starting a business: in the scientific literature, they often appear as a combination of psychological and behavioural factors that influence whether an individual is able and willing to take risks, recognise opportunities, develop an action plan, and mobilise resources (Abun et al., 2017; Kuratko et al., 2021). The impact assessment of educational interventions should therefore not be based solely on satisfaction questions such as "did you like the programme," but should also focus on measurable changes in entrepreneurial attitudes and related skills (Bozward et al., 2023).

Hackathons are located at the intersection of entrepreneurial education and business development. These time-limited, team-based, problem-solving events offer a "learning by doing" (action-based) learning situation, intensive mentoring opportunities, and a social space where participants receive quick feedback on the viability of their ideas (Chia, 2018; Kohne & Wehmeier, 2020; Avila-Merino, 2019). Hackathons, as both a pedagogical and ecosystem tool, are particularly interesting from the perspective of regional business development: by addressing problems based on local challenges, involving corporate partners, and connecting to subsequent incubation channels, they can provide a "fast track" for student ideas (Garcia, 2023; Eimler & Straßmann, 2023).

In the case of the Simonyi Hackathon, the organisers' intentions go beyond a one-off competition experience: the programme specifically aims to strengthen the university's entrepreneurial ecosystem, develop student skills, and connect with partner companies from the real market (Putzer, 2023). From a regional perspective, the question is what kind of short-term, measurable shift such an event can produce regarding attitudes and skills of participants, and whether certain background factors (such as family entrepreneurial background or lack thereof) lead to different career paths.

The aim of this study is therefore to conduct a short-term, pre-post impact assessment of the Simonyi Hackathon course. The focus is not on the actual realisation of business start-ups (which can be interpreted over a longer period of time and under more complex support conditions), but on the direction and extent of changes in entrepreneurial attitudes and related skills that can be measured immediately after the event. The research is based on the following hypotheses and research questions:

Hypotheses:

- H1: The Simonyi Hackathon event increases entrepreneurial attitudes.
- H2: Entrepreneurial parents have a positive influence on their children's entrepreneurial spirits.
- H3: Entrepreneurial spirit is more prevalent among men.

Research questions:

- Question 1: What skills and abilities can the Simonyi Hackathon develop?

- Question 2: Which MBTI personality type shows the greatest change in entrepreneurial spirit?
- Question 3: Is there a connection between MBTI personality types and entrepreneurial spirit?
- Question 4: What is the role of education in training entrepreneurs?

2. Theoretical background

2.1. Entrepreneurial attitude, willingness and mindset

Entrepreneurial attitude encompasses an individual's evaluations, attitudes, and readiness for entrepreneurship. Within the theory of planned behaviour, entrepreneurial intention is shaped by social norms, perceived control, and self-efficacy (Kgagara, 2011; Abun et al., 2017).

An entrepreneurial mindset involves cognitive and behavioural patterns supporting opportunity recognition, risk management, the willingness to learn, and value creation competencies. Kuratko et al. (2021) emphasise that entrepreneurial thinking is not only an innate trait but also the result of developable competencies and learning experiences.

Entrepreneurial attitudes are typically measured using self-report scales. These scales capture the dimensions of risk-taking, creativity, proactivity, independence, and ideas related to starting a business. When evaluating higher education interventions, it is particularly important to examine changes not only cross-sectionally but also over time (before and after), as this makes it easier to see what kind of shifts a given programme may lead to (Bozward et al., 2023).

2.2. University entrepreneurial ecosystems and regional business development

Regional business development is not merely a corporate issue, but rather an institutional and network phenomenon: entrepreneurial activity, innovation, and economic renewal occur in ecosystems where the flow of resources, knowledge, and connections is ensured. In this ecosystem, universities play a dual role: on the one hand, they generate and disseminate knowledge, and on the other, they provide a community and infrastructure platform for entrepreneurial initiatives (Peris-Ortiz, 2017).

The concept of the "entrepreneurial university" is linked to the third mission of higher education (socio-economic exploitation) and includes technology transfer, support for student and researcher enterprises, and the building of a culture of innovation. Battaglia et al. (2022), for example, emphasise that the entrepreneurial university bridges the gap between business start-ups and knowledge transfer activities and treats entrepreneurial activity not only as a subject of study but also as an actual organisational practice.

The regional dimension is reinforced by the fact that the entrepreneurial ecosystems that develop around universities are often linked to local corporate partners, local government and development policy actors, and financing programmes. In the Hungarian business development toolkit, for example, venture capital programmes (such as the JEREMIE experience) also point to the fact that linking financing and knowledge/mentoring is a key condition for growth trajectories (Farkas et al., 2016).

In Hungary, the mission of the National Innovation Agency (NIÜ) is to strengthen the innovation ecosystem and promote a culture of innovation, with a particular focus on universities and student recruitment (NIÜ, 2024). Programmes such as the Hungarian Startup University Program (HSUP) offer a practice-oriented learning path in which students can develop their business and innovation skills through mentoring and project work (HSUP, 2024). Hackathons can also be seen as an "entry point" in this system: in a short period of time, they can provide intensive engagement, a community experience, and quick feedback, which can steer participants toward further business development channels.

2.3. Hackathons as experience-based tools

Hackathons were originally time-limited "marathon" events related to software development, but have now become a methodology used in many areas such as business, sustainability, healthcare, and education (Chia, 2018; Kohne & Wehmeier, 2020). The central element of the event is intensive teamwork: participants interpret a problem, generate ideas, develop prototypes, and present them within a short period of time.

In educational research, hackathons are often interpreted as tools for experiential learning and challenge-based learning. According to Avila-Merino (2019), the "learning by doing" nature of hackathons supports the development of business and entrepreneurial skills because participants work in real-time decision-making situations, facing risks and compromises. Eimler and Straßmann (2023) also emphasise that hackathons provide an opportunity to experience entrepreneurial thinking, especially when the tasks are open-ended, and participants must develop their own solutions.

The impact mechanism of hackathons can be interpreted on several levels. At the individual level, creativity, problem-solving, risk management, and proactivity come to the fore; at the group level, communication, cooperation, and conflict management become visible; and at the ecosystem level, the presence of mentors, corporate partners, and support programmes creates a network of connections from which future projects and collaborations can grow (Garcia, 2023; Putzer, 2023).

However, developing entrepreneurial skills is not automatic: short time frames and competitive situations can increase stress, and participants may be tempted to opt for quick, "obvious" solutions. This phenomenon can also limit the depth of learning, so it is worth combining the impact of hackathons with longer-term mentoring, courses, or incubation programmes (Kohne & Wehmeier, 2020; Bozward et al., 2023).

2.4. Influencing factors: family background, gender differences, and personality types

The literature explains the development of entrepreneurial spirit with several interrelated factors. In the case of family background and parental entrepreneurial role models, role model effects, access to resources, and norm transmission often appear. Lukovszki (2018) points out that, in the Hungarian context, the relationship between entrepreneurial characteristics and external factors is complex, and entrepreneurial competencies can be developed. International evidence suggests that the parental environment, attention, and expectations can play a structuring role in the development of entrepreneurial careers (Hayward et al., 2023).

Gender differences in entrepreneurial activity are persistent: the distribution of European startup founders and the female/male entrepreneur ratios in OECD countries show that

women are underrepresented in certain entrepreneurial fields (EU Startup Monitor, 2018; Erhverv, 2023). However, impact assessments of higher education interventions show mixed results: some studies find differences in risk-taking and entrepreneurial intent, while others suggest that the educational environment can mitigate these differences (Gurel et al., 2021; Kézai & Konczosné Szombathelyi, 2020).

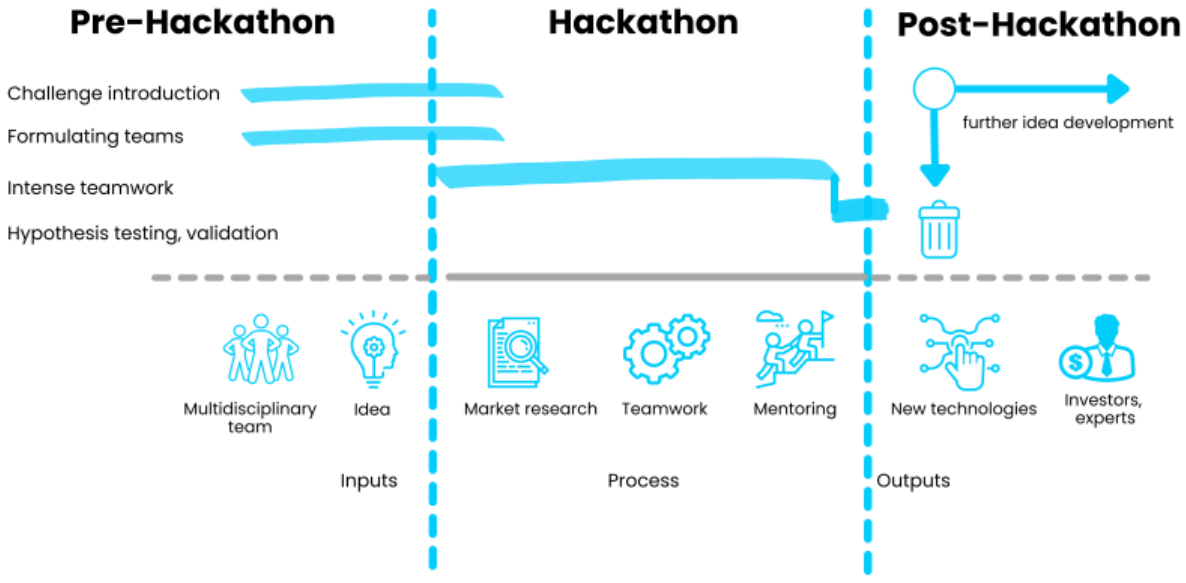
The relationship between personality types and entrepreneurial attitudes is also an area of research. The MBTI typology is suitable for describing participants' preferred information processing and decision-making patterns, which may become relevant in group work and innovation situations (Kiss et al., 2016). Personality type-based differences may also appear in the (initial) attitudes and reactions to interventions, so in this study, I treated the MBTI dimensions as separate units of analysis.

3. Methodology

3.1. Research framework and data collection

The research employed a single-sample, quasi-experimental pre-post framework. Participants completed an online questionnaire before (pre) and immediately after (post) the Simonyi Hackathon event (Figure 1). This design controls for changes in the same individuals, thus allowing stable differences between participants (e.g., general attitudes) to be partially "filtered out." However, its limitation is that, in the absence of a control group, the changes cannot be interpreted as purely causal effects: the observed shifts may be related to the event, but external factors (such as parallel experiences, self-selection) may also play a role.
Pre- and post-questionnaires used identical statements rated on a five-point Likert scale (1 = not typical, 5 = very typical). The surveys also collected information about demographics, family background, and MBTI-based personality type. The sample size in the cleaned, pre-post database is N = 131.

Figure 1: The flowchart of the Simonyi Hackathon



Source: Authors

3.2. Research framework and data collection

To measure entrepreneurial attitude, the questionnaire contained several statements related to business start-ups and entrepreneurial thinking. This study highlights seven statements that were treated as indicators of entrepreneurial spirit. These items refer to creative work, rejection of conventional solutions, risk-taking, intention to start a business, assessment of an entrepreneurial career, the importance of university encouragement, and financial motivation.
To examine skills and abilities, the research built on the entrepreneurial dimensions appearing in the literature and classified the statements into six major ability/skill groups: risk management, decision-making, opportunity recognition, innovation skills, team-building skills, and professional skills. A separate item for communication skills was not included in the questionnaire, so this area is not included in the quantitative analysis.

In examining the differences between the groups, focus was placed on three influencing factors:
(1) parental entrepreneurial background (with two questions: whether they have a business and whether they are full-time entrepreneurs),
(2) gender (male/female), and
(3) broader categories of MBTI personality types (Analysts, Diplomats, Sentinels, Explorers) and the extravert-introvert axis.

3.3. Analytical procedures and decision rules

The data was analysed in several steps. First, the sample was characterised using descriptive statistics (frequency distributions, averages), with a particular focus on demographic composition and MBTI groups. Next, the average differences between the pre- and post-measurements were calculated, showing the average direction in which the individual statements shifted after the Simonyi Hackathon. It is important to note that the average difference alone does not prove causality. Thus, inferential statistical procedures are necessary to test for significance.

The significance of the differences between the pre- and post-values was tested using a paired t-test. The null hypothesis (H0) for each item was that the difference between the pre- and post-averages was 0. The decision rule was the usual $\alpha = 0.05$ significance level: if the p-value is less than 0.05 ($p < 0.05$), then the null hypothesis is rejected and the difference is considered statistically significant; if the p-value is greater than or equal to 0.05 ($p \geq 0.05$), then the null hypothesis is not rejected, meaning that the difference cannot be considered significant (Field, 2018; Pallant, 2016).

One-way ANOVA was used to examine differences based on background factors (gender, parental entrepreneurial status, MBTI groups). In the case of ANOVA, the null hypothesis is that the group means are equal; if $p < 0.05$, a statistically significant group difference is assumed. The main purpose of this study was to map short-term pre-post shifts and compare student groups with different backgrounds.

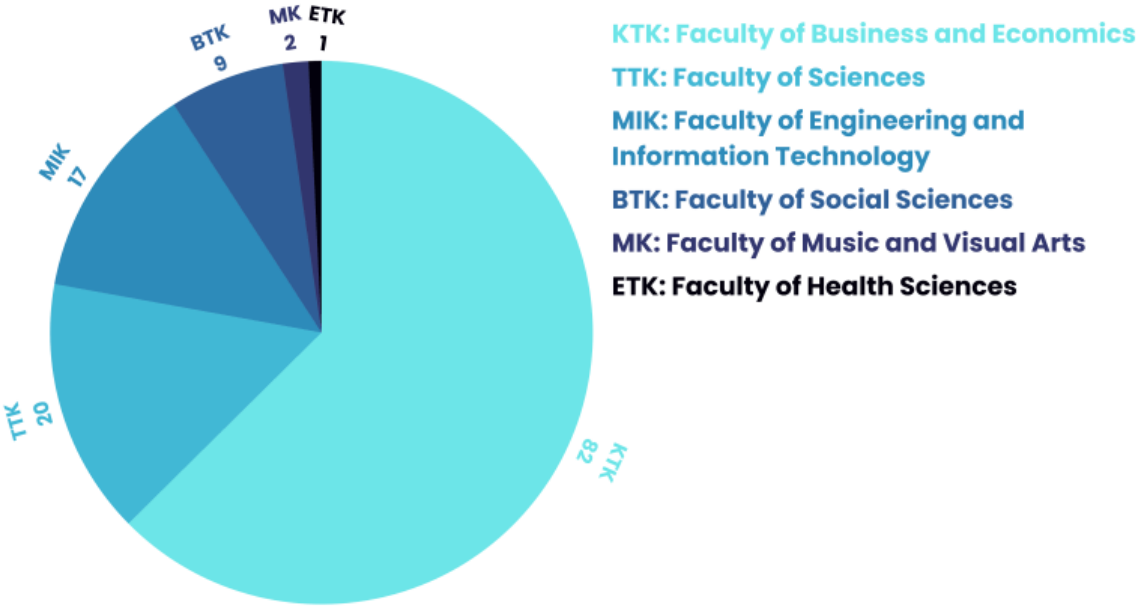
4. Results

4.1. Presentation of the sample

The sample size in the cleaned, matchable pre-post database is N = 131. The sample has a balanced gender distribution (men: 64; women: 67). While most participants study at the Faculty of Business and Economics, the sample also includes students from other faculties (Figure 2).

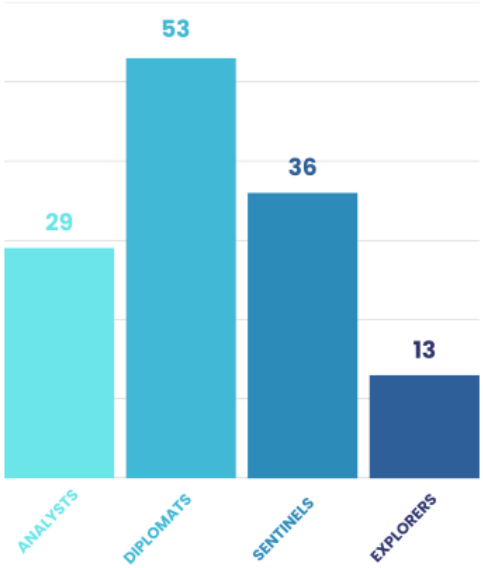
Regarding family background, 47% (n = 61) of respondents had parents with a business, and 44% (n = 57) reported their parents were full-time entrepreneurs.
Based on the MBTI classification, the largest proportion of the sample can be classified as Diplomats (n = 53), followed by Sentinels (n = 36), Analysts (n = 29), and Explorers (n = 13). On the extraverted-introverted axis, 56% of respondents are extraverted, and 44% are introverted (Figure 3).

Figure 2: Distribution of university faculties in the sample



Source: Authors

Figure 3: Distribution of MBTI personality type groups



Source: Authors

4.2. H1 - Changes in entrepreneurial attitudes

Table 1 summarises the average differences between the pre- and post-values of the seven statements associated with entrepreneurial spirit. Based on the descriptive results, a positive change can be observed in six statements, while a negative shift can be seen in one statement ("Being an entrepreneur is a serious career opportunity"). The total change in the statements is 0.046892, which indicates a modest, positive shift overall.

However, the descriptive change alone cannot be considered evidence of causality that the Simonyi Hackathon statistically increased entrepreneurial attitudes. Paired t-test results for entrepreneurial spirit statements (Appendix 1) showed all p-values remained above 0.05, indicating non-significant differences. Thus, hypothesis H1 is not statistically supported; only a descriptive positive trend was observed.

Table 1: Changes in statements associated with entrepreneurial spirit

Questionnaire statements	Degree of change	Direction of change
I like to do thing in an unconventional way.	0.129771	+
I do not want to do things in the usual ways.	0.091603	+
If I had a good business idea, I would be willing to borrow some money from my parents/friends to make it happen.	0.091603	+
My professional goal is to become an entrepreneur.	0.007634	+
Being an entrepreneur is a serious career opportunity.	-0.1145	-
The university should encourage students to become entrepreneurs.	0.083969	+
Entrepreneurship is a good way to earn a lot of money.	0.038168	+
SUMMARY	**0.046892**	+

Source: Authors

4.3. H2 - Parental entrepreneurial background and entrepreneurial spirit

When testing hypothesis H2, the analysis examined whether parental entrepreneurial background (entrepreneurial parents defined as having a business or being full-time entrepreneurs) is related to
(1) the degree of change in entrepreneurial spirit and
(2) the average value of entrepreneurial spirit.

In terms of change, based on Tables 2 and 3, the average change among students with a parental entrepreneurial background is more positive, but the one-factor ANOVA did not yield statistically significant results ($p = 0.346$; $p = 0.189$).

Tables 4 and 5 show the group averages for entrepreneurial spirit. Here, too, no significant group difference was found ($p = 0.518$; $p = 0.548$). Thus, hypothesis H2 cannot be supported, as parental entrepreneurial status showed no statistically significant correlation with the examined indicators.

Table 2: Entrepreneurial parents - ANOVA I

SUMMARY	Does your mother/father have a business?			
Groups	Count	Total	Average	Variance
Yes	61	6.714286	0.110070258	0.578498941
No	70	-0.57143	-0.008163265	0.449503528

ANOVA	Does your mother/father have a business?					
Factors	SS	df	MS	F	p-value	F crit.
Between groups	0.455656783	1	0.455656783	0.894319011	0.346077564	3.914559163
Within groups	65.72567987	129	0.509501394			
Total	**66.18133666**	**130**				

Source: Authors

Table 3: Entrepreneurial parents - ANOVA II

SUMMARY	Is you mother/father currently self-employed/entrepreneur full-time?			
Groups	Count	Total	Average	Variance
Yes	57	8	0.140350877	0.583448417
No	74	-1.85714	-0.025096525	0.446943309

ANOVA	Is you mother/father currently self-employed/entrepreneur full-time?					
Factors	SS	df	MS	F	p-value	F crit.
Between groups	0.881363752	1	0.881363752	1.741132789	0.189332459	3.914559163
Within groups	65.29997291	129	0.50620134			
Total	**66.18133666**	**130**				

Source: Authors

Table 4: The influence of entrepreneurial parents on entrepreneurial spirit I

SUMMARY	Does your mother/father have a business?			
Groups	Count	Total	Average	Variance
Yes	61	214.4286	3.515222482	0.29882904
No	70	250.4286	3.57755102	0.304309798

ANOVA	Does your mother/father have a business?					
Factors	SS	df	MS	F	p-value	F crit.
Between groups	0.126628207	1	0.126628207	0.419631337	0.518272312	3.914559163
Within groups	38.92711848	129	0.301760608			
Total	**39,05374669**	**130**				

Source: Authors

Table 5: The influence of entrepreneurial parents on entrepreneurial spirit II

SUMMARY	Is you mother/father currently self-employed/entrepreneur full-time?			
Groups	Count	Total	Average	Variance
Yes	57	204.1429	3.581453634	0.29071403
No	74	260.7143	3.523166023	0.310470801

ANOVA	Is you mother/father currently self-employed/entrepreneur full-time?					
Factors	SS	df	MS	F	p-value	F crit.
Between groups	0.109392561	1	0.109392561	0.362353945	0.548258347	3.914559163
Within groups	38.94435413	129	0.301894218			
Total	**39.05374669**	**130**				

Source: Authors

4.4. H3 - Gender differences in entrepreneurial spirit

Hypothesis H3 was tested from two angles: comparing the extent of change in entrepreneurial spirit by gender and comparing the average values of entrepreneurial spirit itself. According to Table 6, the change is positive on average for women (0.10021322), while it is slightly negative for men (-0.008928571). However, the ANOVA result is not significant ($p = 0.384$), so the difference cannot be statistically proven.

Regarding entrepreneurial spirit, the average for men is 3.575893 and for women 3.522388, and the difference is not significant (p = 0.578) (Table 7). Consequently, hypothesis H3 is rejected for the present sample. However, gender differences remain a relevant issue at the broader ecosystem level, as the gender distribution of startup founders and entrepreneurship rates in OECD countries shows persistent inequalities (EU Startup Monitor, 2018; Erhverv, 2023).

Table 6: Measuring the impact of gender on changes in entrepreneurial spirit

SUMMARY	Measuring the impact of gender on changes in entrepreneurial spirit			
Groups	Count	Total	Average	Variance
Male	64	-0.57143	-0.008928571	0.529235504
Female	67	6.714286	0.10021322	0.491660436

ANOVA	Measuring the impact of gender on changes in entrepreneurial spirit					
Factors	SS	df	MS	F	p-value	F crit.
Between groups	0.389911131	1	0.389911131	0.764515065	0.383544151	3.914559163
Within groups	65.79142553	129	0.510011051			
Total	**66.18133666**	**130**				

Source: Authors

Table 7: Measuring the relationship between gender and entrepreneurial spirit

SUMMARY	Examining the relationship between gender and entrepreneurial spirit			
Groups	Count	Total	Average	Variance
Male	64	228.8571	3.575893	0.318736
Female	67	236	3.522388	0.286056

ANOVA	Examining the relationship between gender and entrepreneurial spirit					
Factors	SS	df	MS	F	p-value	F crit.
Between groups	0.09370633	1	0.093706	0.31027	0.578479935	3.914559163
Within groups	38.96004036	129	0.302016			
Total	**39.05374669**	**130**				

Source: Authors

4.5. Research question 1 - Changes in skills and abilities

The first research question focused on what skills and abilities the Simonyi Hackathon develops. The study was based on the dimensions identified by Lukovszki (2018), and the questionnaire items were classified into six major ability/skill groups. Table 8 summarises the average differences at the dimension level. At the descriptive level, positive changes can be seen in five dimensions (risk management, decision-making, opportunity recognition, innovation, and professional skills), while there was a negative shift in team-building skills. The total change value is 0.05056052, which indicates a slight positive overall picture.

Paired t-tests were used at the level of specific statements assigned to the dimensions to examine whether the changes were statistically significant. Based on the t-test results in Appendices 2-6, the p-value remained above 0.05 for 52 of the 53 items examined, meaning that the difference between the pre- and post-means is not significant. A significant difference can be observed in only one item: "When I have to set my own goals, I tend to set goals that are difficult to achieve" ($p = 0.000682615$).

Based on the above results, the short-term shifts in skill self-assessment related to the Simonyi Hackathon can be captured primarily at a descriptive level, and statistically verifiable differences appeared only in one statement related to goal orientation. The negative shift in team-building skills can be interpreted in terms of the nature of the course, the groups formed by the organisers, and the intensive time frame, all of which may influence group dynamics and the subjective experience of cooperation.

Table 8: Measuring changes in the dimensions examined

Dimensions	Change	Effect
Risk management capabilities	0.07053435	+
Decision-making abilities	0.03117048	+
Opportunity recognition	0.09012307	+
Innovation skills	0.12680237	+
Communicatioon skills	*0*	*no measurement taken*
Team-building skills	-0.0687023	-
Professional skills	0.05343511	+
Summary	**0.05056052**	+

Source: Authors

4.6. Research questions 2-3 - MBTI personality types and entrepreneurial spirit

The second research question examined differences according to personality types: which MBTI group showed the greatest shift in entrepreneurial spirit. Based on the summary in Table 9, the greatest positive change can be seen in the case of extraverted Explorers, but the one-factor ANOVA did not indicate a significant group difference ($p = 0.314$) (Table 10). This means that, based on the sample, it cannot be stated that the changes associated with

personality types are statistically different from each other; the differences are descriptive in nature.

The third research question examined whether there is a relationship between MBTI personality types and entrepreneurial spirit. This was approached by comparing the average values of entrepreneurial spirit. Based on Table 12, there was a significant difference between the group averages ($p = 0.01189$), suggesting that different personality types may be associated with different levels of entrepreneurial spirit. The correlation here should not be interpreted as causal, but rather as a group difference: different average values appear across personality types.

It can be observed that extroverted Diplomats and Analysts demonstrated the highest and nearly identical average scores. ANOVA results indicated a significant relationship between entrepreneurial spirit and personality type (Table 11).

When breaking down average scores by faculties, the single student from the Faculty of Health Sciences skewed the result, lacking a relevant basis for comparison against the 82 students at the Faculty of Business and Economics (Figure 4).

Table 9: Changes in entrepreneurial spirit based on MBTI personality types

SUMMARY				
Groups	**Count**	**Total**	**Average**	**Variance**
Analysts - Introverted	12	-2	-0.166666667	1.064316636
Analysts - Extraverted	17	2.857142857	0.168067227	0.286314526
Diplomats - Introverted	16	-0.571428571	-0.035714286	0.341496599
Diplomats - Extraverted	37	-1.285714286	-0.034749035	0.468713612
Sentinels - Introverted	22	1.857142857	0.084415584	0.553273257
Sentinels - Extraverted	14	-0.714285714	-0.051020408	0.49798161
Explorers - Introverted	8	2.285714286	0.285714286	0.221574344
Explorers - Extraverted	5	3.714285714	0.742857143	1.014285714

Source: Authors

Table 10: Results of ANOVA on changes in entrepreneurial spirit according to MBTI groups

ANOVA						
Factors	**SS**	**df**	**MS**	**F**	**p-value**	**F crit.**
Between groups	4.196019652	7	0.599431379	1.189476204	0.313721945	2.084857509
Within groups	61.98531701	123	0.503945667			
Total	**66.18133666**	**130**				

Source: Authors

Table 11: Personality types and entrepreneurial spirit

SUMMARY				
Groups	**Count**	**Total**	**Average**	**Variance**
Analysts - Introverted	12	43	3.583333333	0.506338899
Analysts - Extraverted	17	63.14286	3.714285714	0.290816327
Diplomats - Introverted	16	51.42857	3.214285714	0.092517007
Diplomats - Extraverted	37	138.1429	3.733590734	0.256419685
Sentinels - Introverted	22	78.42857	3.564935065	0.393541832
Sentinels - Extraverted	14	49.14286	3.510204082	0.200044853
Explorers - Introverted	8	25.14286	3.142857143	0.239067055
Explorers - Extraverted	5	16.42857	3.285714286	0.112244898

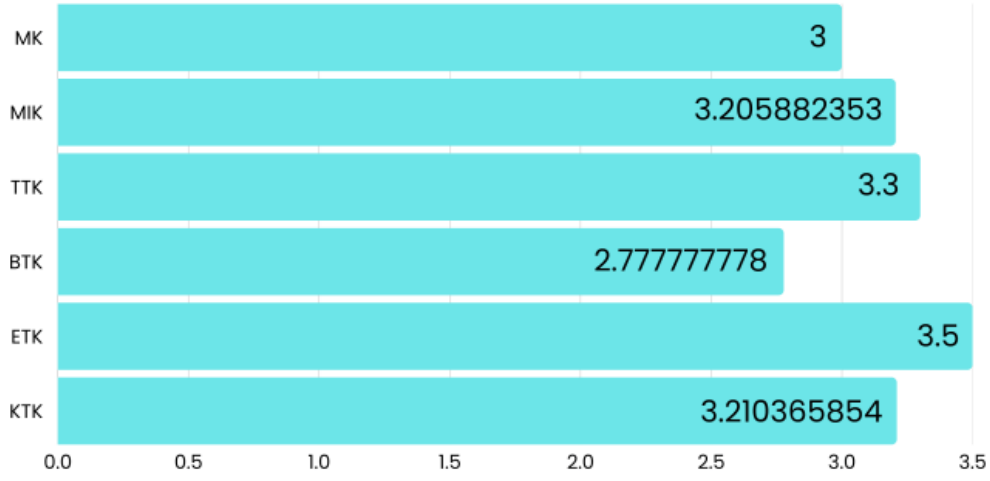
Source: Authors

Table 12: Results of ANOVA on entrepreneurial spirit by MBTI groups

ANOVA						
Factors	**SS**	**df**	**MS**	**F**	**p-value**	**F crit.**
Between groups	5.224683264	7	0.746383323	2.713795165	0.01189	2.084858
Within groups	33.82906343	123	0.275033036			
Total	**39.05374669**	**130**				

Source: Authors

Figure 4: Average values of entrepreneurial spirit by faculties



Source: Authors

4.7. Summary: results of hypotheses and research questions

Tables 13 and 14 summarise the results of testing the hypotheses and research questions. Decisions were made based on statistical decision rules ($p < 0.05$), and where descriptive results and inferential tests gave different pictures, this was indicated separately.

Table 13: Results: Hypotheses

Hypothesis	Content	Examination	Key result	Decision
H1	The Simonyi Hackathon event promotes entrepreneurial attitudes.	Mean difference + paired t-test	Overall, the descriptive statistics show a positive change (0.046892), but the p-values of the related t-tests are ≥ 0.05.	Not justified (no significant increase can be demonstrated).
H2	Entrepreneurial parents have a positive influence on their children's entrepreneurial spirits.	One-way ANOVA	There are no significant group differences in terms of change or entrepreneurial spirit ($p > 0.05$).	Not justified.
H3	Entrepreneurial spirit is more prevalent among men.	One-way ANOVA	There is no significant gender difference in terms of change and entrepreneurial spirit ($p > 0.05$).	Not justified.

Source: Authors

Table 14: Results: Research questions

Research question	Result	Interpretation from the perspective of regional business development
1. What skills and abilities does the Simonyi Hackathon develop?	At the dimension level, the average deviation is mostly positive, but based on the t-test, only 1 out of 53 items is significant ($p = 0.000682615$).	In the short term, hackathons tend to lead to "small shifts"; their regional value lies in the rapid activation of social capital and practical experience.
2. Which MBTI personality type shows the greatest change in entrepreneurial spirit?	Descriptively, a greater positive change can be seen in the Explorers/extraverted group, but the ANOVA is not significant ($p = 0.3137$).	The programme should be designed to be inclusive: short-term attitude change has been proven not to be "type-dependent," so regional talent development can be supported with a broader base.
3. Is there a connection between MBTI personality types and entrepreneurial spirit?	There is a significant difference between the averages of entrepreneurial spirit ($p = 0.01189$).	Different starting attitudes may emerge depending on personality types; this can help in developing targeted mentoring and support

Research question	**Result**	**Interpretation from the perspective of regional business development**
		pathways.
4. What is the role of education in training entrepreneurs?	Education can directly strengthen entrepreneurial attitudes and competencies; however, actual business start-ups require resources and an ecosystem (NIÜ, 2024; HSUP, 2024).	In regional business development, education is effective when it fits into a programme chain (hackathon → mentoring → incubation → financing) and reduces barriers to entry in cooperation with local partners.

Source: Authors

5. Discussion

5.1. What does "small, mostly non-significant" short-term shift mean?

A key finding of the pre-post survey is that participants' responses show a positive shift in several areas at a descriptive level, but most of these were not statistically significant. This suggests that the short time frame serves as a natural limitation. Entrepreneurial attitude and related competencies are partly stable characteristics linked to personality and previous experience, which often do not change dramatically as a result of a single event. Hackathons tend to provide an "intense impulse": they showcase new role models and provide experience and feedback, but deeper attitude change requires time and repeated practice (Bozward et al., 2023; Kuratko et al., 2021).

On the other hand, the descriptive changes and non-significant t-test results may also indicate that the measured shift is small or that the sample is heterogeneous (students from different faculties with varying prior entrepreneurial experience). In such a situation, the "average shift" associated with the Simonyi Hackathon may be blurred, while it may be more significant for certain subgroups (e.g., students who were previously less entrepreneurially oriented). However, based on the current database, this type of differentiated analysis cannot be performed comprehensively because the sample size decreases rapidly as the groups are broken down.

It is worth noting that, based on the t-test results, a significant change appeared in only one statement: the item concerning the method of setting goals ($p = 0.000682615$). This suggests that, in the short term, hackathons are most effective at changing certain situation-specific decision-making patterns. Goal orientation is particularly emphasised in the structure of the hackathon: teams have to decide in a short period of time what fits, what is the "best next step," and what compromises are worth pursuing. The significant shift may therefore be an imprint of adaptation to time-pressured decision-making situations.

An important methodological note is that several separate t-tests were run during the examination of skill and attitude items (53 items in total), creating a multiple testing situation. In such cases, the chance of a significant result appearing purely by chance (type I error) increases, so caution is required when interpreting the only significant item. In future studies, it is advisable to use composite scales, effect sizes, and, if justified by the research objective, multiple test corrections (Field, 2018; Pallant, 2016).

5.2. Family background and gender: Why was there no significant difference?

At first glance, the lack of a significant gender or parental entrepreneurial background may contradict the literature, emphasising the impact of these on entrepreneurial careers (Hayward et al., 2023; Gurel et al., 2021). However, these results do not claim that these factors are irrelevant. Rather, no statistically significant differences emerged within this specific short-term period.

There may be several reasons for this. The questions regarding parental entrepreneurial status are binary in nature (yes/no; full-time yes/no), so they do not capture the nature of the business, its success, the degree of family involvement, or the extent to which the student views the parent as an entrepreneurial role model. In the case of gender differences, the hackathon as a learning environment can actually reduce these differences: shared tasks, shared mentoring, and shared presentation situations "activate" skills and attitudes, and gender stereotypes may be less dominant (Kézai & Konczosné Szombathelyi, 2020).

From the perspective of regional business development, this also carries a practical message: hackathons can potentially serve as inclusive entry points, where the first experience of the entrepreneurial ecosystem is not exclusively linked to students who already have a strong entrepreneurial family background. This can be particularly important in regions where the number of entrepreneurial role models is limited or where students are less likely to see starting a business as a realistic option for socio-cultural reasons.

5.3. Personality types: initial differences and implications for programme planning

In the case of the MBTI groups, the degree of change in entrepreneurial spirit did not differ significantly, but there was a significant group difference in the average values of entrepreneurial spirit. This duality fits well with the assumption that personality plays a role in initial attitudes and preferences, while short-term shifts associated with a short, intensive programme are less "type-dependent."

This is interesting in regional business development because university programmes often try to identify talent and channel it into support pathways. If initial entrepreneurial attitudes differ according to personality types, then mentoring and programme communication can be fine-tuned: for example, different types of feedback and tasks can provide security for a more introverted, thoughtful student and activate something else in a more extroverted, quick-decision-making participant. At the same time, it is important to treat the MBTI not as a deterministic classification, but as a tool for self-awareness and group dynamics (Kiss et al., 2016).

5.4. The role of hackathons in the regional business development "programme chain"

Addressing the fourth research question, findings show that a Simonyi Hackathon alone yields limited significant attitudinal changes. However, hackathons hold immense regional value when integrated into business development programmes.

While education strengthens entrepreneurial competencies, actual start-ups require resources, market knowledge, networks, and infrastructure. This logic is also reflected in domestic ecosystem-building programmes: NIÜ's role is to spread a culture of innovation and connect

ecosystem players, while HSUP offers a multi-year university track based on mentoring and project development (NIÜ, 2024; HSUP, 2024).

From a regional business development perspective, hackathons are a "low barrier to entry" that can simultaneously
(1) engage and motivate,
(2) showcase student talent and teams,
(3) connect them with local business problems and mentors, and
(4) funnel the most promising projects into an incubation or course-based development channel.

This programme chain approach is reinforced when the hackathon is followed by a structured follow-up (e.g., mentoring cycle, prototype financing, pitch training). In this way, the hackathon functions not as a "one-off event" but as an ecosystem infrastructure.

The involvement of corporate partners is particularly important from a regional perspective: hackathons can also provide a platform for recruitment, innovation, and employer branding, while students receive real market feedback. Longer-term impact assessments could therefore measure not only changes in attitudes and skills, but also networking and career tracking indicators (e.g., the continuation of mentor-student relationships, teams entering incubation, project continuation rates).

5.5. Limitations and future research directions

The study has several limitations:
(1) Lacking a control group, pre-post differences cannot be solely attributed to the Simonyi Hackathon.
(2) Self-reported scales are sensitive to social desirability and emotional bias, especially after an intense event.
(3) The higher proportion of business students limits generalisability.
(4) Communication skills, despite being central elements of hackathons, were not measured.
(5) Running multiple separate tests increases the risk of false positives; therefore, isolated significant results require cautious interpretation. Future studies should apply composite scales and effect sizes.

There are several clear directions for future research. On the one hand, it would be worthwhile to examine over a longer period of time, with multiple measurement points (e.g., 3-6 months of follow-up), whether the hackathon experience is "embedded" in the attitudes and decisions of the participants.

On the other hand, following the logic of the programme chain, it would be possible to measure what additional momentum the mentoring or incubation after hackathons brings to entrepreneurial attitudes and what career tracking results it yields. Thirdly, from the perspective of regional business development, it would be particularly valuable to involve the perspectives of corporate partners and local economic actors: what problems they bring, what collaborations are initiated, and what economic and social consequences these have for the region.

5.6. Practical recommendations for regional embedding and impact assessment of hackathons

The regional embedding of hackathons is strongest when the problems raised are not "artificial" but based on real, local challenges. Regional business development actors (local governments, chambers of commerce, local SMEs, large companies, hospitals, civil society organisations) are able to provide a problem map in which student teams not only "generate" an idea, but also create a prototype related to a regional need. This connection creates mutual benefits: students gain a real-world context, while partners gain fresh perspectives and rapid experimentation. To strengthen the regional focus, it can be particularly useful during the organisation process to validate the problems in advance (e.g., through short interviews with the partner) and to have the partner propose a specific "next step" after the hackathon (pilot, test environment, data access).

The quality and composition of mentoring are critical aspects of hackathons. From a regional business development perspective, not only are business mentors needed, but also industry experts, legal/financial advisors, and experienced entrepreneurs (role models). The diversity of mentors can reduce the risk of teams getting stuck too quickly in a single solution direction and support the depth of learning. The value of hackathons at this point is linked to the logic of the university entrepreneurial ecosystem: the university's own incubator, innovation club, or corporate network (e.g., innovation clubs, corporate projects) can provide a mentor base that a region can operate sustainably over the long term (PTE ÁOK, 2024; Battaglia et al., 2022).

Based on the current results, the Simonyi Hackathon has brought about measurable short-term changes in attitudes and skills, but these are mostly non-significant. This further justifies the programme chain approach: The Hackathon should be an entry point rather than a final destination. As a practical recommendation, the Hackathon should be followed by at least 4-6 weeks of "afterlife," during which teams receive structured mentoring sessions, mini-pitch events, and prototype development support. Such an after-programme increases the depth of learning (more iterations, more feedback) and makes the entrepreneurial path more realistic: students experience that there is a supportive infrastructure (programmes, mentors, financiers) in the region that they can join (NIÜ, 2024; HSUP, 2024).

Inclusivity deserves special attention. Although no significant gender difference appeared in the present sample, data from the broader startup ecosystem indicate a persistent underrepresentation of women (EU Startup Monitor, 2018; Erhverv, 2023). When organising hackathons at the regional level, it is therefore worth consciously addressing barriers to entry: for example, by involving female mentors and jury members, providing supportive communication, facilitating safe teamwork, and emphasising learning objectives alongside competition. Scientific diversity is equally important: regional problems often require interdisciplinary solutions, so mixing students from economics, engineering, health sciences, and social sciences can, in itself, increase innovation potential.

Developing impact measurement is important from a regional business development perspective because the financing and long-term sustainability of programmes often require "proof." Pre-post attitude and skill measurement is a good starting point, but it is worth supplementing with behavioural and ecosystem indicators. These could include, for example: how many teams continue the project 1-3 months later; how many enter incubation; how many mentor-student relationships remain; how many prototypes reach the pilot stage; and

how many participants decide to continue with entrepreneurial courses or programmes (Bozward et al., 2023; Garcia, 2023). The regional impact assessment can also include the partner's perspective: how satisfied the companies involved are with the solutions, whether cooperation has started, and whether internships or job offers have been made.

Finally, as a methodological recommendation, it is worth incorporating qualitative elements alongside quantitative scales. Short focus groups or interviews can help to understand why negative descriptive shifts appear in certain dimensions (e.g., team building) or how participants interpret changes in their own entrepreneurial self-image. The mixed-method approach is particularly valuable in a regional conference setting because it shows not only whether something has "changed," but also the mechanisms and institutional conditions under which change occurs.

6. Conclusions

Through a short-term pre-post impact assessment of the Simonyi Hackathon, the study examined how a university hackathon affects participants' entrepreneurial attitudes and self-assessments of entrepreneurial skills. Based on the descriptive results, a positive change can be seen in most of the statements associated with entrepreneurial spirit, and a positive average difference appeared in several skill dimensions. At the same time, based on the results of the paired t-tests, no significant difference can be demonstrated between the pre- and post-measurements in the vast majority of the items examined, with only one statement showing a significant change ($p = 0.000682615$).

Differences in parental entrepreneurial background and gender did not prove to be significant in the present sample in terms of either change or entrepreneurial spirit. There was no significant difference in the degree of change in MBTI personality types, but there was a significant group difference in the average values of entrepreneurial spirit ($p = 0.01189$), which indicates a difference in initial attitudes according to personality type.

For regional business development, the primary conclusion is that short-term attitudinal and skill shifts are modest and mostly non-significant. However, the programme evaluation methodology is also useful at the ecosystem level: it helps translate university interventions from "research to relevance" by providing measurable feedback to local actors (universities, companies, support infrastructure) for programme planning. The regional effectiveness of hackathons can be maximised when events are integrated into a programme chain (mentoring, incubation, prototype support) and are based on local business problems and regional challenges.

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Appendices

Appendix 1: Paired T-test: Risk management

Expected value of paired t-test - Risk management capabilities		
Trait	***Statement***	***P>0.05***
Risk tolerance / Stress management / Tolerance for uncertainty	If there is a chance of failure, will still try to do it.	0.592187579
	I'm taking the risk.	0.173321476
	If I want to be successful I have to take chances when they occur.	0.668641163
	It is too risky to start your own business.	0.446326011
	I'm a risk-taker.	0.130725128
Flexibility	It is not hard for me to adapt to change.	0.952362851
Boldness	When I have to set my own goals, I prefer to set goals that are difficult to achieve.	0.075558055
	If there is a chance of failure, will still try to do it.	0.592187579
Responsibility	I'd rather take the responsibility myself.	0.612502633
Optimism	When I am faced with a challenge, I think more about the results of succeeding than the effects of failing.	0.056543852

Source: Authors

Appendix 2: Paired T-test: Decision-making

Expected value of paired t-test - Decision-making abilities			
Trait	***Statement***	***P>0.05***	***P<0.05***
Goal orientation / Success orientation / Results orientation / Ambition	When I have to set my own goals, I prefer to set goals that are difficult to achieve.		0.000682615
	If I am having problems with a task, I will not leave it but I stick it out until I get the result.	0.580759275	
	When I am faced with a challenge, I think more about the results of succeeding than the effects of failing.	0.056543852	
Ethical thinking, Conscientiousness	Entrepreneurship is an honest profession.	0.470269861	
Perseverance	When I have to set my own goals, I prefer to set goals that are difficult to achieve.	0.580759275	
	If I want to be good at one thing, I have to work hard.	0.131092719	
Internal control attitude	For me, getting what I want has little to do with luck.	0.840249909	
	I determine my own destiny.	0.720394727	
	Being successful is the result of working hard, luck has nothing to do with.	0.619821441	
Ability to work hard	If I want to be good at one thing, I have to work hard.	0.131092719	
	Being successful is the result of working hard, luck has nothing to do with.	0.619821441	
Striving for quality	It is more important to do my job well than to be recognised for it.	0.935511205	
Profit orientation	Entrepreneurship is a good way to earn a lot of money.	0.673166659	
Autonomy / independence	I like to do things in my own way without worrying about what other people thinks.	0.795699043	
	I prefer working alone than with other people.	0.673043441	
	I dislike taking orders.	0.127352748	

Source: Authors

Appendix 3: Paired T-test: Opportunity recognition

Expected value of paired t-test - Opportunity recognition		
Trait	**Statement**	**P>0.05**
Business readiness	A university degree is not necessary to become an entrepreneur.	0.467319397
Opportunity seeking and exploitation	If I had a good business idea, I would be willing to borrow some money from my parents/friends to make it happen.	0.494813967
Entrepreneurial spirit	I like to do thing in an unconventional way.	0.231891639
	I do not want to do things in the usual ways.	0.409707565
	If I had a good business idea, I would be willing to borrow some money from my parents/friends to make it happen.	0.494813967
	My professional goal is to become an entrepreneur.	0.95111291
	Being an entrepreneur is a serious career opportunity.	0.180713258
	The university should encourage students to become entrepreneurs.	0.453135653
	Entrepreneurship is a good way to earn a lot of money.	0.673166659
Searching for variety	It is not hard for me to adapt to change.	0.952362851
Determination	I just need to focus on the task needed to achieve my dreams.	0.065783686
	When I have to set my own targets, I will proceed even if it is not certain that I will get it.	0.075558055
Awareness	I just need to focus on the task needed to achieve my dreams.	0.065783686
Judgment	I dislike taking orders.	0.127352748

Source: Authors

Appendix 4: Paired T-test: Innovation

Expected value of paired t-test - Innovation skills		
Trait	***Statement***	***P>0.05***
Creativity	I like to do thing in an unconventional way.	0.231891639
Problem-solving skill	I like challenges that really stretch my abilities.	0.338483974
	I like to find out about things even if it means handling some problems while doing so.	0.132202354
Innovative thinking	I do not want to do things in the usual ways.	0.409707565
	Entrepreneurs are almost always inventors.	0.064616735
	Entrepreneurs are largely responsible for new innovations, technologies and products.	0.646874042

Source: Authors

Appendix 5: Paired T-test: Team-building

Expected value of paired t-test - Team-building abilities		
Trait	***Statement***	***P>0.05***
Team-building	I prefer working alone than with other people.	0.673043441
Attention to detail	I do not like to have my life organized.	0.110689041

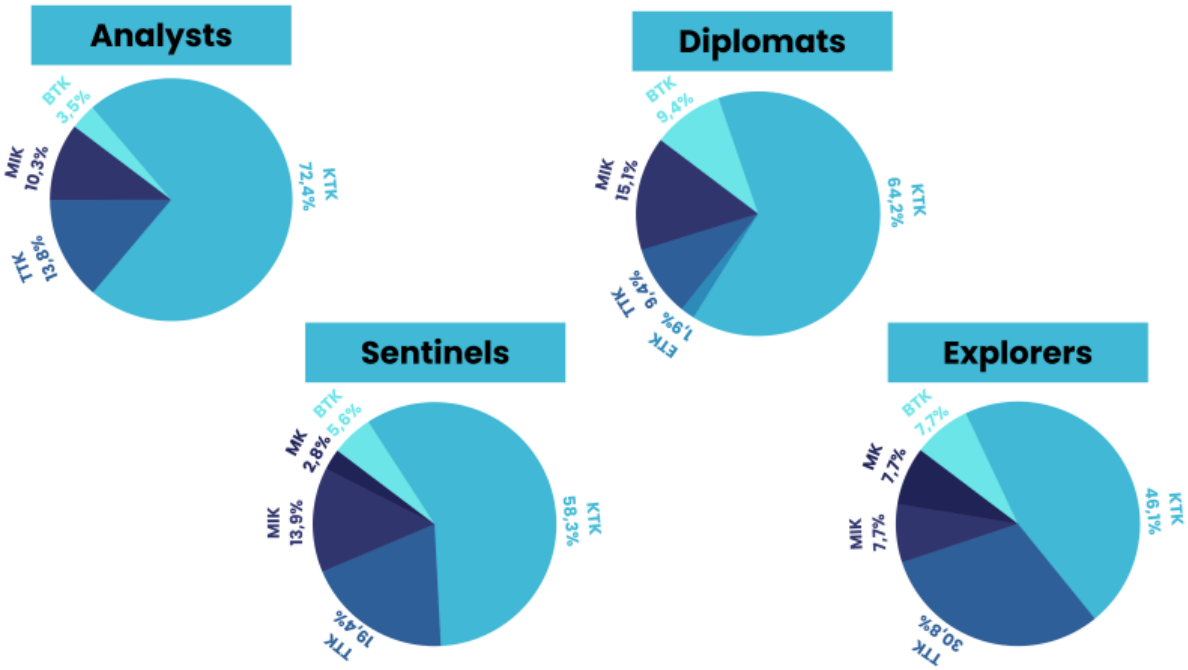
Source: Authors

Appendix 6: Paired T-test: Professionalism

Expected value of paired t-test - Professional skills		
Trait	***Statement***	***P>0.05***
Intelligence	It is more important to do my job well than to be recognised for it.	0.935511205
	I like challenges that really stretch my abilities.	0.338483974
Operational and technical skills	I do not like to have my life organized.	0.110689041
	I can handle a lot of things at the same time.	0.284641092
Openness to gaining experience	I like to find out about things even if it means handling some problems while doing so.	0.132202354

Source: Authors

Appendix 7: Distribution of faculties based on MBTI personality type



Source: Authors

A professional paper

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SOCIAL ENTERPRISES AND INCLUSIVE ECONOMIC GROWTH AT THE LOCAL LEVEL

ABSTRACT

The paper focuses on analysing the role of social enterprises in generating inclusive economic growth at the local level. It is based on the assumption that local development should not be assessed solely through traditional economic indicators, such as income growth or the number of business entities, but also through the capacity to include groups at risk of social and economic exclusion in development processes. From this perspective, social enterprises constitute a specific type of organisation that combines market-oriented economic activity with the pursuit of clearly defined social objectives.
The main aim of the paper is to identify the mechanisms through which social enterprises contribute to inclusive economic growth at the local level and to assess their importance for the socio-economic development of selected local communities. Inclusive growth is understood as a process that supports job creation, increases labour market participation among marginalised groups, and strengthens local social capital, thereby enhancing social cohesion and long-term development potential.
The study adopts a qualitative research approach based on the case study method. The analysis covers selected social enterprises operating in different local government units, diversified in terms of size, economic structure, and social conditions. The cases were selected purposefully to capture the diversity of operational models used by social enterprises and the variety of their interactions with the local environment. Empirical material includes document analysis, secondary data, and semi-structured interviews conducted with representatives of social enterprises and local authorities.
The expected findings aim to identify key factors that enhance the effectiveness of social enterprises in promoting inclusive growth, as well as barriers that limit their impact at the local level.

Key words: *Social enterprise, Inclusive economic growth, Social aims, Local development.*

1. Introduction

Local development is a highly complex process and should not be evaluated solely through economic indicators such as income growth or the number of business entities. In the socio-economic sphere, the crucial factor is a region's capacity to enhance the quality of life of its population, reduce disparities, include groups at risk of social and economic exclusion in development processes, and stimulate civic participation through the generation of social capital. Development understood in this manner corresponds to the concept of inclusive economic growth, characterized by the integration of quantitative, qualitative, economic, and

social dimensions. Within such a framework, social enterprises — as entities combining market activity with the pursuit of social objectives — play a significant role.
The main problem presented in this article concerns the gap in the literature regarding the real impact on inclusive local development. The aim of the article is to answer the following research questions:

1. What characteristics and properties of social enterprises contribute most to inclusive local development?

2. What aspects of inclusive development do social enterprises most influence?

The author's contribution is to review the theory of social enterprise characteristics, linking it to the theory of inclusive local development, and addressing business practice by highlighting the empirical aspects of these theories. Another contribution is to identify the mechanisms of inclusiveness and local development in the context of social enterprises and present them in the form of a model of local participation.

2. Social Enterprises — Definitions

Social enterprises emerged as recognizable actors in the socio-economic landscape and in academic discourse at the end of the twentieth century. Over time, interest in social enterprises has increased across market actors, public institutions, and civil society organizations due to their distinctive characteristics and the multiplicity of functions they perform in the economy, particularly at the local level.

A social enterprise is generally understood as an entity that pursues social objectives within the framework of economic activity. The academic literature emphasizes the ambiguity of the concept and the ongoing debate regarding the definition of a social enterprise (Florczak, 2023; Brdulak, Florczak, 2016).

In order to systematize the definitional framework, in 1996 the European Research Network EMES[1] undertook efforts to identify common criteria for recognizing economic entities that could be classified as "social enterprises" across fifteen countries. Based on empirical research, the network proposed the following definition: a social enterprise may be defined as a private, autonomous organization providing goods or services for the benefit of the wider community, founded or managed by a group of citizens, in which the distribution of profits is subject to constraints (Defourny, 2005).

Within this framework, nine criteria were formulated (four economic and five social) that should be fulfilled by social enterprises. The economic criteria include:
(a) continuous activity in the production of goods and/or provision of services,
(b) a high degree of autonomy,

[1] EMES — a French organization — is a research network dedicated to the study of social enterprises emerging in Europe in the 1990s (1996–1999). The initiative to establish the network was undertaken by the European Commission's Directorate-General for Research, which commissioned the research agenda on social enterprises in the European Union at that time. In subsequent years, EMES expanded its activities and currently brings together research centers and scholars specializing in the social economy and social entrepreneurship from across Europe.

(c) a significant level of economic risk,
(d) a minimum level of paid employment.
The social criteria include:
(a) an initiative launched by a group of citizens,
(b) decision-making power not based on capital ownership,
(c) a participatory nature involving stakeholders affected by the activity,
(d) limited profit distribution,
(e) a clearly defined objective that benefits the community.

This approach constitutes a reference point for the diverse legal forms operating within the administrative and legal systems of European countries.

American approaches to defining social enterprises provide an additional perspective, emphasizing their hybrid character and market orientation. These approaches highlight the social mission, accountability to stakeholders, the objective of creating social value, and the pursuit of financial sustainability through commercial activities.

Table 1: The scope of hybridity in the American approach

Traditional non-profit organizations	**Non-profit organizations conducting income-generating activities**	**Social enterprises**	**Socially responsible businesses**	**Corporations practicing corporate social responsibility**	**Traditional for-profit organizations**
← Motivation — social mission Accountability to stakeholders Income reinvested for social or operational purposes			→ Motivation — profit generation Accountability to shareholders Income distributed among shareholders		
← Objective of creating social value Strategy for sustainable operation: commercial methods →			Objective of creating economic value → Strategy for sustainable operation: philanthropic activities ←		

Source: K.Alter, 2007, s. 147

A social enterprise, as a hybrid organization oriented toward the simultaneous pursuit of social and economic objectives, exhibits the following characteristics (Alter, 2008, p. 147): it employs tools and instruments typical of commercial activity to achieve social goals; simultaneously utilizes social and commercial capital as well as production techniques; generates both social and economic value; allocates revenues derived from commercial activities to cover the costs of social programs; monitors both financial performance and social impact; achieves financial objectives in ways that contribute to the public good; and aligns its strategic orientation with the implementation of its social mission. These attributes identify the social enterprise as an entity that exerts influence on its environment not only in economic but also in social terms.

2.1. Local inclusive growth

Growth constitutes a fundamental category in economics and lies at the core of economic practice. However, the concept of growth itself, particularly within economics as a social

science, has been questioned in relation to its capacity to reflect holistic civilizational progress. Such progress requires not only growth expressed through quantitative parameters but also development understood in qualitative terms, including the advancement of human capital (education, health), technological innovation, institutional effectiveness, environmental quality, and equitable income distribution.

Discussions on the definition of inclusive growth are presented by E. Zelek (Zelek, 2022), who refers to various policy documents and studies. According to the OECD, *"inclusive growth is economic growth that is fairly distributed and creates opportunities for all."* (OECD). The World Bank, in turn, explains inclusive economic development as a type of growth that reduces poverty and enables socially excluded groups to participate in the benefits of economic expansion. The World Bank derives the concept of inclusiveness from the earlier notion of pro-poor growth, developed at the beginning of the century. This concept is defined in two dimensions: an absolute perspective, according to which economic growth is beneficial only if the average incomes of the poor increase, thereby reducing income poverty; and a relative perspective, according to which growth is pro-poor only when the incomes of the poor grow faster than those of the non-poor, meaning poverty declines more than it would if all incomes increased at the same rate. (The World Bank, Commission on Growth and Development, 2008)

One of the broadest and most multidimensional approaches to inclusive growth is presented by the authors of the comprehensive monograph *How to Ach Inclusive Growth* (Cerra, Eichengreen, El-Ganainy, 2021). They propose that inclusive growth should be understood through three perspectives: strong economic growth, inclusive economic growth, and sustainable economic growth.

Ignasiak-Szulc and Kola-Bezka, referring to the definition proposed by E. Mączyńska (Ignasiak-Szulc, Kola-Bezka, 2022), adopt the view that inclusiveness denotes a multidimensional engagement of all participants in socio-economic life that fosters social cohesion and enables the optimal creation and utilization of development potential while preventing its waste (Mączyńska, 2016).

When discussing inclusiveness and inclusion, it is also necessary to address the issue of civic participation within the local environment. Social participation refers to ensuring citizens' involvement in the governance of the community to which they belong (Hausner, 1999). The need to socialize development processes stems from the constitutional principles underlying public administration, such as subsidiarity and local self-government. However, the extent of practical implementation varies. The most common forms of participation include information sharing, consultation, and co-decision-making (Boryczka, 2016).

From this perspective, local inclusive growth can be understood as a specific economic self-help strategy of communities at the regional or local level. Reference should be made here to the assumptions of local development formulated by K. Birkhölzer (Birkhölzer, 2007), which contain clear elements of inclusiveness and also reflect features typical of social enterprises:

1. *Activities for the common good* — based on the assumption that local economic initiatives are linked to a sense of local identity and community engagement. Local enterprises are perceived as elements of an integrated and interdependent socio-economic system that prioritizes overall social benefit over the maximization of individual gains. This is also associated with the concept of social cohesion, defined in

a territorial context through shared experiences and a common system of norms and values (Sufin, 2010).

2. *Integrated holistic approach* — involving a systemic and comprehensive understanding of the economy as a cyclical process of production and reproduction within the local socio-economic space. Birkhölzer also highlights the limitations of local resources and reproductive capacities, emphasizing that competitiveness depends not only on individual entrepreneurship but also on the efficiency of spatial socio-economic systems and their capacity for resource reproduction (Składowa-Hełpa, 2010). Consequently, an essential element of local development policy is the creation of infrastructural and institutional conditions that enable economic actors to operate and contribute to holistic regional growth in both economic and social terms.
3. *Addressing unmet needs* — local economic development should be oriented toward the demand side by identifying and responding to unmet needs. In conventional economic terms, demand is typically associated with purchasing power, which leads to the neglect of the needs of individuals or communities with limited financial capacity. Social enterprises play a crucial role in ensuring the provision of essential and specific services required by local communities.
4. *Restoration of local economic cycles* — initiatives should not be isolated but implemented within an integrated system aimed at holistic local development, thereby activating mechanisms of local economic cycles. Partnerships play a significant role in this process. Local partnerships, within bottom-up development frameworks, design programs to maximize the use of local resources, enhance the value of local products and services, build organizational and investment relationships among economic actors, and stimulate internal economic circulation (Ziomek, 2011).
5. *Building and strengthening social capital* — based on the assumption that the key resource of a community is its intellectual and social potential. Local economic development involves mobilizing these resources and transforming them into tangible socio-economic value. Contemporary economic theories increasingly recognize human and social capital as central to local development. To identify and measure social capital, Birkhölzer proposes several indicators, including the level of trust among community members, the scope and nature of reciprocity, the presence of shared norms, the character of formal and informal social networks, and the effectiveness of communication channels within and beyond the community.

J. Przybysz (2013) and F. Bylok (2020) also refer to a more comprehensive conceptualization of social capital. Synthesizing the contributions of these authors, the studies presented in the cited publications identify the key determinants of social capital, which can additionally be related to the specific context of social enterprises:

1. *Participation in networks*
   The formation of social capital depends on the existence of networks operating at different levels of dependency and intensity. It is therefore conditioned by individuals' willingness to act collectively, generate new connections, contacts, and ultimately networks. In social enterprises, relational networks extend beyond purely business relations to include relationships with beneficiaries and stakeholders involved in the implementation of the social mission.
2. *Reciprocity*
   Social capital involves decision-making and actions oriented toward the interests of others or the group, with the expectation of future return. Reciprocity in social enterprises also derives from the integration of economic and social interests both within the organization and in its external environment.

3. *Trust*
   Trust conditions the willingness to take risks based on the belief in the appropriate and predictable behavior of others within the organization. It enhances participants' sense of security and fosters openness in information exchange. Moreover, in social enterprises trust constitutes a crucial element of relations with external stakeholders, while social activity itself serves as the primary determinant shaping this form of trust.
4. *Social norms*
   These constitute a source of internal, informal social control that may substitute for more formal and institutional sanctions. Social norms are unwritten yet widely understood rules defining desirable and acceptable behavior within a given social context. In social enterprises, such norms underpin the essence of the organization's mission and culture.
5. *Community*
   The coexistence of trust, networks, norms, and reciprocity creates a community characterized by shared ownership of resources. In the context of social enterprises, community is also grounded in participation in and co-creation of the social outcomes generated by the organization's activities.
6. *Proactivity*
   The development of social capital relies on voluntary engagement in community activities. In social enterprises, particular emphasis is placed on proactive involvement in the pursuit of the social mission.
7. Individual and collective resource endowment
   These resources are acquired through participation in diverse social networks and can be exchanged for other goods or services. Social enterprises transform resources not only into specific products or services but also into social added value generated through both social and economic activities.

To complement social entrepreneurship at the local level, it is necessary to indicate the features resulting from the combination of attributes typical of the private, non-governmental, community, and public spheres (Szczudlińska-Kanoś, 2013), and ultimately characteristic of social enterprises:

Private sector
– "exchange of equivalents," particularly within the closed cycle of the local economy
– exchange of goods and services based on an agreed value — a commercial goal characteristic of the market mechanism
– orientation toward efficiency and productivity
– "capital controls labour," meaning that capital owners decide on the creation and nature of jobs

In this respect, social enterprises participate in the natural market game and competition, which:
– justifies the presence of such entities in the socio-economic space,
– adds a social attribute to the market mechanism,
– contributes to the economization of social capital,
– releases human capital not engaged in the free market

Non-governmental sector
– activities of civic and social organizations
– engagement in the public interest and social goals not aimed at profit

Social enterprises anchor their main mission in this sphere of the socio-economic space, which influences:
– the ability to identify social needs and translate them into the market sphere,
– the combination of diverse resources and on-balance and off-balance assets in economic activity

Public sector
– orientation toward the "redistribution of goods and wealth" — public goods and services provided by the state and local government to equalize opportunities and ensure access to basic goods
– efforts to reduce socio-economic exclusion and limit economic and social inequalities
Through their activity at the interface with the public sector, social enterprises:
– individualize and increase the effectiveness of social and welfare services otherwise delivered by public organizations
– constitute an element of social security as workplaces and spaces for socio-economic integration of people with special needs

Social entrepreneurship
– combination of economic and social goals within activity
– introduction of social, non-economic values into transaction mechanisms
– contribution of individuals based on reciprocity and solidarity in economic activity
– citizens and social purpose exercising control over capital
– development of responsible consumption
From a market perspective, social enterprises are a complex phenomenon, while at the same time possessing the greatest flexibility both in adapting to the needs of particular sectors and in drawing benefits from the resources of the private, public, and social spheres.
According to the literature, social enterprises emerge in areas where (K. Duczkowska-Małysz, 2012):

1. The unemployment rate is significantly higher than average, and the long-term unemployed have little chance of finding work. This indicates that social enterprises are directed toward socially excluded communities.
2. Defective economic structures are unable to modernize on their own and generate innovative products. Shortcomings in the technical and infrastructural base of the local economy are compensated by social capital, local solidarity, and cooperation.
3. Faulty demographic structures point to labour market difficulties that will require special solutions, also indicating a specific type of service demand expressed by the local community.
4. The degradation of the natural and cultural functions of regional resources is observed.
5. Poorly developed technical and social infrastructure blocks processes of economic development.

2.2. Literature Synthesis

Based on the literature review, several key characteristics of social enterprises can be identified that contribute most to inclusive local development:

a) The primacy of social purpose over profit maximization. A key characteristic is the focus on the good of the local community and the identified social purpose. The primary significance of inclusiveness here is the directing of resources to groups at risk of social and economic exclusion, and consequently, the reduction of inequalities.

b) Participatory management. Decisions made in social enterprises relate to the development of local democracy and the development of shared responsibility for the local environment.
c) Hybridity – combining social and market goals ensures economic efficiency and social inclusiveness.
d) Local embeddedness and citizen initiative indicate better adaptation to local needs and cross-sectoral integration between social, market, and public entities in society.

From the perspective of the definition of inclusive growth (OECD, World Bank, Mączyńska), social enterprises have a particularly strong impact on the following dimensions:

a) Equitable distribution of development benefits, which is related to the reinvestment of profits in the local economy
b) Utilization and development of local resources – particularly important from the perspective of previously untapped natural, cultural, social, competency, and relational resources.

From the literature review, social enterprises can be identified as operational tools for inclusive social development, and they also fulfill compensatory functions (where markets and public institutions are ineffective) and transformative functions (changing the social and economic structure of the local economy).

3. Methodology

This study adopted a qualitative research approach, analyzing six selected case studies. The research focused on specific social enterprises operating in Poland across various industries and business types, including social services—care, healthcare, catering, and e-commerce—as well as entities implementing environmental initiatives.

The selection of entities was intentional and focused on the following criteria:

1) The enterprise is active at the local level, which is important for linking it to inclusive local development,
2) It pursues social goals alongside its business activities—it is classified as a social enterprise according to the criteria,
3) It addresses at least one aspect of inclusive development (e.g., professional inclusion, utilization of local resources, access to services, development of social capital, cross-sectoral operations),
4) The availability of information about its activities.

The analysis is based on desk research, organizational reports, and secondary data sources, including organizational reports, official websites, and materials released to the public. The selected materials were processed through qualitative and comparative analysis, aiming to identify aspects of the dimensions of inclusiveness of social enterprises and their contribution to inclusive local development. It is important to note the limitations of the presented study. This primarily concerns the number of entities, which prevents scaling the results, and focuses on individual case studies. However, the adopted qualitative and case study method allows for an in-depth, inductive analysis of the entities, taking into account their specific characteristics and the specific local environment in which they operate.

4. Social Enterprises in Local Inclusive Growth — The Case of Poland

Within this framework, the development of social entrepreneurship is interpreted as a response to the crisis of the bipolar paradigm of state and market, introducing mechanisms associated with active social policy (Rymsza, 2003). A similar view is expressed by C. Borzaga (Borzaga, 2007), who argues that neither the market — responsible for the production and allocation of private goods — nor the state — responsible for public goods and those not produced by the market — adequately fulfills its role in shaping citizens' sense of security and quality of life. Consequently, there is a need for a new structure based on the logic of pluralism of actors, sectors, and regulatory mechanisms involving various components of civil society. The bipolar model assumes that:

(a) a strict distinction can be drawn between private goods produced by the market and public goods provided by the state;
(b) market regulation can enhance service efficiency according to principles of individual contribution and engagement;
(c) public institutions are capable of identifying citizens' preferences regarding public goods and those not supplied by the market.

Social enterprises constitute one of the key mechanisms for implementing inclusive local growth, as they combine economic activity with the pursuit of social objectives, mobilizing the resources of local communities and including individuals and groups remaining on the margins of the labor market and social life in development processes. Their distinctive feature lies in the ability to integrate market efficiency with social solidarity, thereby creating development trajectories that are both economically viable and socially equitable. The analysis of selected entities demonstrates the multidimensional impact of social enterprises on local development, encompassing job creation, the development of social services, the strengthening of social capital, and the enhancement of territorial cohesion. Moreover, these organizations contribute to the democratization of local economies by promoting participatory governance, stakeholder engagement, and community ownership of development processes. In this sense, social enterprises not only respond to existing socio-economic deficits but also proactively shape new opportunities for inclusive participation in economic life.

The Social Cooperative POŻYTEK[2] in Tłuszcz, as the first social cooperative established in Wołomin County, provides an example of an entity that systematically contributes to inclusive growth by developing the local social services infrastructure and integrating persons at risk of social exclusion into the labor market. The operation of the "Mali Odkrywcy" Children's Club, a specialized equipment rental service, and the provision of care services respond to the real needs of residents of several municipalities, increasing the availability of services necessary for the daily functioning of families, older persons, and persons with disabilities. By reducing barriers to access essential services, the cooperative enables broader participation in social and economic life, particularly for caregivers and individuals with limited mobility. Of particular importance is the personal assistance service for persons with disabilities delivered in cooperation with local government units, which strengthens the autonomy of beneficiaries and supports their integration into community life. This model reinforces partnerships between the public and social sectors, stabilizes the local labor market, and ensures the predictability of service provision, which constitutes one of the foundations of inclusive development. Employing more than one hundred people indicates that a social

[2] http://spoldzielniasocjalnapozytek.pl/s/; access: 10.02.2026

enterprise can become a significant local employer, especially for individuals facing difficulties in obtaining employment in the commercial sector, while simultaneously generating multiplier effects in the local economy through increased consumption and tax revenues.

The POŻYTEK Social Cooperative in Tłuszcz, the first social cooperative established in Wołomin County, is an example of an entity that systematically contributes to inclusive growth through the development of local social service infrastructure and the integration of people at risk of social exclusion into the labor market. The operation of the "Little Explorers" Children's Club, specialized equipment rentals, and the provision of care services responds to the real needs of residents of several municipalities, increasing the availability of services essential for the daily functioning of families, seniors, and people with disabilities, representing a significant contribution to the inclusive development of the municipality. The cooperative's role in reducing barriers to accessing basic services is noticeable, as it enables broader participation in social and economic life, particularly for caregivers and people with limited mobility. This is one of the key aspects that connects the economic and social goals of the enterprise with those aimed at the local community and improving the quality of life of its beneficiaries. Of particular importance is the personal assistance service for people with disabilities, implemented in collaboration with local government units, which strengthens beneficiaries' autonomy and supports their integration into the local community. This model strengthens partnerships between the public and social sectors, stabilizes the local labor market, and ensures predictable service delivery, which is one of the foundations of inclusive development. Data from the social enterprise indicates that it creates over one hundred jobs. This observed correlation indicates that the social enterprise is a significant local employer, particularly for individuals who struggle to obtain employment in the commercial sector, while simultaneously generating multiplier effects in the local economy through increased consumption and tax revenues.

To summarize, we can point to:
a) the inclusive dimension – integrating people at risk of social exclusion – particularly people with disabilities and their caregivers – through access to social services
b) operationalization of impact: leveraging local resources and partnerships (public-social sectors), developing social services, and creating jobs, which reduces access barriers and strengthens social capital and participation
c) the nature of the impact: both direct (employment of excluded people, access to social services, improving the quality of life of recipients) and indirect (shaping local institutions and intersectoral relations).

A similar mechanism of influence on inclusive local growth can be observed in the activities of the PODKOWA[3] Social Cooperative, established by the municipalities of Kobyłka and Jadów. This entity provides care, personal assistance, and respite services, as well as economic services addressing the daily needs of residents, including childcare through the “Klub Smyka.” Socio-occupational integration constitutes the primary dimension of inclusiveness in the cooperative’s activities, as it creates jobs for individuals with limited opportunities in the open labor market and offers pathways for skills development and professional reintegration. At the same time, the development of care services enables greater labor market participation of family members of dependent persons, indirectly increasing local economic activity and improving the quality of life of the community. The cooperative

[3] https://spoldzielnia-podkowa.pl/; access: 10.02.2026

thus functions as an institutional mechanism that reduces the care burden on households while expanding the productive capacity of the local labor force.

Based on the analysis, the following patterns can be identified:
a) the inclusiveness dimension – the availability of social services targeted at people at risk of social exclusion.
b) operationalization of impact – the inclusive aspect of cross-sectoral cooperation in the economic development should be emphasized here, as the PODKOWA Social Cooperative provides care services for residents of Kobyłka based on a contract from the Kobyłka Social Welfare Center.
c) nature of impact – direct impact – the provision of social services, job creation, and direct effect – participation in the local economic cycle.

The dimension of inclusive local development also includes social enterprises operating in the fields of ecological economy and education. EKO NA MAKSA[4] Ltd., operating in rural areas near Żyrardów, combines commercial activity with ecological education and the creation of jobs for persons facing labor market difficulties. Providing residents of smaller localities with access to healthy food and promoting pro-environmental attitudes through workshops and mobile initiatives contributes to improving quality of life and disseminating social innovations in peripheral areas that often experience limited access to public services and sustainable consumption options. By integrating environmental objectives with employment creation, the enterprise advances a model of inclusive green development that aligns social inclusion with ecological responsibility. Thus, this enterprise supports inclusiveness not only in economic and social terms but also in environmental terms, aligning with the concept of sustainable local development and demonstrating how social enterprises can facilitate just transitions toward more sustainable economic systems.

The presented case suggests the following conclusions:
a) The dimension of inclusiveness: a complex inclusiveness emerges here – which simultaneously concerns economic inclusion (creating jobs and increasing the income of people at risk of exclusion), social inclusion (building consumer education and local ecological solidarity), and environmental inclusion (using local resources for sustainable consumption).
b) Operationalization of impact: combining economic activity with environmental education and the local distribution of goods (e.g., organic products), which influences consumer attitudes, fosters local solidarity, and develops and creates employment in the green economy.
c) Nature of impact: direct impact (creating jobs, access to products and services, increasing residents' ecological awareness) and indirect impact (striving for a long-term, sustainable transformation of the local socio-economic environment) can be distinguished.

An important example of a comprehensive approach to inclusiveness is the activity of the non-profit company Victus[5] in Łasin, which operates as part of a broader ecosystem of support for persons with disabilities. Cooperation with a foundation, occupational therapy workshops, and the Perspektywa Social Cooperative creates a coherent system of socio-professional reintegration, enabling the transition from therapeutic support to employment and independent living. The provision of catering services for schools, older persons, and residents of the municipality simultaneously meets local needs and creates employment

[4] https://ekonamaksa.pl/; access: 10.02.2026
[5] http://www.odpowiedzialnezakupy.pl/uslugi/515-victus-obiady-domowe-i-catering.html; access: 10.02.2026

opportunities for persons with disabilities, thereby transforming beneficiaries of social assistance into active contributors to the local economy. Such a solution strengthens social cohesion, reduces dependence on welfare systems, and increases the economic independence of beneficiaries, which constitutes the essence of inclusive growth. Furthermore, the existence of an integrated support ecosystem enhances the resilience of the local community by ensuring continuity of assistance and employment pathways.

The entity analyzed demonstrates the following patterns:
a) Inclusiveness dimension: systemic inclusiveness regarding the full inclusion process (from care, treatment, and therapy, through social and economic reintegration, to full-time employment and independence), particularly for people with disabilities.
b) Operationalization of impact: shaping a comprehensive institutional ecosystem (foundation, occupational therapy workshop, social cooperative) that gradually enables beneficiaries to function independently in the labor market and socio-economic system.
c) Nature of impact: direct impact (employment, increased economic independence, meeting local service needs) and indirect impact (independence from the benefits system, development of local economic prosperity through inclusion in the labor market).

In rural areas, the use of local economic resources also represents an important instrument of inclusive development. The NATURA[6] Social Cooperative, operating in an agricultural region, conducts fruit and vegetable processing activities in cooperation with local agri-food enterprises. Job creation in rural areas and the development of processing activities contribute to the diversification of the local economy, the reduction of labor migration, and the strengthening of regional economic self-sufficiency. By adding value to local agricultural production, the cooperative supports endogenous development and reduces the vulnerability of rural communities to external market fluctuations. The reference to cooperative traditions indicates that social enterprises can serve as modern forms of economic self-organization of local communities, revitalizing historical practices of mutual support while adapting them to contemporary market conditions.

The presented case suggests the following conclusions:
a) Inclusiveness dimension: territorial and economic inclusiveness – refers to the inclusion of rural residents in local economic processes through the use of local endogenous resources.
b) Operationalization of the impact: the development of agri-food processing and cooperation with local businesses lead to increased added value of agricultural production, diversification of the economic structure, and reduction of human capital outflow.
c) Nature of the impact: direct impact (job creation, development of local processing, increased income) and indirect impact (promoting the region's economic self-sufficiency, reducing migration, increasing resilience to market fluctuations).

The activities of the company PREPS[7] also align with the model of inclusive growth by supporting local entrepreneurship and creating employment opportunities for individuals in difficult life situations. Providing services for the e-commerce sector enables local entrepreneurs to expand into new markets, thereby strengthening the competitiveness of the regional economy and facilitating digital transformation at the local level. Planned activities within the circular economy further emphasize the environmental dimension of development by promoting resource efficiency and waste reduction. This enterprise exemplifies an entity that, through the integration of economic, social, and environmental objectives, enhances the

[6] https://dotacje-24.pl/spoldzielnia-socjalna-natura/; access: 10.02.2026
[7] https://www.preps.com.pl/, access: 10.02.2026

resilience of the local economy to structural changes such as digital transformation and economic crises, while simultaneously fostering inclusive participation in emerging economic sectors.

The presented case demonstrates the following:
a) Dimension of inclusiveness: sectoral inclusiveness – concerning the inclusion of local entrepreneurs and people at risk of exclusion in new economic sectors (e-commerce, circular economy) and digitalization mechanisms.
b) Operationalization of impact: Shaping inclusiveness towards digitalization and, consequently, increasing the competitiveness of local companies. Implementing the circular economy concept helps to sustainably and effectively engage local resources.
c) Nature of impact: direct impact (job creation, support for business activity, development of digital services) and indirect impact (increased regional competitiveness, adaptation to structural changes).

The presented examples indicate that social enterprises function as catalysts of inclusive local growth, as they integrate various dimensions of development — economic, social, institutional, and environmental — into coherent local strategies. By creating jobs for individuals at risk of exclusion, developing services that address community needs, mobilizing social capital, fostering cross-sector cooperation, and stimulating innovation, they contribute to increased social cohesion and improved quality of life for residents. Consequently, social enterprises can be regarded as key actors in local development strategies oriented toward inclusiveness and sustainable development, capable of bridging gaps left by both market and state mechanisms and of shaping more resilient and participatory local economies.

Comparative analysis of cases.
Referring to the above cases, we can draw cross-cutting conclusions: all entities implement inclusive employment and include beneficiaries in the market system, and some also implement inclusiveness through the provision of social services, the use of local environmental resources, and intersectoral cooperation. The table below summarizes the conclusions.

Table 2: The participation of social enterprises in inclusive local development

Enterprise	Main activity	Dimension of inclusiveness	Impact on local development
POŻYTEK	Care services, assistance, childcare	Employment of persons at risk of exclusion	Development of social services and the labor market
PODKOWA	Care, assistance, respite care	Socio-occupational integration	Support for families and activation of residents
EKO NA MAKSA	Organic trade, education	Employment for persons facing difficulties	Development of the local economy and ecology
Victus	Catering and food services	Employment of persons with disabilities	Social reintegration system

Enterprise	Main activity	Dimension of inclusiveness	Impact on local development
NATURA	Agri-food processing	Employment in rural areas	Diversification of the rural economy
PREPS	E-commerce services	Employment for persons in difficult life situations	Support for local entrepreneurship

Source: Author

5. Conclusions

Inclusive local growth constitutes a significant phenomenon within the socio-economic space. It promotes balanced socio-economic development by ensuring the inclusion of all social groups in market transactions, the labor market, and access to the supply of goods and services provided by enterprises, thereby shaping citizens' quality of life. Inclusion also encompasses the mobilization of community social capital and cooperation among the public, market, and social sectors in shaping both the level of local growth and its qualitative development.

When addressing the question of which economic actors most effectively perform these inclusive functions, social enterprises should be identified as key entities. Organizations that integrate economic and social objectives represent natural leading actors of inclusive growth within the local economic environment. They contribute through employment-generating activities, the activation of social capital, the creation of services tailored to individuals with special needs, and the development of cross-sectoral cooperation with public, social, and market actors.

In this regard, the functions of social enterprises play a significant role, particularly in local employment, especially for individuals who encounter difficulties in obtaining work in the commercial sector, while they may also constitute a transitional stage toward entry into the open labor market. This function is directly connected with a change in the economic status of employed persons, and this in turn influences the local economy from the perspective of the local context. In this respect, it is necessary to indicate employment inclusion, economic inclusion, and the inclusion of transactional processes within the local business cycle. The employment aspect also concerns the inclusion in the labor market of family members of dependent persons, thanks to the care opportunities offered by social enterprises, which additionally increases economic activity and improves the quality of life of the community.

Therefore, inclusion also has the character of citizens' access to a wide range of services. Particularly social and welfare services — caregiving, health, educational, cultural, as well as maintenance and household support services. Social enterprises in this respect institutionally support households and citizens with special needs through an innovative range of services while simultaneously increasing the productive potential of local human capital and social capital.

Indicated in the article, the provision of catering services for educational institutions, older persons, and residents of the municipality simultaneously satisfies local needs and creates jobs for persons with disabilities, transforming beneficiaries of social assistance into active participants in the local economy. This solution strengthens social cohesion, reduces

dependence on support systems, and increases the economic independence of beneficiaries, which constitutes the essence of inclusive growth. In this respect, cooperation between social enterprises and local government, local public institutions, as well as social organizations and other commercial entities is also of significant importance.

Attention should also be paid to the aspect of ecological inclusion in local economies. By integrating environmental objectives with job creation, the enterprise develops a model of inclusive green development that combines social inclusion with ecological responsibility. This is particularly important in the currently emphasized models of circular economies. In turn, the provision of services for the e-commerce sector enables local entrepreneurs to expand into new markets, strengthening the competitiveness of the regional economy and facilitating digital transformation at the local level.

The presented cases confirm the patterns identified in the literature regarding social enterprises in the context of achieving socio-economic goals.

The case study was selected for entities operating in small towns, particularly those requiring inclusive development processes. A comparative analysis of the theoretical and empirical sections demonstrates a relationship between the characteristics of local inclusive development and the specific characteristics of social enterprises, which implement aspects of economic and social inclusion at the level of their mission, strategy, and ongoing operational processes.

The effectiveness of social enterprises in influencing inclusive local development stems from their dual-goal implementation profile, which is also related to the multidimensionality of inclusive activities – addressing economic, social, resource-related, and relational aspects, as well as aspects of direct and indirect impact.

The theoretical contribution of this article is to develop an interpretation of inclusivity by integrating theories on inclusion with local development, social enterprises, and practical case studies. Mechanisms and patterns related to inclusivity were also identified. It is important to note the research limitations resulting from the small number of entities included. This study provides a starting point for future research in the following areas: quantitative research, analysis of the degree and level of economic and social impact of social enterprises on inclusive local development, and spatially differentiated comparative studies of determinants, drivers, and barriers.

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A scientific paper

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I HAVE NO TIME TO WASTE: OVERCOMING A LACK IN CAPABILITIES DURING PERCEIVED OPPORTUNITY EXPLOITATION AMONG CROATIAN SUCCESSFUL DROPOUT ENTREPRENEURS

ABSTRACT

While dropout phenomena at university is widely studied in many disciplines, leaving education to enter entrepreneurship has attracted less attention from scholars. Existing research tends to frame dropout primarily as a negative outcome, yet for a subset of individuals it represents a strategic step toward opportunity exploitation. This study investigates how dropout entrepreneurs signal credibility and compensate for human capital deficiencies, and what specific roles early formal and informal collaborators play in this process. To address these questions, the study employs qualitative content analysis supported by MAXQDA to systematically examine collected narratives of successful Croatian dropout entrepreneurs. The findings reveal that to overcome initial capability constraints and build legitimacy, these entrepreneurs heavily rely on distinct categories of early contributors. Specifically, formal collaborators ("joiners," such as early employees and technical experts) compensate for missing operational and technical competencies, while informal supporters ("helpers," such as family, peers, and mentors) provide essential emotional, strategic, and resource-based support. Together, these contributors play instrumental roles not only in bridging knowledge gaps but also in legitimizing the emerging venture, expanding access to resources, and accelerating learning processes in the absence of formal education pathways. Overall, this study provides new insights into the mechanisms through which dropout entrepreneurs overcome capability constraints and highlights the importance of early collaborative interactions in shaping entrepreneurial success. By reframing dropout as a context in which alternative forms of human capital acquisition emerge, the paper extends current understandings of entrepreneurial capability development and opens avenues for future research on non-traditional entrepreneurial trajectories.

Key words: *Dropout entrepreneurs, Early contributors in venture creation, Disadvantages in human capital accumulation.*

1. Introduction

The emergence of entrepreneurial ideas and opportunity recognition are common during university studies (e.g., Junça-Silva et al., 2024; Farrokhnia et al., 2026), which contributes to the strengthening of students' entrepreneurial intentions. However, some young individuals who have recognized a perceived business opportunity, especially those who are aware of the need to act quickly due to a highly changing environment (e.g., McMullen, et al., 2024), consider formal university education an obstacle to opportunity exploitation and a "waste of time". Some of them are probably further encouraged to drop out of enrollment or discontinue their studies by the widespread narrative of successful dropout entrepreneurs (e.g., Stypińska et al., 2023).

When launching an entrepreneurial venture, entrepreneurs must establish both their own legitimacy as founders and the legitimacy of the venture in order to be able to access the resources they lack (e.g., Zhang and White, 2016). Exploiting a perceived opportunity and launching a business venture requires different combinations of resources in terms of economic, social and human capital. Education represents an important source of legitimacy for entrepreneurs because they provide socially recognized confirmation of knowledge, competencies, and expertise. According to signaling theory in entrepreneurship (e.g., Bafera and Kleinert, 2023) in order to gain trust and attract collaborators, entrepreneurs use a variety of strategies to effectively signal their human capital, such as prior education, industry experience and experience in starting a business. They do this by demonstrating personal attributes such as authenticity, passion, and the ability to clearly articulate their vision, among other things. For entrepreneurs, signaling the credibility of their competencies through specific features of their educational biography makes it easier to mobilize resources (e.g., Ko and McKelvie, 2018; Piva and Rossi-Lamastra, 2018).

Novice entrepreneurs who lack formal human capital in form of higher education, often build legitimacy by signaling social and collective capital, i.e., the ability to gather competent collaborators and establish relationships with legitimate actors, thereby indirectly communicating their own credibility and potential (e.g., Plummer et al., 2016). The narratives in which they address the public and signal their legitimacy can be embellished images of reality or the future (e.g., Garud et al., 2014) that support the myth of the success of dropout entrepreneurs or garage entrepreneurs (e.g., Cunha, et al., 2025), or they can express the realistic situation and give credit to people who managed to overcome their capability deficiencies in the early stages of their activities.

Our research question addresses how do individuals, social mechanisms, and key events shape the process of starting a business and early business development among young entrepreneurs without formal education and prior entrepreneurial experience?

Drawing on the premises of social learning theory, human capital theory, the theory of planned behavior, particularly subjective norms and perceived behavioral control (entrepreneurial self-efficacy), and effectuation theory, this research analyzes which individual entrepreneurs without completed formal education involve in the process of founding and developing their ventures, and what specific roles these actors take on during different stages of business development. Examining the interplay of individual initiative and collective support, the paper shows how social networks and external human capital act as compensatory mechanisms that mitigate the risks associated with limited resources in the early stages of entrepreneurial activity.

The manuscript is organized into six main sections. It begins with an Introduction that outlines the research problem, contextualizes the phenomenon of dropout entrepreneurship, and states the primary research question. The subsequent Theoretical background section reviews the relevant literature, establishing the conceptual foundation for the study by drawing on theories of effectuation, planned behavior, and social capital. The Methodology section describes the qualitative content analysis approach employed, followed by the Research design section, which details the procedures for sample selection and data collection. The core findings from the analysis of entrepreneurial narratives are presented in the Results section. Finally, the Discussion and conclusion section interprets these findings, discusses their theoretical and practical implications, particularly for higher education institutions, and summarizes the study's contributions, limitations, and avenues for future research.

2. Theorethical background

Drawing on Sarasvathy's (2001) seminal work on effectuation logic, the process of recognizing business opportunities is strongly shaped by individual self-efficacy and the logic of effectuation, which influences the way entrepreneurs perceive and exploit opportunities (Chinyoka, 2020; Engel et al., 2014; Mumi et al., 2025). In contrast to the causal approach, effectuation involves making decisions under conditions of uncertainty by relying on available resources, who the entrepreneur is, what he knows, and whom he knows instead of planning for predefined goals (Gumel, 2018; Martín-Navarro et al., 2023). Such an approach is particularly relevant for young entrepreneurs who act as bricoleurs, using existing resources and social connections to develop an already recognized opportunity (Palamida et al., 2017).

Entrepreneurial self-efficacy and perceived behavioral control, key elements of the theory of planned behavior, refer to an individual's belief in their own ability to manage resources and overcome challenges and significantly increase the likelihood of exploiting business opportunities (Arroyo et al., 2021; Branchet et al., 2018; Duong and Trang, 2019; St-Jean and Tremblay, 2020). Higher levels of self-efficacy are associated with greater risk-taking, persistence, and greater sensitivity to entrepreneurial opportunities (Herlina et al., 2025). The role of universities in developing entrepreneurial intentions, knowledge and skills through building human capital, creativity and self-confidence necessary for starting a business has been widely explored in the literature (Dabić, 2019; Gieure et al., 2019; Schimperna et al., 2021; Kurniawati et al., 2025). Through education, practical projects and mentoring support, universities strengthen self-efficacy, resilience and perceived control over the entrepreneurial process and reduce the fear of failure, but at the same time they also seek to respond to the “fear of missing out” by integrating experiential learning and practical competencies (Villanueva & Martins, 2022; Chagi et al., 2025).

Individuals who bypass formal education are more likely to rely on effectuation logic and social networks to compensate for the lack of traditional human capital (Linton & Klinton, 2019). Social capital provides them with access to complementary knowledge and skills that they would otherwise acquire through education, which makes it easier to overcome the complexities of business development (Liao et al., 2022; St-Jean & Tremblay, 2020). In this context, the perception of opportunities and entrepreneurial intentions, as described by the Shapero-Sokol model, depend on the assessed desirability and feasibility of action (Mikić et al., 2020). However, the mechanisms by which individuals with limited formal education compensate for competence gaps during the opportunity-taking phase are still under-researched. This study therefore analyzes how successful Croatian entrepreneurs without formal education mobilize

early associates and informal networks to overcome capability limitations (Cardon et al., 2025). Entrepreneurs often form diverse teams composed of family members, friends, former colleagues, and mentors, as early entrepreneurial ventures are largely team processes (Bolzani et al., 2019; Held et al., 2018; Wasim et al., 2023). Such networks provide key resources, knowledge, and social capital necessary in conditions of high uncertainty and limited resources (Edelman et al., 2016).

Individuals, so called “joiners”, become part of the entrepreneurial team, most often as early employees, and actively contribute their knowledge, skills, and work to the development of the nascent company. In addition to formal team members, the research also highlights the importance of “helpers”, individuals who provide informal support, assistance, or resources, such as family members, friends, or mentors, and whose role is particularly important in overcoming resource constraints characteristic of the early stages of entrepreneurship. People who join entrepreneurial ventures are motivated not only by financial benefits but also by non-financial motives such as autonomy, responsibility, intellectual challenge, personal fulfillment, and identification with the vision of the company (Balen & Tarakci, 2023). They are often attracted by the belief in the founders' abilities and the potential of the recognized opportunity (Argaw & Liu, 2024).

Since entrepreneurs rarely possess all the necessary competencies at the start of a business, they rely on social capital to access complementary human capital (Sheng et al., 2024). Social network theory, grounded in Granovetter's (1973) foundational work 'The Strength of Weak Ties,' distinguishes between strong ties, which provide trust and emotional support, and weak ties, which provide access to new information and opportunities outside the immediate environment (Santarelli & Tran, 2012; Yuan, 2022). Weak ties are particularly important in the opportunity exploitation phase because they provide specific knowledge unavailable within close networks (Santarelli & Tran, 2012).
The interaction of human and social capital creates added value because networks connect different actors and facilitate resource mobilization (Sheng et al., 2024; Yuan, 2022). The concept of resource bricolage further explains how entrepreneurs with limited resources combine available resources — capital, labor, and knowledge — to sustain their businesses, with social networks playing a key role (Yuan, 2022). Subjective norms, shaped by social networks and environmental expectations, further influence entrepreneurial behavior and resource mobilization.

3. Methodology

This research used secondary data collected from publicly available sources, such as newspaper articles, podcasts, and other media content. The choice of this methodology is based on the fact that such sources already contain rich, spontaneously generated statements from actors, which allows for the exploration of discourses, representations, and dominant narratives without additional burdening the participants (e.g. Harris, 2001).

The use of secondary media data is particularly justified in situations where primary data collection is difficult or impossible (e.g. due to geographical, ethical, security or time constraints), and at the same time allows for a broader geographical and temporal coverage of the observed phenomenon. The research was conducted on successful dropout entrepreneurs, who are often not easy to approach directly due to their high professional engagement, limited availability, media exposure, but also potential selectivity in participating in research. The

respondents are dropout entrepreneurs who are owners and managers of companies that they have owned and managed for at least 10 years and who are finalists in competitions or have been awarded by entrepreneurial, economic and other relevant associations in Croatia.

Qualitative analysis of such documents, such as content analysis, thematic or discursive analysis, enables the systematic coding and interpretation of already existing texts and broadcast content, thereby increasing the efficiency of research and making optimal use of available resources, while maintaining methodological rigor. The sample size of 11 entrepreneurs is considered appropriate for the qualitative research approach applied in this paper, as the aim was to achieve an in-depth understanding of the phenomenon, rather than statistical generalization. The selected sample enabled the analysis of information-rich cases relevant to the research question, with the number of units of analysis sufficient to identify recurring patterns and key themes within the collected narratives. This ensures analytical saturation in the context of the phenomenon under study and contributes to the methodological soundness of the research.

As the dropout myth of success is strongly embedded in the public narrative with the support of prominent entrepreneurs and even organizations that support university dropouts, it has attracted the attention of researchers who, for example Watt (2016) question the dropout myth of success and self-reliance, prompted by the fact that many dropout entrepreneurs' narratives emphasize that they achieved their success independently without the help of higher education. Following the call made by Audretsch and Lehmann (2023) that narrative and stories should be included into the field of entrepreneurship and storytelling strategies that support entrepreneurial narratives Burnell et al. (2023), this research relies exclusively on entrepreneurs' statements and stories. Therefore, faces data narrativity problems and, as pointed out by Van Lent et al. (2023) entrepreneurs' subsequent memories are often too structured, linear, and purposeful. Aware of this approach's limitations, we chose it because public appearances and storytelling by prominent dropout entrepreneurs who are perceived as successful influence the persistence of the myth of success.

The goal of this research is to examine how young entrepreneurs without formal education and prior entrepreneurial experience perceive and navigate the lack of capabilities and resources during the exploitation of recognised business opportunities, with particular emphasis on the roles of early associates, social networks, and legitimacy construction.

The research is guided by the following research questions:

1. How do entrepreneurs without formal qualifications signal credibility to compensate for human capital deficiencies in the early stages of exploiting business opportunities?
2. How do formal and informal collaborators contribute to compensating for founders' missing competencies?

In this paper, we did not use any of the quantitative measures to assess the success of entrepreneurs, nor did we, like Buenstorf et al. (2017) investigate whether dropouts are truly successful. In this research we choose to focus on entrepreneurs, recognized by the profession and the public, who dropped out, interrupted, or significantly delayed their higher education.

4. Research design

The study was structured into three phases: the first two focused on sample formation, and the third on content analysis.

During the first phase, entrepreneurs whose stories were suitable for the research were selected. Successful dropout entrepreneurs were selected, and the criterion of success was being a finalist or receiving at least one award from entrepreneurial, economic and other relevant associations in Croatia. The second selection criterion was that the business owned and managed by them for 10 years or longer because their business had survived the most sensitive initial period of 5 years and because there is a greater chance that they will be recognized by the profession and the public and that they will be perceived as successful. Successful entrepreneurs are often invited to speak in public, give interviews in various forms from podcasts, specialized magazines to daily newspapers, and often in these conversations they touch on their beginnings or it is precisely these beginnings that particularly attract the public's attention.

As mentioned above, we selected relevant awards for entrepreneur and businessperson of the year in Croatia and selected the finalists and award winners. Then we checked their level of formal education on the company's website, personal Linkedin profiles and other publicly available sources on the Internet. After reviewing the educational background of the entrepreneurs, we selected those whose biographical data indicate that at the time of starting a business they had and/or still had completed high school as their highest level of formal education. By checking the public appearances of the selected entrepreneurs, we selected eleven entrepreneurs who started their businesses as high school students, immediately after graduating from high school or while studying at a higher education institution. We then checked publicly available sources where they explained the reasons why they did not continue their education, dropped out, or completed it in a significantly longer period than usual.

Following the academic debate on the ethical issue of revealing the identities of public figures in qualitative reasrches (Harrington, 2025; Stommel and De Rijk, 2021) and especially research dealing with personal narratives on the Internet (Burles and Bally, 2018; Joseph, 2023), we decided not to reveal them due to the considerable diversity among the selected entrepreneurs. Entrepreneurs differ in their approach to public appearances, ranging from what the journalists in articles describe as "self-deprecating" ones to those who, by their own admission, use their personal stories of beginnings as part of a communication strategy to attract attention and promote their companies.

In the second phase, we collected published stories about the selected entrepreneurs. We found the data source by searching the web using keywords - along with the entrepreneur's name, we also listed the words biography, beginning, education, college, and the names of their current companies and the companies they founded immediately after graduating from high school or during their studies. The podcasts were selected following the methodological framework and recommendations provided by Kulkov et al., (2024) in their paper, and podcasts were selected primarily based on the criteria of relevance and credibility. The podcasts were transcribed using the audio and video transcription software Buzz.

In the third phase, the analysis was undertaken using a qualitative content analysis method, which allows researchers to gain a deeper understanding of social reality by examining meanings, themes and patterns in the text, supported by MAXQDA qualitative data analysis software. In accordance with the method, the research sample was purposively selected,

enabling the research questions to be addressed. The analysis was guided by research questions and focused on emerging themes and patterns. The coding scheme was developed both inductively and deductively, from data, previous related studies and theories. After coding all texts, the codes were grouped into themes, enabling the identification of patterns and the drawing of inferences.

5. Results

The research shows how entrepreneurs without formal education and previous entrepreneurial experience at the beginning of their entrepreneurial journey manage to overcome challenges in the early stages of their company development. Despite pronounced limitations in resources and competencies, entrepreneurs demonstrated a high level of perceived control over their own actions, which is in line with the theory of planned behavior, according to which belief in the ability to manage available resources stimulates the intention and readiness to engage in entrepreneurial action even in conditions of uncertainty. Key factors of their success include compensating for deficiencies in human capital, shaping legitimacy, mobilizing collaborators and helpers, using social networks, and reacting to key events in the entrepreneurial process. However, a similarity is noticeable in their life stories: their interest in the field in which they started their business began in high school, as a hobby, and through various informal means they acquired the knowledge and skills that they later needed in their business venture.

Entrepreneurs were aware of their shortcomings, especially in managerial, technical and communication skills and in work organization. Their entry into entrepreneurship was not all a quick act out of fear of missing out on an opportunity, but also stemmed from circumstances such as continuing the family business or helping parents. In addition, they faced resource constraints, including financial constraints, a lack of labor, and limited professional contacts, which they compensated for through the mobilization of social capital – family, friends, and mentors. Despite pronounced limitations in resources and competencies, entrepreneurs demonstrated a high level of perceived control over their own actions, which is consistent with the theory of planned behavior, according to which belief in the ability to manage available resources stimulates the intention and readiness to engage in entrepreneurial action even in conditions of uncertainty.

They built legitimacy primarily through institutional recognition. The first formal contracts with clients not only secured resources, but also served as a signal of credibility to the market and future partners. The involvement of the first investors further confirmed credibility, while media visibility allowed entrepreneurs to draw attention to their ventures, replacing limitations in marketing and highlighting their stories of "outsiders". Generational differences in the narrative showed that older entrepreneurs rarely emphasized their dropout status, while younger ones often presented the decision to leave college as a strategic or inevitable step in their development.

Colleagues, including friends and first employees, played a key role in complementing entrepreneurs' competencies, while informal helpers – mentors, investors and family – provided emotional, resource and strategic support. Some collaborators stayed long-term, and some became co-owners, while hiring friends sometimes caused difficulties in separating professional and personal relationships. The role of university professors and support in opportunity recognition is also interesting, ranging from support "exceptional, more than expected and deserved given early student status" to dissuasion and non-support. The

interaction of strong and weak social ties shaped the subjective norms of entrepreneurs, with close relationships providing normative and emotional support, while wider networks enabled social validation of their actions. This mechanism was particularly significant in a social context in which the completion of formal education is perceived as a key prerequisite for professional success, as social networks partially compensated for the deficit in institutionally recognized legitimacy.

Entrepreneurs compensated for their shortcomings through various mechanisms: associates replaced competencies they lacked, they acquired knowledge through interaction and advice, the reputation of associates was transferred to the entrepreneur, and by participating in networks and events, they expanded access to new actors and markets. Iterative teamwork and practical testing of prototypes enabled accelerated learning and adaptation.
Social mechanisms further empowered entrepreneurs. Strong relationships with family, friends, and mentors provided trust, emotional security, and long-term support, while weak ties provided access to new clients, market information, and innovative resources. Intermediary events connected entrepreneurs with key actors, partners, and investors, opening up new opportunities and fostering the legitimation of the venture.

Key events in the development of ventures included the decision to drop out of college, various awards in competitions including business plan competitions and presentations, hiring the first collaborators, securing the first customers, crises that encouraged collaboration, and strategic growth milestones. Each of these events shaped the support network, legitimation, and learning process, enabling entrepreneurs to overcome initial skill gaps and successfully develop their ventures. Overall, young entrepreneurs without formal education compensate for human capital deficiencies through a combination of collaborators, helpers, social networks, and institutional legitimation, using creative learning mechanisms, signaling credibility, and iterative development, which enable them to successfully realize their entrepreneurial ventures.

Entrepreneurs, in the beggining of their entrepreneurial journey, without formal education compensate for their human capital deficiencies through a combination of collaborators, helpers, social networks, and institutional legitimation, using creative learning mechanisms, signaling credibility, and iterative development, which enables them to successfully realize their entrepreneurial ventures.

The entrepreneurs in the study differ in the reasons why they interrupted, did not continue, or prolonged their education after completing high school. Although they all entered entrepreneurship during this period, this was not the primary reason; rather, they did not continue due to factors ranging from inadequate grades in high school, lifestyle changes, and lack of motivation to continue their education. After initial success and stabilization of knowledge, they engaged in acquiring formal and informal education, most often in the field of governance and management, but also in other areas. Their attitude towards not completing their education ranges from regret to emphasis that they would do the same again today. It is interesting that all entrepreneurs included in this research actively collaborate with HEIs on development projects, through mentoring, and that they regularly hold public lectures as a kind of role model about their entrepreneurial activities.

6. Discussion and conclusion

This study investigates how Croatian dropout entrepreneurs overcome the lack of formal competencies in the early stages of business development, with a particular focus on the role of collaborators and social networks. The results reveal complex dynamics between three key actors: the entrepreneurs themselves, their helpers and joiners, and Higher Education Institutions (HEIs). Our analysis points to profound implications for higher education, which finds itself in a paradoxical position, torn between fostering entrepreneurship and internal policies aimed at reducing dropout rates.

One of the central findings concerns the success narrative surrounding dropout entrepreneurs. A clear difference in the perception of education between younger and older generations of entrepreneurs is observed. Younger entrepreneurs, inspired by globally renowned examples of dropout entrepreneurs, often build their legitimacy on the "myth of overnight success", which suggests that formal education is an obstacle, not a prerequisite, for innovation. This narrative, as Stypińska et al. (2023) point out, becomes a powerful tool for self-promotion and attracting resources, thus influencing the wider student population and normalizing the decision to drop out. On the other hand, older entrepreneurs more often justify their decision with pragmatic reasons, relying less on mythical rhetoric.

The key driver of the decision to drop out is the awareness of the necessity of a quick reaction in order to exploit a perceived business opportunity. In a dynamic environment, time is perceived as the most valuable resource, and formal education as a "waste of time", which is in line with the findings of McMullen et al. (2024). Since they lack a diploma as a formal signal of competence (Bafera and Kleinert, 2023), these entrepreneurs are forced to seek legitimacy outside the academic system. They do this by activating social capital – by gathering a team of competent collaborators (joiners) and relying on a network of informal helpers (helpers). In this way, as Plummer et al. suggest (2016), collective capital becomes a substitute for individual human capital, signaling to the market and investors the potential of the venture despite the founders' lack of formal qualifications.

The research also identified that the reasons for dropping out are often not solely personal, but also organizational. The structure, pace and content of many higher education programmes are not adapted to the needs of individuals with expressed entrepreneurial intentions. This mismatch has direct implications for career decisions and encourages entry into entrepreneurship as an alternative path. This poses a serious challenge for the higher education system, which is losing talented and proactive individuals because it does not offer them sufficiently flexible and practically oriented educational pathways. HEIs are thus caught between the fear of missing out and the fear of failure. Students driven by fear of missing out drop out in order to seize business opportunities, while HEIs promote a culture in which failure is not stigmatized. Ironically, HEIs often use the success stories of dropout entrepreneurs as examples of good practice in their promotional materials, implicitly encouraging the behavior that their internal policies seek to suppress.

This situation forces HEIs to balance two seemingly contradictory messages: 1) "seize the opportunity and drop out if necessary" and 2) "don't be afraid of failure, education gives you security". The role of HEIs should be transformed from passively monitoring dropout rates to actively identifying students with high entrepreneurial potential (those with pronounced fear of missing out). Instead of perceiving them as a problem, HEIs could offer them alternative support models, such as mentoring, temporary status freezing or modular programs that enable

a quick return to the education system. Although official quality management policies emphasize the importance of reducing dropouts, starting an entrepreneurial venture is rarely cited as a legitimate reason for leaving studies.

For HEIs, these findings underscore the urgency of developing flexible, accelerated educational pathways and micro-credentialing programs that accommodate high-potential students with expressed entrepreneurial intentions, allowing them to pursue both formal qualifications and business opportunities simultaneously. By offering modular, practice-oriented curricula, mentorship integration, and formal recognition of entrepreneurial projects, HEIs can retain talented students while simultaneously strengthening the quality of support available to dropout entrepreneurs, thereby transforming the current paradox into an opportunity for institutional innovation and societal value creation.

Finally, the question arises: are dropout entrepreneurs truly role models, or does their success rest on a narrative that ignores the crucial role of collaborators and social capital? Our study suggests that the myth of the "lone genius" is far from reality. The success of these entrepreneurs is not the result of individual brilliance alone, but rather the ability to mobilize collective intelligence and resources. Therefore, instead of uncritically celebrating the dropout phenomenon, higher education should recognize and support the importance of teamwork, social skills, and network capital as key elements of entrepreneurial success, regardless of the individual's formal educational status.

This research has several limitations. First, it relies on publicly available narratives and retrospective storytelling, which can lead to recall bias and selective self-presentation. Second, the research is not based on primary data collection, but on secondary sources, which can limit the depth and accuracy of the analysis. Additionally, the analyzed narratives were created at different time intervals from the beginning of the respondents' careers, which may affect their objectivity due to memory distortions, subsequent rationalizations, or changes in personal and professional perspectives over time.

Future research should deepen our understanding of the motivations behind joiners and helpers joining inexperienced dropout entrepreneurs, particularly in the context of perceived opportunities, risks, and informal signals of potential. It is also recommended to explore in more detail the dynamics of the joining process itself, including whether individuals are primarily attracted by the dropout entrepreneurs themselves or by existing team members (joiners and helpers), as well as the role of social networks and interpersonal relationships in these decisions.

Additionally, it would be useful to examine the attitudes of joiners and helpers towards valuing their own contribution to entrepreneurial success, which is often dominantly interpreted through the narrative of the dropout entrepreneur. In this sense, future research could analyze potential discrepancies between individual perceptions of contribution and publicly constructed success stories.

Furthermore, we recommend conducting empirical and comparative research that would provide a deeper understanding of the phenomenon of dropout entrepreneurship, the dynamics of entrepreneurial teams, and alternative paths to human capital development outside formal educational frameworks. We believe that such research should include longitudinal approaches, comparisons across industries and institutional contexts, and analysis of the different career trajectories of participants involved in such entrepreneurial ventures.

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A scientific paper

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CORRUPTION AND ACCESS TO ENTREPRENEURIAL FINANCE IN CROATIA

ABSTRACT

A sufficient amount of financial resources available to economic actors is as crucial as the accessibility of these resources for achieving entrepreneurial goals. The topic of this research is the relationship between the level of corruption and access to entrepreneurial financing in Croatia, with a special emphasis on the impact of corruption on the availability of capital and investment opportunities for companies from various sources. The research aims to determine how corruption limits access to financial resources and compares the Croatian business environment with that of countries at various levels of economic development. Therefore, the research employs a comparative methodology, analyzing Croatia in relation to Slovakia, which has a similar economic and transitional background. Additionally, Croatia is compared to Germany, a highly developed member of the European Union known for having a lower perception of corruption and a more advanced financial market. The comparison is based on available statistical indicators, including corruption perception indexes and measures of entrepreneurship financing availability. The research utilized statistical methods to analyze data collected from international sources, and the results were interpreted using correlation analyses and comparative indicators. Of course, access to entrepreneurial finance can be influenced by other variables, which is the research gap of this paper. The research results indicate there is a strong and negative correlation between the level of corruption and access to entrepreneurial finance. Countries with lower levels of corruption, such as Germany, record significantly more favorable conditions for financing entrepreneurial projects, while in Croatia and Slovakia, corruption and the perception of non-transparency significantly limit the availability of capital and investor confidence. The research shows that reducing corruption is essential for enhancing access to entrepreneurial finance and promoting economic growth in Croatia, which is also a specific contribution of this article.

Key words*: access to entrepreneurial finance, corruption perception index, financial system, small and medium-sized enterprises.*

1. Introduction

Entrepreneurship is among the key drivers of economic development and innovation in today's economies. Access to financial resources for entrepreneurs is crucial in stimulating investment, creating new jobs, and enhancing the economy's competitiveness. However, effective access to financing does not depend solely on economic development or the institutional framework of the financial system, but also on the level of transparency and trust in the business environment.

Corruption is becoming one of the main structural issues restricting access to capital and hindering the balanced development of entrepreneurship.

Corruption is an abuse of trust and public authority for personal gain. It negatively impacts economic efficiency, diminishes a country's investment attractiveness, and undermines the credibility of investors, banks, and entrepreneurs within the entire system. In countries with a high perception of corruption, the costs of doing business increase, the processes of approving loans and investments become more complex, and the risks of non-transparent business operations deter domestic and foreign investors. Consequently, entrepreneurs, particularly those in small and medium-sized businesses, face increased challenges in securing the financial resources necessary for their development and expansion.

Croatia, as a transition economy and a European Union member, has faced long-standing challenges regarding institutional transparency and corruption perceptions. Despite various reform efforts to strengthen the institutional framework, corruption levels still exceed the average of developed EU member states, which is also evident in the accessibility of financing for entrepreneurship. A similar situation exists in other post-transition countries, such as Slovakia. In contrast, countries with lower levels of corruption, like Germany, have more efficient financial support mechanisms and better-developed capital markets.

The research focus is on the analysis of the relationship between corruption levels and the availability of entrepreneurial finance in Croatia, comparing it with selected countries: Slovakia and Germany. The aim is to determine how corruption impacts access to financial resources, specifically how the perception of institutional non-transparency and inefficiency can limit entrepreneurs' financial inclusion.
The scientific and social importance of this research lies in the fact that understanding the causal relationship between corruption and financial access enables the design of more effective public policies and instruments to encourage entrepreneurship. In the context of the Croatian economy, which is currently facing challenges such as slower growth, a weaker investment cycle, and limited access to capital, the results of this analysis can help identify key institutional obstacles. Additionally, the findings can inform recommendations aimed at reducing these barriers.

2. Overview of Previous Research

A significant amount of research has explored the issue of corruption and its effects on various economic indicators. Group of authors (Beck et al., 2006) conducted an analysis using new data from over 2,500 companies across 37 countries to investigate how banking supervision and corruption influence companies' ability to obtain external financing. The paper concludes that a supervisory strategy aimed at enhancing private banking oversight, which requires banks to disclose accurate information to the private sector, helps reduce the extent to which bank corruption hinders companies' ability to secure external financing. Regulations that strengthen private supervision have a particularly beneficial effect on the integrity of bank lending in countries with sound legal institutions. Corruption leads to a higher concentration of corporate capital ownership and increased reliance on bank financing for external funding (Du, 2008). The company's management, leveraging political influence gained through bribery, is notably adept at

expropriating from external investors. Concentration of ownership and reliance on bank financing are means to mitigate the problems of corporate governance under a corrupt government.
Another authors (Anokhin & Schulze, 2009) investigated the relationship between corruption control and levels of innovation and entrepreneurship in 64 countries. They found that better corruption control was associated with higher levels of entrepreneurship and innovation. One research (Smith, 2016) used data from the US Department of Justice on local political corruption and found that companies in more corrupt areas held less cash and had more influence than those in less corrupt places. The relationship between corruption and influence was strongest among companies that operated primarily around their headquarters. Furthermore, companies reduce their liquid assets and increase their debt obligations to limit expropriation by corrupt local officials. Interesting research relates to the relationship between public sector corruption at the state level in the United States as well as to enterprise value and enterprise disclosure policies (Dass et al., 2016). The authors discovered that enterprises in corrupt areas have significantly lower value and transparency of information. Other authors (Galli et al., 2017), examined the impact of corruption levels on the demand for bank loans. Their study analyzed a sample of 68,115 observations collected from the ECB-SAFE survey, focusing on SMEs established in 11 countries of European area between 2009 and 2014. The authors conclude that the level of corruption plays a role in bank loan applications when small businesses are under investigation. The research indicates that anti-corruption policies and measures aimed at increasing economic transparency could be crucial in mitigating the negative impacts of a poor institutional environment on small businesses' access to credit.

Richer countries with better access to international financing grow faster and are less prone to the negative impacts of corruption than developing countries (Cieślik & Goczek (2018). Another group of authors (Giannetti et al., 2020) investigated the effects of an anti-corruption campaign in China on enterprises, focusing on capital allocation efficiency, sales growth, and the cost of debt, and found that reducing corruption leads to improved enterprise performance, especially for small and young enterprises. An interesting study (Liu et al., 2020) empirically tested the hypothesis of the effects of corruption on enterprises' access to bank loans using econometric models based on survey data of 2,848 enterprises in China collected by the World Bank. The results demonstrate an inverted U-shaped relationship between corruption and enterprises' access to bank loans: low levels of corruption increase companies' access to bank loans, while high levels of corruption prevent companies from obtaining bank loans. Improving institutional quality is positively associated with companies' access to bank credit and attenuates the effects of corruption on enterprises' external financing. This study, therefore, sheds light on the real effects of corruption and the determinants of enterprises' access to bank credit in developing countries.

Interesting research relates to the impact of enterprise-level financial constraints and corruption in the business environment on growth for more than 10,000 SMEs in 28 countries in Eastern Europe and Central Asia (Ullah, 2020). Among other things, the author provided empirical evidence that enterprise-level corruption hinders SMEs' access to finance and severely hampers their growth in transition economies. Other group of authors (Adomako et al., 2021) explored how institutional networking mediates the relationship between perceived corruption and the growth of SMEs. They also examined the effect of financial distress on the relationship between perceived corruption and institutional networking. This study was based on data from 212 SMEs operating in Ghana. The study's findings indicate that perceived corruption is positively related to institutional networking, and this relationship is strengthened when financial slack levels are higher. The findings also show

that institutional networking positively mediates the relationship between perceived corruption and SME growth.
Corruption can harm SMEs' access to finance by reducing profits, increasing demand for credit, increasing the likelihood of bankruptcy, creating uncertainty about an enterprise's future earnings, and exacerbating the problem of asymmetric information between borrowers and lenders (Amin & Motta, 2021). The research shows a large negative impact of higher corruption on SMEs' access to finance. The analysis indicates that the negative effect of corruption on access to finance is significantly lower in countries where financial institutions protect the rights of both borrowers and lenders, laws enhance credit information, and credit bureaus are present. Corruption is more detrimental to enterprises that typically have better access to finance without corruption, such as those led by men, larger enterprises, and those with higher performance.

Panel regression results provide a positive association between corruption and credit risk in financing economic actors on a sample of 178 countries from 2000 to 2017 (Hasan & Ashfaq, 2021). Subsample analysis supports the "grease the wheels" hypothesis, indicating that in nations with high corruption, corruption can be advantageous under weak governance and excessive regulatory pressure. This study highlights the need for strong governance mechanisms to effectively reduce high levels of corruption in countries. Other authors (Murta & Gama, 2023) investigated a sample of 640 commercial banks in 42 European countries from 2013 to 2019. The authors found that corruption negatively affects the importance of loans in banks' assets and positively affects the share of non-performing loans.

Some authors (Amin & Motta, 2023) investigated the impact of bureaucratic corruption on access to finance for SMEs in the manufacturing sectors of 79 developing countries. Corruption can obstruct enterprises to obtain finance by reducing profits, increasing the demand for credit, increasing the likelihood of bankruptcy, creating uncertainty about future profits, and exacerbating the problem of asymmetric information between borrowers and lenders. They also found that higher corruption makes it more difficult for SMEs to access finance in more competitive product markets, as well as for small compared to medium-sized enterprises. Interesting study used enterprise-level data from 73 developing economies to examine the effects of these problems on enterprise performance showed that corruption and financial constraints hinder enterprise growth, employment, productivity, and innovation (Priya & Sharma, 2023). Group of authors investigated the impact of perceptions of corruption on intrapreneurship (Sánchez-Vidal et al., 2024). The authors discovered that perceptions of corruption influence intrapreneurship, revealing a quadratic relationship between corruption and intrapreneurship in less economically developed countries. The relationship varies depending on the levels of economic development.

Corrupt practices and perceptions can seriously hinder economic growth and innovation (Farinha & López-de-Foronda, 2024). This may be due to poorer access to corporate finance, higher cost of capital, its effects on competition, misallocation of resources, and distortions in the composition of public spending and the effectiveness of government policies. On a sample of 450 SMEs across South Africa the findings align with the expectation that corruption undermines the efficiency of trade credit management for SMEs (Otto, 2024). Surprisingly, however, they also suggest that SMEs are willing to engage in corrupt practices, as they may perceive a benefit in improved efficiency in managing trade credit. Group of authors (García-Gómez et al., 2025) examined how national corruption impacts financial constraints faced by enterprises. The authors used a sample of 21 European countries from 2002 to 2022, comprising 22,974 observations per enterprise. We

find that corruption increases financial constraints. They further found that as countries become more transparent, enterprises face fewer financial constraints, and that increasing transparency at the country level reduces financial constraints only for enterprises with lower information asymmetry, higher institutional ownership, or higher foreign ownership.

In Croatia, there is very little research on the impact of corruption on individual economic phenomena. In the context of this research, we highlight conclusion that the prevalence of corruption and its significance are an obstacle to the development of entrepreneurship in Croatia (Budak, 2006). Similarly, Kolaković et al. (2019) concluded that entrepreneurs generally use informal sources of financing when starting a business if they do not have other available financial sources or market participants. Corruption suppression in Croatia and its methods are ineffective and a paradigm shift is needed to achieve proper economic goals (Piplica, 2021). Similarly, another group of authors (Luković et al., 2023) concluded in their research on corruption that Croatia lacks a developed macro-national system with clearly defined and coordinated development goals, which is why Croatia lags behind other EU member states in terms of development dynamics. Piplica (2024) further investigated the connection between corruption and the development of entrepreneurship in Croatia, Slovakia, and Latvia. Through an empirical analysis of the differences and similarities between the mentioned countries, he identified best practices and recommendations for further improving the entrepreneurial environment and encouraging entrepreneurship in conditions of economic transition.

3. Comparative Similarities and Differences Between Croatia, Slovakia and Germany

Our research investigates the relationship between corruption and access to entrepreneurial finance in Croatia. We first conducted a comparative analysis using relevant indicators from Slovakia, a country with macroeconomic similarities to Croatia. Additionally, we compared Croatia with Germany, which has more macroeconomic differences from Croatia. The similarities between Croatia and Slovakia stem from their mutual transition trajectory, institutional challenges, and structural characteristics of small open economies within the EU. There are numerous similarities between Croatia and Slovakia as countries of the common European market that have undergone the transition from an administrative-planned to a market economy, similar geographical size and population, level of economic development, open economies more sensitive to external shocks, with the euro as a means of circulation and payment (Slovakia introduced the euro in 2009, Croatia in 2023, which makes them part of the same monetary union and facilitates comparisons of financial conditions.). Both nations significantly depend on foreign direct investment (FDI) for capital and technological advancement. Croatia and Slovakia are both highly integrated into the European market, with significant shares of exports and imports relative to their GDP. They rely heavily on economic developments within the EU. Both countries also have historical challenges related to the efficiency of public administration, the perception and risk of corruption, and the quality of the regulatory environment. As EU members, Croatia and Slovakia apply standardized regulations (banking regulations, competition protection, and financial reporting standards). Both countries have business structures and levels of innovation below the European average, with productivity rates that are relatively low compared to Western European nations.

Croatia and Slovakia have similar average earnings per employee. The average monthly net salary per employee in Croatia in 2024 was 1,318 euros. The median net salary for December 2024 was

1,156 euros, meaning that half of the employees received less and half more than that amount. The average nominal monthly gross salary in Slovakia for 2024 is 1,524 euros. After taxes and contributions, the average net salary is estimated at around 1,050 euros. Additionally, Croatia and Slovakia have experienced negative demographic trends, losing a significant portion of their working-age populations over the past decade due to emigration and an aging population. The population loss is particularly significant in Croatia, which lost 312,523 people (a 7.53% decline) between 2015 and 2025, while Slovakia's population decreased by 33,127 (a 0.61% decline).

Germany is not only a shareholder of the common European market, like Croatia and Slovakia, but also a key country in the establishment of the European Union. Germany is a strong industrial economy with a high GDP per capita, a developed innovation system, and a high share of high-tech sectors, while Croatia and Slovakia are still strengthening their technological capacities. Slovakia and Croatia have faster relative growth of catch-up (convergence), while Germany is in a phase of stable, slower growth. It should be noted that Germany is a key trading partner for both Croatia and Slovakia. Although Croatia and Slovakia have low unemployment rates for the working-age population, both countries have structural employment problems. On the other hand, Germany has strong institutions and low unemployment rates. Slovakia is among the leading car producers per capita in Europe, which gives it a strong export orientation, while Croatia is more dependent on tourism, and Germany has a steadier industrial base.

Germany has a significantly higher GDP per capita than Croatia, with a strong industrial base. The average gross annual salary in Germany was approximately 50,000 euros, translating to about 4,300 euros in gross monthly income, or roughly 2,750 euros net. The net salary largely depends on the tax bracket and benefits. This amount is significantly higher than the income of employees in Croatia and Slovakia. All three economies, despite their differences, face demographic challenges such as an aging population and labor shortages. Table 1 lists some of the most important comparative indicators for the observed countries.

Table 1: Some comparative indicators for Croatia, Slovakia and Germany (2024)

Indicator / Countries	**Indicator**	**Croatia**	**Slovakia**	**Germany**
Area	km²	56594	49035	357569
GDP, current prices	U.S. dollars (billions)	92.5	140.6	4658.5
GDP p/c, current prices	U.S. dollars	23989.1	25925.2	54989.8
GDP percent changes	% change	3.8	2.0	-0.2
Inflation, average consumer prices	% change	4.5	3.2	2.5
Unemployment rate	% total labor force	5.5	5.4	3.4
Employment rate	% of people aged 20 to 64	73.6	78.1	81.3
Average net monthly salary	Euro	1318	1050	2750
Average gross monthly salary	Euro	1877	1524	4300
Population	in millions	3.9	5.4	84.7
General government net debt	% GDP	45.6	52.9	47.7
General government gross debt	% GDP	57.6	58.0	63.9
Current account balance	% GDP	-1.2	-2.8	5.7
Median age of the population	age	45.4	42.6	45.5
Population age structure (children)	0-14 years (% of total population)	14.0	16.0	13.9

Indicator / Countries	Indicator	Croatia	Slovakia	Germany
Population age structure (working age)	15-64 years (% of total population)	62.9	65.7	63.6
Population age structure (older people)	65 or over years (% of total population)	23.0	18.4	22.4

Source: World Economic Outlook database 2025, Eurostat 2025, Statista 2025

Germany's export sector is based on high-tech products, while Croatia exports mainly lower-value-added products. Germany has a well-developed research and development (R&D) ecosystem, including Fraunhofer institutes and strong universities, while R&D investments in Croatia are significantly lower. Similarly, German courts, regulators, and administration are generally considered more efficient, and the level of institutional predictability is higher. Croatia continues to experience weaknesses in the public sector, political influence, and administrative efficiency.

The German financial system is significantly more developed than the Croatian financial system, with a wider range of financial instruments, a stronger banking industry, and a more developed capital market (stock exchange, funds, insurance). Germany, known for its highly developed institutions and a lower perception of corruption compared to Croatia, offers a broader range of financial instruments, such as leasing, factoring, and venture capital. Additionally, it has more advanced stock exchanges and greater investment capacity among its banks. The German financial system is defined by a robust banking market, including Landesbanken, Sparkassen, and commercial banks; a strong sector of institutional investors; an advanced capital market; a corporate bond market; stable regulation; and low credit risk.

Croatia has significantly shallower and more concentrated financial markets. Germany has established vocational education systems and high labor productivity, while the Croatian labor market is characterized by limited flexibility, insufficient investment in labor skills, and a lower proportion of highly qualified workers. Indeed, the differences also lie in the lower competitiveness of the Croatian economy compared to the German economy. Croatia and Slovakia are post-transition economies with a large share of foreign investors that have high dependence on bank financing, often owned by foreign parent banks, shallow capital markets, limited development of alternative sources of financing (venture capital, crowdfunding), and higher risk premiums, especially for small and medium-sized enterprises. Both countries have problems with institutional quality.

4. Research

4.1. Applied Model and Research Methods

Access to entrepreneurial finance can be influenced by various factors such as human resources, company size, financial market conditions, market competition, and others, but they were not explored in this article. The development of a model to analyze the relationship between corruption suppression and access to entrepreneurial finance in Croatia relies on gathering relevant data and employing appropriate statistical techniques. We estimated that corruption could be assessed using the Corruption Perception Index (CPI), while access to entrepreneurial finance would be evaluated through the Global Entrepreneurship Monitor (GEM) indicators. The Corruption Perceptions Index

(CPI) was created in 1995 as a composite indicator to measure perceptions of corruption in the public sector across various countries worldwide. The CPI relies on 13 data sources that include assessments by experts and business executives on a range of corrupt practices in the public sector, including bribery, diversion of public funds, use of public office for private gain, nepotism in the civil service, and state capture. The methodology consists of selecting the original data, rescaling it, aggregating the rescaled data, and reporting a measure of uncertainty. The calculation process also includes a strict quality control mechanism consisting of parallel independent calculations carried out by two internal researchers and two academic consultants not affiliated with Transparency International.

In this article we will measure access to entrepreneurial finance using the GEM indicator. There is no entirely objective measure of the quality or level of this indicator, as it can have multiple dimensions. The GEM approach for assessment involves gathering subjective judgments from several identified national experts, each of whom completes an online National Expert Survey (NES). This survey is conducted by at least 36 experts in each economy, often more, each selected for their expertise by the relevant National Team and approved by GEM. Each expert rates a series of statements that make up the Framework Conditions on an 11-point Likert scale from 0 to 10, according to their opinion of whether each of these statements is completely false (scored as 0), neither true nor false (five), completely true (10), or any point in between. Since the same questions arise in all countries, the results are highly comparable internationally. When making comparisons, it is essential to remember that these assessments can vary based on context. For instance, national experts may have different opinions on the accessibility of entrepreneurial finance depending on the level of development in their respective economies. To evaluate access to entrepreneurial finance, experts from Croatia, Slovakia, and Germany examined four key statements regarding the following aspects: access to debt financing, availability of reasonably priced financial support services, access to start-up capital, and access to growth capital after the initial launch.

To test the hypothesis that the corruption perception index (CPI) influences access to entrepreneurial finance in Croatia, we will employ linear regression analysis. In this case, we are testing the following hypothesis: the null hypothesis (H0) posits that there is no statistical relationship between corruption and access to entrepreneurial finance. Conversely, the alternative hypothesis (H1) asserts that there is a statistical relationship between corruption and access to entrepreneurial finance. In order to test this hypothesis, we can calculate the p-value in linear regression. If the p-value is lower than the selected level of significance (0.05), we will reject the null hypothesis and conclude that there is a statistically significant connection between corruption and access to entrepreneurial finance in Croatia.

This model will use regression analysis to estimate the relationship between these two variables:

$$Y = \beta 0 + \beta_1 X_1 + + \varepsilon$$

where:
Y represents the entrepreneurial environment in a given country
X_1 represents the corruption index in a given country.
β0 is the (intercept)
β1 is the regression coefficient that measures the influence of the corresponding independent variable on the dependent variable
ε represents the error or unaccounted variability.

In our analysis, we will utilize the comparative method to examine corruption and access to entrepreneurial finance in Croatia and Slovakia, two countries that share similar macroeconomic and other indicators. Next, we will compare Croatia and Germany, which, based on macroeconomic and other indicators, could serve as a guideline for enhancing the growth and development of the Croatian economy. The following scenarios were analyzed: (1) all three countries together, (2) only Croatia and Slovakia, (3) only Croatia and Germany. The goal is to investigate whether there is a statistically significant relationship between the institutional indicator (corruption) and the economic environment (access to entrepreneurial finance).

Using statistical tools such as the statistical analysis software Statistica v.14.0.1, we will estimate the regression model and analyze the coefficient values to understand their impact on access to entrepreneurial finance. We will also assess the statistical significance of the coefficients to determine whether the relationships between the variables are truly significant. We will evaluate how corruption in Croatia impacts access to entrepreneurial finance based on the results obtained. Some further analysis could include considering changes in perceptions of corruption, which is a certain limitation of this research.

4.2. Research Results

For this analysis, we collected data on the Corruption Perception Index in Croatia, Slovakia, and Germany, as well as data on access to entrepreneurial finance in these countries for the period from 2015 to 2024. Our analysis considered a total of 30 indicators, with 10 indicators for each of the three countries: Croatia, Slovakia, and Germany. In addition, we incorporated indicators reflecting the perception of corruption in these countries. This data constitutes a time series or panel data collected from various periods (table no. 2).

Table 2: Corruption and access to entrepreneurial finance in Croatia, Germany and Slovakia

Year	CPI/ rank Croatia	Croatia AEF	Croatia AEF rank	CPI/rank Germany	Germany	Germany AEF rank	CPI/rank Slovakia	Slovakia	Slovakia AEF rank
2024	47/63	3.7	14/19	75/15	4.5	13/23	49/59	3.7	13/19
2023	50 /57	4.4	6/19	78/9	4.3	9/16	54/47	4.1	9/19
2022	50/57	4.1	6/16	79/9	5.0	10/22	53/49	4.7	3/16
2021	47/63	3.7	14/19	80/10	5.1	1o/19	52/56	4.5	4/19
2020	47/63	4.2	27/45	80/9	5.3	12/45	49/60	4.6	20/45
2019	47/63	4.15	35/54	80/9	5.31	11/54	50/59	4.5	30/54
2018	48/60	3.97	35/54	80/11	4.75	22/54	50/57	4.79	18/54
2017	49/57	4.02	35/54	81/12	4.72	18/54	50/54	4.86	16/54
2016	49/55	3.79	48/65	81/10	4.95	10/65	51/54	4.86	13/65
2015	51/50	3.3	53/62	81/11	4.3	23/62	51/50	4.28	24/62

AEF – Access to entrepreneurial finance, AEF scale: 0 = very inadequate insufficient status, 10 = very adequate sufficient status. Rank out of 45 recorded in brackets.

Source: https://www.transparency.org/en , https://www.gemconsortium.org/reports/latest-global-report

The average level of corruption perception in all three observed countries is 59.6, which represents a lower level of corruption, but the indicator varies from as high as 47 (recorded in Croatia) to 81 (recorded in Germany). Furthermore, the average level of access to entrepreneurial finance is 4.4

for all three observed countries, but varies from 3.3 (recorded in Croatia) to 5.3 (recorded in Germany).

Table 3: Descriptive Statistics (Croatia, Germany and Slovakia)

Variable	Valid N	Mean	Minimum	Maximum	Std. dev.
CPI	30	59,63333	47,00000	81,00000	14,41379
AEF	30	4,41500	3,30000	5,31000	0,50659

Source: Author's calculations

Germany perceives its institutional environment as better than Croatia and Slovakia, which have similar values in terms of perceived corruption. The AEF values indicate that Germany has better access to finance, followed by Slovakia, while Croatia has the lowest average values. Variability is highest in Germany, reflecting temporal fluctuations in the financial market.

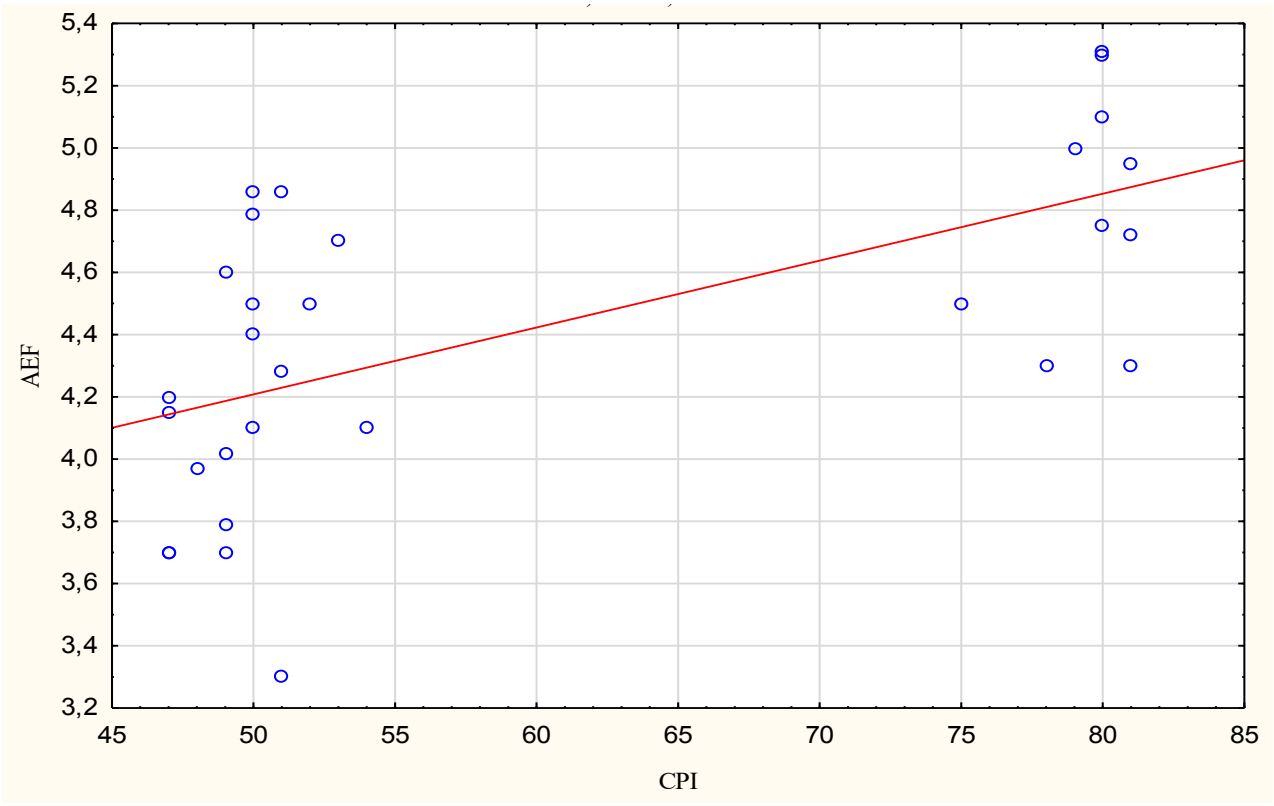
Table 4: Regression Results

Regression Results (Croatia, Germany, Slovakia)				
dependent: AEF	R = 0,61143958	F = 16,71832	R^2= 0,37385836	df = 1,28
no. of cases: 30	adjusted R^2= 0,35149616	p = 0,000331	standard error of estimate: 0,407955057	
intercept: 3,133494846	std. error: 0,3221467	t (28) = 9,7269	p = 0,0000	CPI b*= 0,611
Regression Results (Croatia and Slovakia)				
dependent: AEF	R = 0,35696577	F = 2,628589	R^2= 0,12742456	df = 1,18
no. of cases: 20	adjusted R^2= 0,07894814	p = 0,122340	standard error of estimate: 0,422892676	
intercept: 0,255094340	std. error: 2,441802	t (18) = 0,10447	p = 0,9180	CPI b*= 0,357
Regression Results Croatia and Germany				
dependent: AEF	R = 0,80765839	F = 33,77057	R^2= 0,65231207	df = 1,18
no. of cases: 20	adjusted R^2= 0,63299608	p = 0,000017	standard error of estimate: 0,343814611	
intercept: 2,543008237	std. error: 0,3249899	t (18) = 7,8249	p = 0,0000	CPI b*= 0,808

Source: Author's calculation

The Pearson correlation coefficient between CPI and AEF for the entire sample of 30 observations is r = 0.61. This indicates a moderately strong positive linear relationship: where corruption is lower (CPI is higher), there is better access to financing. The correlation matrix is symmetric, indicating a weak to medium-strong association without assuming direction of causality. The decrease in corruption is closely tied to improved access to entrepreneurial financing in Croatia, Germany, and Slovakia, as clearly shown in graph no. 1 and quantitatively demonstrated in table no. 5.

Graph 1: CPI and AEF in Croatia, Germany and Slovakia
Y = 3,1335+0,0215*x



Source: Author's calculation

Table 5: Regression equation: AEF = 3,133 + 0,611 × CPI

Parameter	Coefficient	Std. error	t-value
Intercept (β_0)	3,133	0,322	9,73***
CPI slope (β_1)	0,0373	0,0091	4,09***

*** p < 0,001

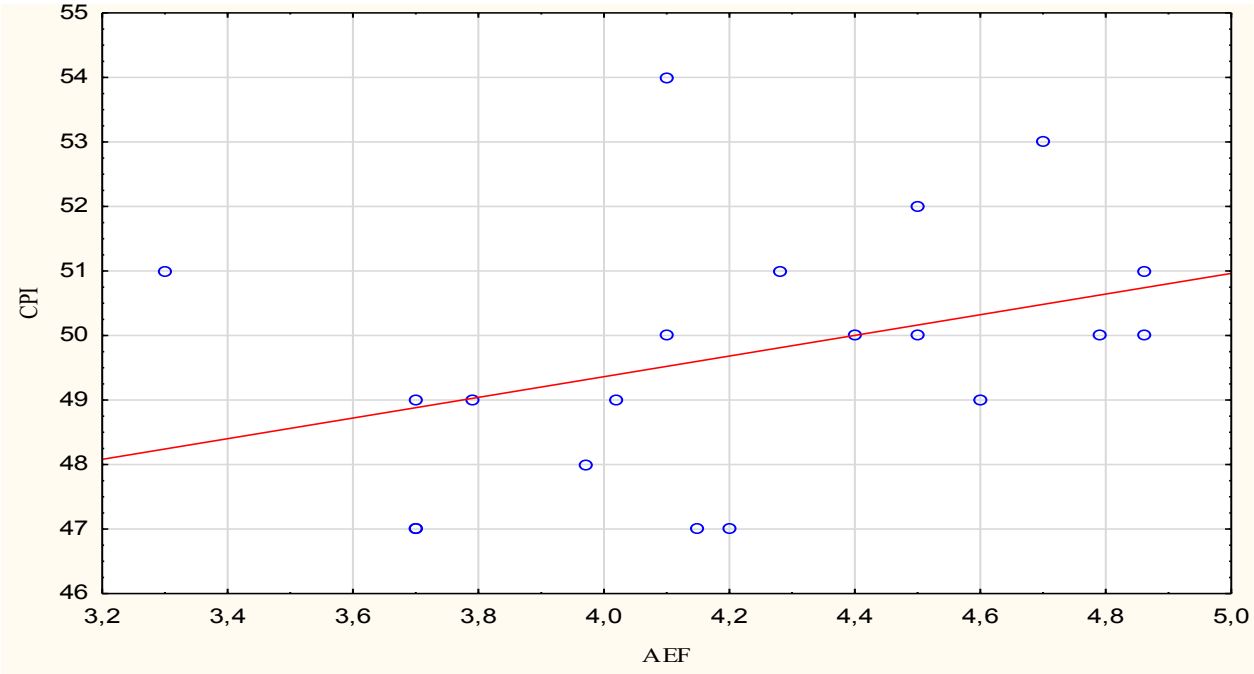
Source: Author's calculation

Intercept of 3.133 with t (28) = 9.73 and p < 0.0001 demonstrates that the theoretical level of AEF at the minimum CPI is statistically significantly different from zero. This means that even in countries with a lower corruption perception index (such as Croatia), there is a basic level of access to finance. It is also clear that a one-point increase in CPI leads to an increase in AEF of about 0.037 points. In standardized form, a one-standard-deviation increase in CPI leads to an increase in AEF of 0.61 standard deviations. This coefficient is statistically significant (p < 0.001).

The Corruption Perceptions Index accounts for a significant 37.4% of the variation in access to entrepreneurial financing, while 62.6% is explained by other factors, including market size, development of the banking system, regulatory environment, and macroeconomic conditions. The F-statistic of 16.72 at p = 0.000331 confirms that the model as a whole is statistically significant. The probability that the relationship found is simply a product of chance is less than 0.05%, which

is firm evidence for the null hypothesis. At this level (all three countries), we can safely conclude that corruption affects financing conditions.

Graph 2: CPI and AEF in Croatia and Slovakia
Y = 42,9586+1,6009*x



Source: Author's calculation

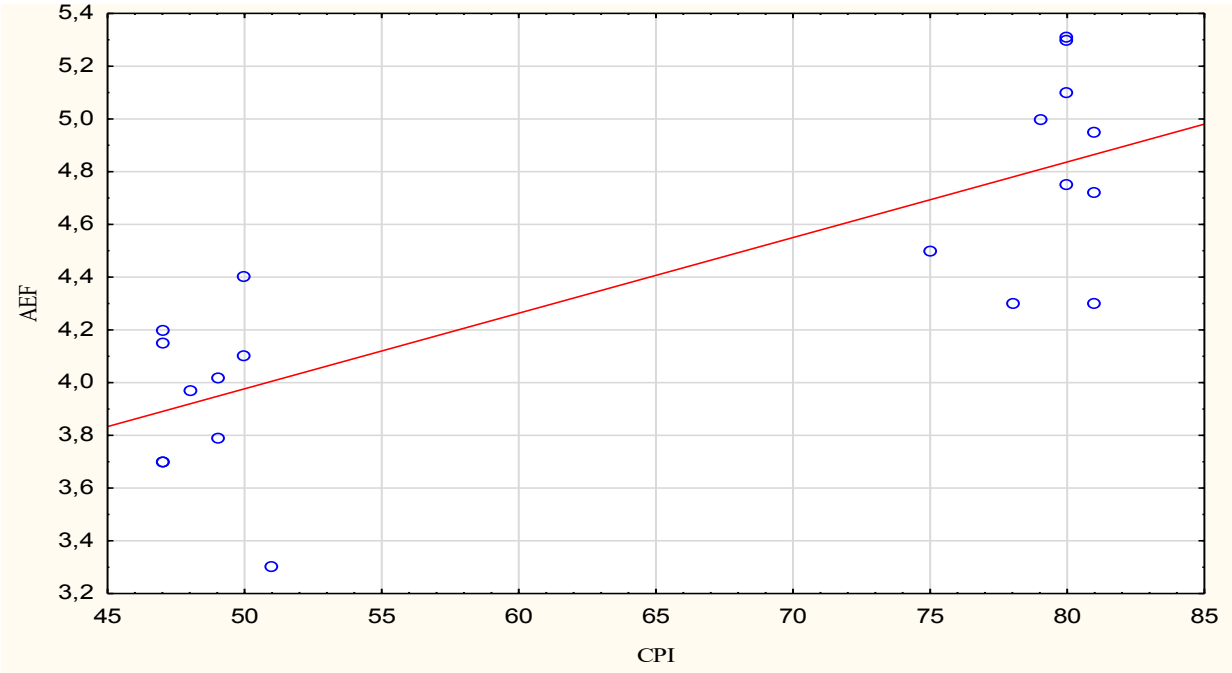
Table 6: Regression equation: AEF = 0,255 + 0,357 × CPI

Parameter	Coefficient	Std. error	t-value
Intercept (β_0)	0,255	2,442	0,105
CPI slope (β_1)	0,0357	0,0450	0,793

p (for slope) = 0,122; not statistically significant at α = 0,05
Source: Author's calculation

When we include Croatia and Slovakia in the analysis, the relationship between the CPI and AEF is not statistically significant. The intercept (0.255) has a large standard error (2.442) and is not significant (t = 0.105, p = 0.918). The correlation of 0.357 is not sufficient to conclude about the systematic effect of corruption on financing in this smaller sample. In this sample, the CPI accounts for only 12.7% of the variation in the AEF. This is because both countries have a similar institutional level, and their CPI differences are not substantial enough. The F-statistic of 2.63 with p = 0.122 suggests that we cannot claim with sufficient confidence that the corruption index affects financing when considering only these two countries. At the usual significance level of 5% (α = 0.05), this p-value is too high to reject the null hypothesis (graph no. 2 and table no. 6).

Graph 1: CPI and AEF in Croatia and Germany
Y = 2,543+0,0287*x



Source: Author's calculation

Table 7: Regression equation: AEF = 2,543 + 0,0281 × CPI

Parameter	Coefficient	Std. error	t-value
Intercept (β_0)	2,543	0,325	7,82***
CPI slope (β_1)	0,0281	0,0048	5,81***

*** p < 0,001
Source: Author's calculation

When we compare Croatia with Germany, a strong connection is evident, which is statistically highly significant. Almost 81% of the variation in one variable is related to the variation in another. This result is significantly better than the overall model's score of 0.611. The intercept value is 2.543, with t (18) = 7.82 and p < 0.0001, indicating high significance. A one-point increase in the Consumer Price Index (CPI) leads to an increase in the Aggregate Expenditure Function (AEF) of 0.028 points. In standardized form (b* = 0.808), a one standard deviation increases in CPI results in a 0.81 standard deviation increase in AEF – an extremely strong effect. The corruption perception index explains 65.2% of the variation in access to financing between Croatia and Germany. This is more than twice as much as in the case of Croatia and Slovakia (12.7%) and significantly more than in the entire sample (37.4%). The F-statistic of 33.77 with p = 0.000017 is extremely significant. Therefore, this confirms that the difference in institutional quality (measured by the CPI) between Croatia (CPI ≈ 48.5) and Germany (CPI ≈ 79.1) is crucial for understanding the differences in the affordability of financing. Germany, with a higher CPI, has a significantly better financial system for entrepreneurs. The information is evident from graph no. 3 and table no. 7.

The analysis of residuals does not show any serious problems: there are no highly influential outliers, the residuals are relatively small and randomly distributed. The regression results are methodologically sound and reliable for inference.

Table 8: Synthetic comparison of all three scenarios

Scenario	R	R^2	p-value	Significant?
Croatia, Germany and Slovakia	0,611	0,374	0,0003	YES ***
Croatia and Slovakia	0,357	0,127	0,122	NO
Croatia and Germany	0,808	0,652	0,000017	YES ***

Source: Author's calculation

Significant differences are evident in the observed 3 analysis scenarios. The difference in R^2 values is dramatic: 37.4% (all) → 12.7% (Croatia and Slovakia) → 65.2% (Croatia and Germany). This shows that the size of the institutional "gap" between countries is critical to the strength of the link. The explanation is that Croatia and Slovakia are of a similar institutional level (CPI 48–51 and 49–54), which means that the CPI did not vary enough between these countries to explain the variation in AEF. Germany differs drastically (CPI 75–81), so the difference in CPI between Croatia and Germany directly corresponds to the difference in AEF. The average link for all three countries ($R = 0.611$) indicates that the association assumption across the sample appears valid, though with greater heterogeneity. We conclude that the effect is most pronounced when countries are institutional.

4.3. Hypothesis testing with t-test

Our null hypothesis is that corruption does not affect access to entrepreneurial financing, that is, H_0: Coefficient β_1 (slope) = 0. The alternative hypothesis is H_1: Coefficient $\beta_1 \neq 0$, which means that corruption impacts financing. In this section, we will review the t-test results for all three scenarios. When we include all three countries in the analysis, the t-value for the slope is high (≈ 4.09), $p < 0.001$, and we reject H_0. The evidence that corruption affects financing is clear and strong. When we include Croatia and Slovakia in the analysis, the t-value for the slope is low (≈ 0.79), $p = 0.122$. Consequently, we do not reject H_0. There is not enough evidence to indicate that corruption significantly impacts financing in this sample. When we include Croatia and Germany in the analysis, the t-value for the slope is very high (≈ 5.81), $p < 0.001$, so we reject H_0. The evidence is even stronger than for all three countries.

When considering Croatia, Germany, and Slovakia together, there is a clear, statistically significant positive relationship ($R = 0.611$, $p < 0.001$). This means that countries with lower levels of perceived corruption generally have better access to entrepreneurial finance. However, the strength of this relationship depends significantly on the difference in the institutional environment between the countries. When comparing only Croatia and Slovakia (two with similar institutional levels), the relationship is weak and not statistically significant. However, when Croatia is compared with Germany (with a larger difference in the CPI), the relationship becomes firm ($R = 0.808$, $p < 0.001$).

Other factors not included in the study may explain part of the remaining variation, which is a limitation of the study.

5. Conclusion

The research shows a strong and negative correlation between the level of corruption and access to entrepreneurial finance. Countries with lower levels of corruption, such as Germany, experience significantly more favorable conditions for financing entrepreneurial projects, while in Croatia (and its similar country, Slovakia), corruption and perceptions of non-transparency significantly limit the availability of capital and investor confidence. Overall, the research confirms that reducing corruption is a key prerequisite for improving access to entrepreneurial finance and stimulating economic growth in Croatia. Limitations of the research refer to the simplicity of the model and the scope of the dataset.

Therefore, institutional reforms (reducing corruption) in Croatia are not only ethically important, but also have direct economic effects on the financial capabilities of the private sector. Reducing corruption in Croatia can significantly improve access to financing for entrepreneurship, especially if Croatia continues to develop towards the German level of institutionality. The research conducted, therefore, has additional pragmatic importance for the Croatian executive branch, which must include the above findings in the implementation of economic policy to achieve the set economic goals more easily.

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A scientific paper

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EFFECTUATION IN MODERN ENTREPRENEURSHIP: A REVIEW OF THEORETICAL AND EMPIRICAL EVIDENCE

ABSTRACT

Effectuation has emerged as a prominent theoretical framework for understanding entrepreneurial decision-making under conditions of uncertainty. Unlike traditional causation-based approaches, effectuation emphasizes the use of available means, experimentation, stakeholder engagement, and control over an unpredictable future. The purpose of this paper is to provide a comprehensive review of the key theoretical and empirical contributions to the effectuation literature and to examine its relationship with entrepreneurial behaviour and organizational outcomes. Drawing on a structured review of relevant studies, the paper synthesizes existing knowledge on the core principles of effectuation and discusses how effectual decision-making is associated with innovativeness, proactiveness, and adaptability within organizations. Particular attention is given to empirical findings linking effectuation to innovation-related and organizational performance outcomes, highlighting the context-dependent nature of these relationships. The review indicates that the effects of effectuation vary across organizational settings; however, these differences appear to be more systematic than previously assumed, particularly with respect to firm size and environmental conditions. The analysis further identifies several gaps in the existing literature. Specifically, prior research has predominantly focused on small firms and start-ups, while medium-sized and large organizations, as well as highly regulated sectors such as ICT, banking, and insurance, remain underexplored. In addition, the role of generational differences among employees has received limited attention, despite its potential relevance for understanding how effectuation is applied in contemporary organizations. By synthesizing current theoretical and empirical insights, this review contributes to a clearer understanding of the role of effectuation in modern entrepreneurship and outlines directions for future research aimed at extending the application of effectuation to diverse organizational and industrial contexts.

Key words: *Effectuation; Entrepreneurship; Entrepreneurial Behaviour; Innovation; Organizational Performance.*

1. Introduction

The contemporary business environment is characterized by a high level of uncertainty, accelerated technological change, global competition, and increasing complexity of markets and organizational processes. Under such conditions, traditional decision-making approaches based on forecasting future events, long-term planning, and clearly defined goals are increasingly proving to be insufficient. As emphasized by Sarasvathy (2001), decision-making logics that assume environmental stability and predictability lose their effectiveness in contexts

of high uncertainty, where future market conditions are difficult or impossible to forecast reliably.

Entrepreneurship is widely recognized in economic and management literature as one of the key drivers of economic growth, innovation, and competitiveness. Numerous studies confirm that entrepreneurial orientation contributes to organizational innovativeness, faster adaptation to market changes, and improved organizational performance (Covin & Slevin, 1989; Covin & Slevin, 1991; Wiklund & Shepherd, 2003). However, despite the extensive body of entrepreneurship research, the question of how entrepreneurs and managers make decisions under conditions of uncertainty remains relatively under conceptualized, particularly outside the context of small and newly established firms (Coudounaris, 2012; Reymen et al., 2015).

In this context, effectuation theory emerged as an alternative logic of entrepreneurial decision-making, introduced by Sarasvathy (2001). Unlike causation logic, which starts from predefined goals and focuses on selecting optimal means to achieve them, effectuation begins with available means-knowledge, skills, experience, and networks and allows goals to emerge and evolve over time. Sarasvathy (2001, 2008) emphasizes that effectuation does not seek to predict the future, but rather to actively shape it through action, experimentation, and collaboration with relevant stakeholders. Later empirical work provides more nuanced evidence, suggesting that the relevance of effectuation depends strongly on the decision-making context rather than on the logic itself. Wiltbank et al. (2006) argue that control-based logics, rather than predictive ones, enable entrepreneurs and organizations to manage uncertain environments more effectively. Dew et al. (2009) demonstrate that more experienced entrepreneurs tend to prefer effectual principles, such as affordable loss and flexibility, whereas less experienced decision-makers rely more heavily on causal planning. Read et al. (2009) further emphasize that effectuation fosters experimentation and learning, which is particularly important in the early stages of entrepreneurial ventures, as well as in dynamic industries.

In this context, it becomes evident that effectuation may have a positive impact on organizational innovativeness and adaptability (Berends et al., 2014; Baker et al., 2016), as well as on organizational performance (Smolka et al., 2018; Yu et al., 2018). However, the findings are not unequivocal. Reymen et al. (2015) and Smolka et al. (2018) caution that the effects of effectuation are highly context-dependent, influenced by factors such as industry characteristics, organizational size, and the stage of organizational development. The majority of existing studies focus on small and medium-sized enterprises, start-ups, and technology-oriented organizations, while medium-sized and large organizations—particularly in highly regulated sectors such as banking and insurance—remain significantly underrepresented in the literature. An important yet insufficiently explored aspect concerns the role of entrepreneurial behaviour as a mechanism through which effectuation may influence organizational performance. Entrepreneurial behaviour, encompassing innovativeness, proactiveness, and risk-taking propensity (Miller, 1983; Covin & Slevin, 1991) is frequently identified as a key determinant of organizational success in uncertain environments. Nevertheless, relatively few studies systematically examine entrepreneurial behaviour as a mediating variable in the relationship between effectuation and organizational performance, especially in mature organizations.

Furthermore, an increasing number of authors emphasize the importance of generational differences among employees in contemporary organizations (Bartz et al., 2017; DeIuliis & Saylor, 2021). Generations X, Y, and Z differ in values, knowledge, skills, and attitudes toward innovation, which may significantly influence how effectuation is applied and how

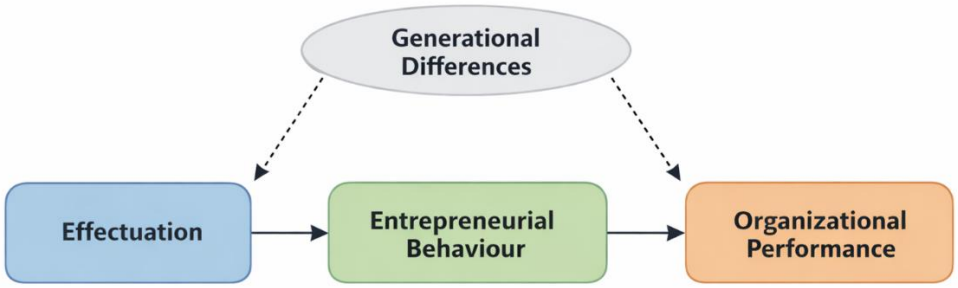
entrepreneurial behaviour is expressed within organizations. Despite this, generational affiliation has received only marginal attention as a contextual factor in effectuation research, representing an important research gap.

Based on the above, the aim of this paper is to provide a review of theoretical and empirical insights into effectuation as a contemporary logic of entrepreneurial decision-making and to conceptually integrate existing research on its relationship with entrepreneurial behaviour and organizational performance. Particular emphasis is placed on identifying research gaps in the context of medium-sized and large organizations, as well as in the ICT, banking, and insurance sectors, and on the potential role of generational differences among employees in explaining these relationships. Building on the reviewed literature, this paper adopts a more integrative perspective by outlining a conceptual framework in which effectuation is linked to organizational performance through entrepreneurial behaviour as a central mechanism.

2. Conceptual Model and Methodology

While prior research has examined the relationships between effectuation, entrepreneurial behaviour, and organizational performance, these links have often been explored in isolation. To provide a more structured understanding, this paper proposes a conceptual framework that integrates these constructs into a coherent model. The model assumes that the effectuation is expected to influence entrepreneurial behaviour by encouraging experimentation, flexibility, and proactive engagement with opportunities under uncertainty. Entrepreneurial behaviour, in turn, represents a key mechanism through which organizations translate decision-making logics into performance outcomes. Furthermore, generational differences may shape how individuals interpret and apply effectual principles, thereby influencing both entrepreneurial behaviour and its outcomes.

Figure 1: Conceptual model of effectuation, entrepreneurial behaviour and organizational performance



Source: Author

Figure 1 illustrates the proposed conceptual model. Effectuation is positioned as an antecedent of entrepreneurial behaviour, which in turn influences organizational performance. Entrepreneurial behaviour is therefore conceptualized as a mediating mechanism through which effectuation translates into organizational outcomes. In addition, generational differences are introduced as a moderating factor that may influence both the effectuation- behaviour and behaviour-performance relationships.

This study employs a structured literature review as its methodological approach. A structured review occupies a middle ground between a fully systematic review and a narrative overview: it applies explicit, documented procedures for identifying and selecting sources, while allowing for interpretive synthesis of the findings. This approach is appropriate given the aims of the paper, which are to map an established and theoretically rich body of knowledge, identify key themes and relationships, and develop an integrative conceptual framework rather than to quantitatively aggregate effect sizes across studies.

The literature search was conducted in two major academic databases: Web of Science (WoS) and Scopus. Both databases were searched independently to maximize coverage and minimize the risk of missing relevant contributions. The searches were restricted to peer-reviewed journal articles written in English and published between January 2000 and December 2024. The lower boundary of 2000 was chosen because it corresponds to the publication of Sarasvathy's (2001) foundational article, which formally introduced effectuation theory and marked the beginning of the cumulative research tradition examined in this review. The search strings were constructed using combinations of the following terms applied to titles, abstracts, and keywords: "effectuation", "entrepreneurial behaviour", "entrepreneurial orientation", "innovation", and "organizational performance". The initial search yielded a broad set of studies, which were subsequently screened based on relevance to the research topic. Final selection the studies was dependent upon the following criteria. Inclusion criteria required that each article: (1) provided substantive theoretical or empirical insights into effectuation or related decision-making logics; (2) addressed at least one of the core constructs examined in this review, namely effectuation, entrepreneurial behaviour, or organizational performance; and (3) offered sufficient methodological or conceptual detail to allow meaningful interpretation and synthesis. Articles were excluded if they referenced effectuation only in passing, lacked sufficient analytical depth, or addressed constructs that were peripheral to the scope of this review. Finally, each article was read and coded according to its primary research focus (theoretical contribution, empirical study, or review), the core constructs addressed (effectuation, entrepreneurial behaviour, organizational performance, generational diversity), the organizational context examined (start-ups, SMEs, large firms, regulated industries), and the key findings reported. The synthesis was organized around the four thematic areas that structure the subsequent sections of this paper: (1) the conceptual foundations of effectuation; (2) the relationship between effectuation and entrepreneurial behaviour; (3) the relationship between effectuation and organizational performance; and (4) generational differences as a contextual factor. The final sample consisted of approximately 43 articles, which were included in the analysis.

3. Effectuation as A Decision-Making Logic: Theoretical Overview

3.1. Concept and Emergence of Effectuation

Effectuation represents a logic of entrepreneurial decision-making that has emerged as a response to the limitations of traditional, prediction-oriented approaches in environments characterized by high uncertainty. The concept was introduced by Sarasvathy (2001), who argued that entrepreneurial action cannot be adequately explained by linear models that assume stable goals and predictable market conditions. Instead, effectuation is based on the idea that entrepreneurs act in situations where the future cannot be reliably forecasted and therefore focus on controlling what they can influence rather than predicting outcomes (Sarasvathy, 2001; Sarasvathy, 2008). In contrast to causation logic, which begins with predefined objectives and

seeks optimal means to achieve them, effectuation starts from available means and allows goals to emerge over time through interaction with the environment. This approach reflects the realities of entrepreneurial practice, particularly in early-stage ventures and dynamic industries, where uncertainty is pervasive and information is incomplete (Wiltbank et al., 2006; Dew et al., 2009). The emergence of effectuation marked an important shift in entrepreneurship research, as it challenged dominant assumptions about rational planning and highlighted the role of action, learning, and adaptability in entrepreneurial processes. Over time, effectuation has evolved from a theory describing expert entrepreneurial behaviour into a broader framework applicable to various organizational contexts (Read et al., 2009; Perry et al., 2012).

Recent research has also advanced measurement of effectuation by conceptualizing it as a set of decision-making heuristics rather than a static behavioural orientation. For instance, Koller et al. (2025) develop a situational judgment test that captures the context-dependent use of effectual principles, thereby providing a more nuanced understanding of how effectuation operates in practice

3.2. Principles of Effectual Decision-Making

The effectuation framework is commonly described through a set of interrelated principles that guide decision-making under uncertainty. One of the central principles is the bird-in-hand principle, which emphasizes starting with existing means such as knowledge, skills, experience, and social networks rather than pursuing predefined goals (Sarasvathy, 2001). This principle encourages entrepreneurs to focus on what they already possess and to build opportunities incrementally. Another key principle is affordable loss, which shifts attention away from expected returns toward the maximum level of resources that decision-makers are willing to risk. By limiting potential losses, entrepreneurs reduce the perceived risks associated with experimentation and increase their willingness to act in uncertain situations (Sarasvathy, 2001; Read et al., 2009). The crazy quilt principle highlights the importance of stakeholder engagement and partnerships in the entrepreneurial process. Through collaboration with self-selected stakeholders, entrepreneurs co-create opportunities and reduce uncertainty by sharing commitments and resources (Sarasvathy, 2008; Chandler et al., 2011). This relational dimension of effectuation underscores the social embeddedness of entrepreneurial decision-making. Finally, effectuation emphasizes leveraging contingencies and surprises as potential sources of opportunity rather than viewing them solely as threats. Unexpected events are seen as inputs for creative problem-solving, reinforcing the idea that the future can be shaped through action (pilot-in-the-plane principle) rather than predicted in advance (Sarasvathy, 2001; Sarasvathy, 2008).

3.3. Relationship Between Effectuation and Causation

Although effectuation and causation are often presented as opposing decision-making logics, recent research suggests that they are better understood as complementary rather than mutually exclusive. Entrepreneurs and managers frequently combine elements of both logics, adjusting their decision-making approaches to the specific characteristics of the environment (Read et al., 2009; Chandler et al., 2011). Causation-based logic tends to be more effective in stable and predictable contexts, where objectives can be clearly defined and outcomes reasonably forecasted. In contrast, effectuation is particularly valuable in uncertain and ambiguous situations, where flexibility, experimentation, and learning are essential (Perry et al., 2012).

Empirical studies indicate that successful entrepreneurial processes often involve a dynamic interplay between effectual and causal logics over time, rather than reliance on a single approach (Chandler et al., 2011). This perspective has important implications for organizational decision-making, as it suggests that firms can benefit from developing the capability to switch between or integrate different logics depending on contextual conditions.

3.4. Application of Effectuation Beyond Start-Ups

While early effectuation research primarily focused on individual entrepreneurs and start-up firms, subsequent studies have extended the analysis to broader organizational contexts. Research indicates that effectual decision-making can also be observed in medium-sized and large organizations, particularly in activities related to innovation, strategic renewal, and new business development (Perry et al., 2012; Berends et al., 2014). In established organizations, effectuation is often applied selectively, such as within specific projects, teams, or innovation units, rather than across the entire organization. This selective application allows firms to experiment with new ideas while maintaining overall strategic control through formal structures and planning processes (Chandler et al., 2011). The relevance of effectuation in highly regulated industries remains relatively underexplored. Nevertheless, increasing digitalization, technological change, and competitive pressures have introduced new forms of uncertainty even in traditionally stable sectors, creating conditions under which effectual principles may support organizational adaptability and innovation (Reymen et al., 2015).

Table 1: Overview of key effectuation studies

Author(s)	Year	Research context	Main findings
Sarasvathy	2001	Individual entrepreneurs	Foundations of effectuation theory
Wiltbank et al.	2006	Strategy under uncertainty	Control rather than prediction
Dew et al.	2009	Experienced entrepreneurs	Expertise and effectuation
Chandler et al.	2011	Empirical validation	Distinguishing causation and effectuation
Smolka et al.	2018	Organizations	Synergy between effectuation and causation

Source: Author

4. Effectuation and Entrepreneurial Behaviour

4.1. Entrepreneurial Behaviour in Organizational Contexts

Entrepreneurial behaviour represents a key concept in entrepreneurship and management research and is commonly associated with innovativeness, proactiveness, and a willingness to take risks. Early conceptualizations emphasized entrepreneurship as firm-level behaviour rather than solely individual action, highlighting its relevance for organizational competitiveness and growth (Miller, 1983). Research further developed this perspective by linking entrepreneurial behaviour to strategic orientation and organizational outcomes (Covin & Slevin, 1989; Covin & Slevin, 1991).

Within organizational contexts, entrepreneurial behaviour is increasingly viewed as a critical capability that enables firms to respond effectively to environmental uncertainty and change. Organizations that encourage entrepreneurial behaviour are more likely to engage in opportunity recognition, experimentation, and innovation, thereby enhancing their adaptability and long-term performance (Wiklund & Shepherd, 2003; Rauch et al., 2009).

4.2. Effectuation as A Determinant of Entrepreneurial Behaviour

Effectuation has been increasingly examined as an important antecedent of entrepreneurial behaviour, particularly in uncertain and dynamic environments. By emphasizing action, experimentation, and learning rather than detailed upfront planning, effectual decision-making encourages individuals and organizations to engage in entrepreneurial activities despite limited information and high ambiguity (Sarasvathy, 2001; Read et al., 2009).

A closer look at the evidence suggests that effectuation supports key dimensions of entrepreneurial behaviour, especially innovativeness and proactiveness. The principle of affordable loss reduces the perceived risks associated with experimentation, thereby lowering barriers to entrepreneurial action (Sarasvathy, 2001; Chandler et al., 2011). As a result, organizations applying effectual principles may be more willing to explore novel ideas and pursue emerging opportunities. This perspective indicates that effectuation does not merely support entrepreneurial behaviour in a general sense, but actively shapes its intensity and form, particularly in environments characterized by ambiguity and rapid change. More recent empirical studies further highlight the importance of individual-level moderators in the effectuation process. For example, Wang et al. (2025) show that personality traits such as openness and extraversion significantly strengthen the relationship between effectuation and entrepreneurial intention, suggesting that the impact of effectual logic depends on individual characteristics.

4.3. Stakeholder Engagement and Entrepreneurial Behaviour

A central element of effectuation is the emphasis on stakeholder engagement and collaboration. Through partnerships with self-selected stakeholders, organizations can access complementary resources, knowledge, and capabilities that support entrepreneurial behaviour (Sarasvathy, 2008; Chandler et al., 2011). This collaborative approach is particularly relevant in organizational settings, where entrepreneurial initiatives often require coordination across functional boundaries and cooperation with external partners. By involving stakeholders early in the decision-making process, organizations can co-create opportunities and reduce uncertainty, thereby strengthening their capacity for entrepreneurial action (Read et al., 2009).

4.4. Contextual Factors Shaping Entrepreneurial Behaviour

The relationship between effectuation and entrepreneurial behaviour is influenced by a range of contextual factors, including organizational structure, industry characteristics and environmental dynamics. Research indicates that entrepreneurial behaviour may manifest differently across organizational contexts, depending on the degree of formalization, resource availability, and competitive intensity (Rauch et al., 2009). In more formalized organizations, entrepreneurial behaviour is often concentrated within specific units or projects rather than distributed uniformly across the firm. In such cases, effectuation may coexist with causation-based approaches, allowing organizations to balance flexibility and control while fostering entrepreneurial initiatives (Chandler et al., 2011; Perry et al., 2012). Overall, the literature

suggests that effectuation provides a useful framework for understanding how entrepreneurial behaviour emerges and is sustained within organizations, particularly under conditions of uncertainty.

5. Effectuation and Organizational Performance

5.1. Organizational Performance as A Multidimensional Concept

Organizational performance represents a central concept in management and entrepreneurship research, yet it remains theoretically complex and multidimensional. Early studies emphasized the need to distinguish between different dimensions of performance, such as financial outcomes, growth, market position, and innovation-related indicators (Venkatraman & Ramanujam, 1986). This multidimensional perspective has been widely adopted in subsequent research, particularly in studies examining entrepreneurial and strategic phenomena.

In entrepreneurship research, organizational performance is often linked to the company´s ability to identify and exploit opportunities, adapt to environmental changes, and develop sustainable competitive advantages. Empirical studies suggest that entrepreneurial orientation and related behavioural patterns contribute not only to financial performance but also to non-financial outcomes, such as innovation capability and strategic renewal (Wiklund & Shepherd, 2003; Rauch et al., 2009). This broader understanding of performance is particularly relevant when examining effectuation, as effectual decision-making emphasizes experimentation, learning, and long-term opportunity creation rather than short-term optimization of outcomes.

5.2. Effectuation and Organizational Performance Outcomes

Over the past decade, research has increasingly focused on examining the relationship between effectuation and organizational performance, producing mixed but generally positive findings. Several studies report that effectuation is positively associated with innovation-related outcomes, flexibility, and adaptability, especially in environments characterized by high uncertainty (Read et al., 2009; Berends et al., 2014). However, the effects of effectuation on financial performance are less straightforward. Smolka et al. (2018) and Yu et al. (2018) argue that effectual decision-making may not lead to immediate financial benefits, as experimentation and iterative learning can initially reduce efficiency. Over time, however, these processes may contribute to superior performance by enabling firms to identify viable opportunities and adjust their strategies accordingly. These findings highlight the importance of considering time horizons and contextual factors when evaluating the performance implications of effectuation. Rather than producing uniform outcomes, effectuation appears to influence different dimensions of performance in different ways. Taken together, these findings suggest that effectuation should not be viewed as a universally superior decision-making logic, but rather as a context-sensitive approach whose effectiveness depends on environmental conditions, organizational characteristics, and the time horizon of performance evaluation.

5.3. Contextual Influences on the Effectuation–Performance Relationship

The relationship between effectuation and organizational performance is strongly influenced by contextual variables, including firm size, industry characteristics, and environmental uncertainty. Research indicates that effectuation is particularly beneficial for small and

medium-sized enterprises operating in dynamic and uncertain environments, where flexibility and rapid decision-making are critical (Reymen et al., 2015).

Nevertheless, recent studies suggest that effectuation can also contribute to performance in medium-sized and large organizations, particularly when applied within specific projects, innovation units, or strategic initiatives (Berends et al., 2014; Smolka et al., 2018). In such contexts, effectual decision-making often coexists with more formal planning processes, allowing organizations to balance exploration and exploitation. Industry context further shapes the effectiveness of effectuation. In highly regulated industries, formal rules and compliance requirements may constrain entrepreneurial action. However, increasing technological change and digitalization have introduced new forms of uncertainty even in traditionally stable sectors, creating opportunities for effectual approaches to support innovation and adaptation (Reymen et al., 2015).

5.4. Effectuation in Medium-Sized and Large Organizations

While early effectuation research focused primarily on start-ups and small firms, an increasing number of studies have extended the analysis to medium-sized and large organizations. These studies suggest that effectuation can play a meaningful role in organizational contexts characterized by complexity, multiple stakeholders, and structural constraints (Berends et al., 2014; Smolka et al., 2018).

In larger organizations, effectuation is often applied selectively, rather than as a dominant decision-making logic across the entire firm. For example, effectual principles may guide decision-making in innovation projects, new product development, or strategic renewal initiatives, while causation-based approaches continue to dominate routine operational activities (Chandler et al., 2011). This selective application allows organizations to benefit from the flexibility and adaptability of effectuation without undermining the stability provided by formal planning and control mechanisms. As such, effectuation and causation can be viewed as complementary logics that jointly contribute to organizational performance in complex and uncertain environments (Perry et al., 2012).

Table 2: Selected empirical studies

Author(s)	Variable	Main findings
Berends et al.	Innovation	Positive connections
Yu et al.	Performance	Indirect effect
Smolka et al.	Performance	Context-dependent
Reymen et al.	Strategic decisions	Dynamic application

Source: Author

Notably, most studies report indirect or context-dependent effects, indicating that simple linear relationships between effectuation and performance are unlikely. Overall, the evidence suggests that effectuation contributes more consistently to innovation-related and adaptive outcomes than to short-term financial performance, indicating that its primary value may lie in enabling long-term strategic flexibility rather than immediate efficiency gains.

6. Generational differences and effectuation

6.1. Generational Diversity in Contemporary Organizations

Contemporary organizations are increasingly characterized by generational diversity, as multiple generations coexist within the same workplace. Most commonly, these include Generation X, Generation Y (Millennials), and Generation Z, each shaped by different socio-economic conditions, technological developments, and career experiences. Previous studies indicate that generational affiliation influences values, work attitudes, communication styles, and approaches to learning and innovation (Bencsik et al., 2016; Hershatter & Epstein, 2010). In organizational contexts, generational diversity represents both a challenge and an opportunity. Differences in expectations, technological competencies, and attitudes toward change may create tensions, but they can also enhance creativity and problem-solving when effectively managed. Understanding generational characteristics is therefore important for explaining variations in entrepreneurial behaviour and decision-making within organizations (Bartz et al., 2017).

6.2. Generational Differences and Entrepreneurial Behaviour

A closer look at the evidence suggests that entrepreneurial behaviour may vary across generations due to differences in experience, risk perception, and familiarity with technology. Younger generations are often described as more open to experimentation, digital technologies, and flexible work arrangements, whereas older generations tend to rely more heavily on accumulated experience, established routines, and structured decision-making processes (Hershatter & Epstein, 2010; Bencsik et al., 2016). These differences can influence how entrepreneurial behaviour is expressed within organizations. For example, younger employees may demonstrate higher levels of proactiveness and innovativeness, while older employees may contribute through strategic judgment and risk management. Entrepreneurial orientation research suggests that combining these complementary strengths may enhance organizational outcomes in uncertain environments (Rauch et al., 2009).

6.3. Generational Perspectives on Effectual Decision-Making

Despite the growing interest in effectuation, relatively little research has explicitly examined generational differences in the application of effectual decision-making. Nevertheless, existing studies imply that generational characteristics may shape how individuals interpret and enact effectual principles. Differences in professional experience, cognitive styles, and access to networks may influence how decision-makers rely on available means, affordable loss, and stakeholder engagement (Sarasvathy, 2001; Perry et al., 2012). Younger generations, for instance, may leverage digital networks and technological skills as key means for opportunity creation, while older generations may draw more strongly on accumulated industry knowledge and established professional relationships. These differences suggest that effectuation should be understood as a flexible and context-sensitive decision-making logic rather than a uniform behavioural pattern.

6.4. Implications of Generational Diversity for Effectuation Research

The limited attention given to generational differences represents a notable gap in the effectuation literature. Incorporating a generational perspective may enhance understanding of how effectuation operates within organizations characterized by diverse workforces and

complex social dynamics (Bartz et al., 2017; DeIuliis & Saylor, 2021). From a theoretical perspective, examining generational differences may help clarify boundary conditions of effectuation and explain variation in its outcomes across organizational contexts. From a practical standpoint, insights into generational diversity can inform the design of organizational practices that support entrepreneurial behaviour and innovation by aligning decision-making approaches with the characteristics of different generational groups.

Overall, integrating generational perspectives into effectuation research offers a promising direction for future studies and contributes to a more nuanced understanding of entrepreneurial decision-making in contemporary organizations. In this sense, generational differences may be understood not only as a demographic characteristic, but as an important boundary condition that influences how effectual logic is interpreted and enacted within organizations.

7. Findings, Implications for Future Research and Conclusions

Although the literature on effectuation has expanded significantly, it remains characterized by a relatively fragmented structure. Many studies focus on specific principles or contexts without systematically connecting effectuation to broader organizational mechanisms. As a result, the cumulative development of the field is somewhat limited, and the relationships between key constructs are often implicitly assumed rather than explicitly modelled. The purpose of this paper was to provide a structured review of theoretical and empirical research on effectuation as a contemporary logic of entrepreneurial decision-making and to examine its relationship with entrepreneurial behaviour and organizational performance.

7.1. Reaffirming Effectuation's Role and Context-Dependency

Consistent with prior research, our structured review confirms that effectuation offers a viable alternative to predictive decision-making, particularly in contexts characterized by high uncertainty and limited information. The core principles of effectuation—emphasizing available means (bird-in-hand), managing downside risk (affordable loss), fostering collaborations (crazy-quilt), and leveraging contingencies (lemonade and pilot-in-the-plane)—collectively support experimentation, learning, and adaptive action (Sarasvathy, 2001; Read et al., 2009; Perry et al., 2012). These characteristics align closely with entrepreneurial behaviour, which is increasingly recognized as a critical driver of innovation and competitiveness in contemporary organizations (Miller, 1983; Covin & Slevin, 1991; Rauch et al., 2009).

However, our synthesis of empirical findings underscores the complex and context-dependent nature of the relationship between effectuation and organizational performance. While effectuation is frequently associated with positive innovation-related outcomes and enhanced organizational adaptability, its direct effects on short-term financial performance are not always immediate or uniform (Berends et al., 2014; Smolka et al., 2018; Yu et al., 2018). This highlights the necessity of considering diverse performance dimensions and longer time horizons when evaluating the impact of effectual decision-making. Effectuation's primary value appears to lie in fostering long-term strategic flexibility and resilience rather than immediate efficiency gains.

7.2. Advancing a Conceptual Framework for Integrated Understanding

A key contribution of this paper lies in moving beyond a purely descriptive account of existing studies by proposing a structured conceptual model (Figure 1). This framework explicitly integrates effectuation, entrepreneurial behavior, and organizational performance, positioning entrepreneurial behavior as a mediating mechanism and generational differences as a crucial contextual factor. This integrated perspective offers a more nuanced understanding of how effectuation translates into organizational outcomes and provides a robust basis for future empirical testing.

7.3. Expanding the Scope of Effectuation Research: Beyond Start-ups and into Regulated Industries

Our review highlights the increasing recognition that effectuation's applicability extends beyond start-ups and small firms to encompass medium-sized and large organizations. In these larger, more complex entities, effectuation is often applied selectively within specific innovation projects, strategic renewal initiatives, or highly uncertain decision-making situations (Chandler et al., 2011; Perry et al., 2012). This selective application enables organizations to strategically balance flexibility and control by combining effectual and causation-based logics, thereby fostering innovation while maintaining stability.

7.4. The Untapped Potential of Generational Differences

A critical gap identified in the existing literature is the limited attention given to generational differences in effectuation research. As contemporary organizations increasingly comprise multiple generations with differing values, skills, and approaches to uncertainty, incorporating a generational perspective may enhance understanding of how effectuation is interpreted and enacted in practice (Bencsik et al., 2016; Bartz et al., 2017). Examining generational differences may also help explain variation in entrepreneurial behaviour and performance outcomes across organizational contexts.

Overall, this paper contributes to the entrepreneurship literature by integrating theoretical and empirical insights on effectuation and by identifying key contextual factors that shape its application and outcomes. Future research would benefit from more systematic empirical studies examining effectuation in mature organizations, regulated industries, and generationally diverse workforces. Such research endeavors, guided by the conceptual framework proposed herein, will further advance the understanding of entrepreneurial decision-making in modern, uncertain business environments. By explicitly considering the interplay of effectuation, entrepreneurial behavior, organizational performance, and generational differences, scholars can develop more robust theories and practical guidelines for fostering entrepreneurship across a wider range of organizational and industrial contexts.

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PERCEPTIONS, PREFERENCES, AND TRAVEL INTENTIONS OF FOREIGN TOURISTS TOWARD COSMETIC SURGERY SERVICES IN KVARNER

ABSTRACT

The aim of this paper is to determine perception, preferences and travel intentions of foreign tourists for cosmetic surgery in the Kvarner region, an emerging destination for medical tourism. Empirical research was conducted in 2025 on a sample of 361 respondents with prior experience or interest in using cosmetic surgery services abroad. A structured questionnaire was used to assess social influence, perceived behavioural control, perceived risks, medical service quality and destination attributes, and behavioural intentions. Findings indicate that tourists perceive Kvarner's cosmetic surgery services as high-quality, trustworthy, cost-effective, and low risk when compared with the treatments in their home countries. They expressed strong confidence in being able to organize their travel arrangements, communication with cosmetic surgery service providers, and managing their post-procedural recovery process. They are strongly interested in traveling abroad, and to Kvarner in particular, in the next three years to use cosmetic surgery services, as well as to revisit the destination due to them. Beyond medical treatments, the variety of cosmetic services, and the relaxing experience of treatment further reinforce their revisit intentions. Social influence from family and peers have proven to be moderate, which indicates that tourist´s decisions are largely self-driven. This study contributes to the literature of medical tourism by providing destination-specific insights into the foreign tourist's decision-making processes. Practical implications are offered for healthcare providers, destination managers, and policymakers who are interested in improving competitiveness of Kvarner as a medical tourist destination through development of integrated medical tourism offer, quality assurance of cosmetic surgery services, and building a sense of trust.

Key words: *Theory of planned behaviour, medical tourism, cosmetic surgery, Kvarner.*

1. Introduction

The increase in international mobility of patients as well as medical professionals, accompanied by significant capital investments, the exchange of medical technologies and well-established regulatory frameworks among world countries contributed to the formation of new patterns of provision and use of health services. Patients are traveling more internationally to use some form of medical services, whether we discuss dental work, infertility treatment, cosmetic surgery, etc. This resulted in development of medical tourism as a specific form of tourism (Lunt et al., 2011), which significantly changed the healthcare scene of countries that decide to focus on developing it through provision of high-quality medical services by top skilled medical professionals at the lower prices. This enables destinations to profile themselves as more attractive and competitive on the medical tourism market (Alkier et al., 2021, 479; Lubowiecki-Vikuk and Dryglas, 2019a; 2019b).

Cosmetic surgery belongs among the most developed segments of medical tourism, considering that a significant number of patients decide to travel abroad to use higher quality and often much cheaper procedures compared to those in the country where they live. According to ISAPS (2025, 9-41) a total of 17,415,678 procedures were performed worldwide in 2024, top five being eyelid surgery (2,115,360 procedures, +72,60% in relation to 2020), Liposuction (2,087,189 procedures, +36,8% in relation to 2020), Breast Augmentation (1,658,615 procedures, +2,1% in relation to 2020), Scar Revision (1,156,446 procedures, n.d. for comparison) and Rhinoplasty (1,083,631 procedures, +27,1% in relation to 2020). According to gender, five top surgical procedures for women were Liposuction (1,792,323 procedures), Eyelid Surgery (1,625,597 procedures), Breast Augmentation (1,611,758 procedures), Abdominoplasty (945,636 procedures) and Scar Revision (836,458 procedures), while men were interested in Eyelid Surgery (489,763 procedures), Gynecomastia (383,656 procedures), Scar Revision (319,987 procedures), Liposuction (294,866 procedures), and Rhinoplasty (287,398 procedures). Previously presented indicators showed growth of interest for surgical beauty treatments. Changes in beauty standards, accompanied by cultural values and rapid development of medical technology indicate cosmetic surgery becoming even greater global phenomenon than ever before (Statista, 2025). In the Republic of Croatia aesthetic medicine and plastic surgery services represent an important element of its medical tourism offer, which is why its service providers are actively investing in quality of its services, introduction of new medical technologies, and education of its medical personnel. All the improvements are actively promoted online through official websites and social media (Ordinacija.hr, 2025; Alkier Tomić et al., 2025). Kvarner region, as a Croatian destination with the longest tradition of health tourism development, has been developing its medical tourist offer in the last few decades, with special attention paid to cosmetic surgery and aesthetics. However, research studies focused on Croatia, and Kvarner region as a destination of beauty and health are practically non-existent. The aim of this study is to determine the perception, preferences and travel intentions of foreign tourists for cosmetic surgery in the Kvarner region. Its findings provide a significant contribution to both theory and practice. The paper is structured in the following order: after the introduction, authors will present the theoretical background, methodology, empirical findings, discussion and conclusion.

2. Theoretical Background

Medical tourism has gained on importance over the years and is recording significant progress and development (Samir and Karim, 2011; Connel, 2006; Connell, 2013; Siddoo et al., 2024;

Jalali et al., 2025; Mo et al., 2025). This is supported by the findings of Fortune Business Insights according to which in 2025 the size of medical tourism market was estimated at 38.2 billion USD, and it is forecasted that it will reach 250.02 billion USD by 2034, respectively a CAGR of 23.31% in the observed period. European region took a dominant position on the medical tourism market in 2025 by participating with 36.51% in the total market share (Fortune Business Insights, 2026). The size of the cosmetic medical tourism market was globally estimated at 7.23 billion USD in 2025, and it is forecasted that it will reach 48.74 billion USD by the year 2034, respectively a CAGR of 23.71% in the observed period. European region dominated in this segment as well in 2025 by participating 58.83% in the total market share. Cosmetic medical tourism market trends indicate an increase of medical tourists who are aware of the present beauty standards, they are well informed about the advantages of aesthetic procedures and have rising disposable income that they are willing to spend on this type of services. Increasing interest for plastic surgery interventions contributes significantly to the growth of the overall cosmetic medical tourism market. The cosmetic procedures can be invasive (liposuction, rhinoplasty, eyelid surgery) or non-invasive (such as Botox injections, dermal fillers, etc.). The growing interest in such treatments contributes to the increase of the number of patients and strengthening the cosmetic surgery market. Data from the International Society for Aesthetic Plastic Surgery published in June 2024 show that in 2023, approximately 2.2 million liposuction and 1.1 million rhinoplasty procedures were performed. Significance and the developmental potential of this type of offer was recognized by government authorities of many world countries who choose to organize marketing campaigns, to form better market opportunities for cosmetic service providers, as well as for potential patients. Well prepared and conducted campaigns in a form of educative events, social media campaigns, and use of informative resources can increase the awareness about all the effects, benefits and safety of cosmetic procedures among consumers, based on which potential patients will be able to make an informed and positive decision about having a procedure. The positive effects are twofold: a) there will be an increase of medical procedures which will have a positive effect on the revenue of service providers; and b) patient´s needs will be satisfied (Fortune Business Insights, 2026). Tourist destinations should plan future development and improvement of their cosmetic medical tourism offer in accordance with the preferences of tourists/patients, which is possible to determine by conducting empirical research studies. Studies on medical cosmetic surgery tourism focus significantly on determining their motives (Lestari, 2025; Robertson et al., 2021) as well as perceived quality and satisfaction with medical services (Majeed et al., 2020; Park et al., 2021; Ramos & Cuamea, 2019; Campbell et al., 2020).

However, throughout the years Theory of planned behaviour developed by Ajzen (1991) has been significantly implemented in research studies focused on determining interrelations of how constructs *subjective norms* (Roll Bennet, 2022; Boguszewicz-Kreft et al., 2020; Seow et al., 2017), *perceived behavioural control* (Liang et al., 2019; Martin et al. (2011), and *attitudes* (Liang et al., 2019; Park et al., 2021) influence behavioural intention. *Perceived benefits* (Liang et al., 2019; Chaulagain et al., 2021) and *perceived risks* (Boguszewicz-Kreft et al., 2022; Liang et al., 2019; Nam, 2020) were added later in the study of Seow et al. (2017) with the aim of determining its influence on behavioural intentions of medical tourists (Liang et al., 2019; Boguszewicz-Kreft et al., 2020), considering they have exceptional importance in the decision-making process about choosing and visiting a destination (Ajzen, 1991; Bui, 2024).

Subjective norms reflect individuals' views on how important the opinions and attitudes of other people in their social environment are to them about how they should behave (Zhuang et

al., 2021; Bilgihan et al., 2015; Ajzen, 1991). In the context of medical cosmetic tourism, they imply whether tourists who choose to undergo cosmetic surgery procedures base their decisions on whether or not their friends and relatives expect them to do so (meaning their approval and/or encouragement, or possibly quite the opposite, disapproval), and what their expectations are regarding the reaction of these people after they learn that the individual has undergone cosmetic procedures. Studies show that subjective norms can contribute towards formation of a significant social pressure that can significantly influence making a positive or negative decision to travel and undergo cosmetic procedures (Ajzen, 1991; Dash, 2021; Nguyen et al., 2020; Boguszewicz-Kreft et al., 2020; Roll Bennet, 2022). Empirical studies of Liang et al. (2019), Dash (2021), and Seow et al., 2017) confirm a positive influence of subjective norms on medical tourist´s decision-making process for visiting a destination and using medical cosmetics services. From the above, it is visible that subjective norms explain the influence of social pressure and expectations of other, relevant persons for the individual. However, in addition to social expectations, the perception of one's own control over behavior also also has a significant role in forming intentions (Ajzen, 1991).

Perceived behavioural control indicates how capable a tourist feels to organize their journey abroad, with the aim of experiencing high-quality medical services, and to what extent the outcome of the entire journey will be successful. The high score of this construct indicates that a tourist who makes a decision to go on a journey motivated by cosmetic surgery procedures feels confident and capable enough to successfully organize and implement the entire travel process (communication and agreement with the medical institution regarding the arrival and use of cosmetic procedures, transportation to the medical institution and back home, receiving a cosmetic procedure), and that they can have an influence on a positive medical outcome through successful communication with medical staff, following the instructions received in the post-period, and a safe return home. The above can positively influence making a positive decision to go abroad for a cosmetic procedure (Liang et al., 2019; Boguszewicz-Kreft et al., 2022; Seow et al., 2017). Following, it is necessary to observe individual evaluation of this type of behaviour, which within Theory of Planned Behaviour is defined through formed attitudes (Ajzen, 1991).

Attitudes in tourism include feelings and beliefs which have a significant impact on behavioural intentions of tourists (Almeida García et al., 2015). The attitudes formed about cosmetic surgery influence whether potential patients will travel motivated by this type of service, and if yes, how will they evaluate their overall experience during their stay in a medical facility and in a destination. During their stay and after using cosmetic surgery services, patients will evaluate their experience in the context of whether it is worth using them, whether they achieved value for money, if the service used improved their appearance and quality of life, to what extent were they satisfied with the overall experience, etc., which significantly affects the formation of a patient's sense of satisfaction and trust in the provider of cosmetic surgery services, and the formation of a positive attitude towards the destination itself (Majeed et al., 2020; Park et al., 2021). Park et al. (2021) analysed relevance of hospitals as providers of cosmetic surgery services and facilitating agents in development of cosmetic surgery medical tourism. The findings indicate quality of cosmetic surgery services (tangibles, sense of safety, empathy) having a positive influence on patients' attitudes towards medical tourism, which reflects their sense of satisfaction with medical tourism offer. It has also been proven that quality of service provided by the facilitator has a moderating effect of hospitals' service quality dimensions on service satisfaction. Findings of Majeed et al. show that perceived quality of cosmetic surgery services positively influences tourists' intentions in the form of formation of emotional attachment, sense of trust and visit intention both directly

and through mediating role of joint co-creation (Majeed et al., 2020). Considering that within Theory of Planned Behaviour attitudes are formed based on the assessment of expected behavioural outcomes, following authors will discuss perceived benefits.

Through *Perceived benefits* tourists can evaluate what they have received during their stay in a destination in a form of services and experiences in relation to what they spent (money, free time) (Petrick, 2002, 119). Study of Chen and Chen (2010) indicates possibility of perceived value being a better predictor of repurchase intention in relation to quality and satisfaction (Cronin, 2000; Oh, 2000) which is why measuring it is extremely important due to enabling service users to compare the value among services and at the same time it helps tourist service providers to determine their strong and weak points according to the dimensions of value (Petrick, 2002, 120). When it comes to cosmetic procedures or aesthetic surgery, patients consider the perceived quality of the medical service received (e.g., the competence and expertise of the medical staff) and whether the experience met their expectations as part of the benefits achieved. Empirical studies (Majeed et al., 2020; Menvielle et al., 2011) have shown that the higher patients perceive the quality of the medical service, the more likely they will make a positive decision to visit an aesthetic tourism destination (directly or indirectly through shared co-creation of value.

Perceived risk is of exceptional relevance in cosmetic surgery tourism since it can be a deciding factor based on which potential patients decide whether to travel and visit a particular cosmetic surgery facility and use their services. Risk perception needs to be monitored regularly and closely because findings like these can help service providers, and destination stakeholders to take appropriate actions. In her study Nam (2020, 138-142) determined that infleunce of risk perception influences medical tourist´s decision-making process. Patients in this case were most concerned about not experiencing all the advantages of cosmetic surgery like high-quality medical services, saving costs, and surgical outcomes they wished. Concern was expressed for potential lack of experience of medical staff, which might have negative influence on outcome and level of satisfaction. These findings indicate that the higher the medical risk perception, the greater the concern and reduction of confidence in traveling for cosmetic services. Based on the findings Nam also proved the importance of segmentation of tourist´s profiles on how they perceive risks ("Risk Sensitive," "Risk Neutral" and "Risk Concerned"). Findings like these represent crucial information based on which it is mandatory to plan appropriate communication and support provision, since different groups of medical tourists need different approach and provision of information, based on their level of concern. Additionally, medical tourists expressed concern regarding the potential complications in the post-procedure period (pain, infections, etc.) and how this might influence their holiday. No concern was expressed for the period after returning home. Liang et al. (2019) determined that perceived risk had a negative influence on the attitude, perceived behavioural control and subjective norms of medical tourists. Boguszewicz-Kreft et al. (2022) determined a strong negative impact of perceived risk on attitude of medical tourists, respectively, if they perceive the risk as greater, they will have a less favourable attitude about medical tourism services. The findings presented within this chapter explain the relevance of observing influence of subjective norms, perceived behavioural control, and attitudes, perceived benefits and perceived risks on behavioural intention of tourists traveling for cosmetic surgery procedures. Findings like these can be of significant use for both cosmetic surgery providers and destination stakeholders and provide insight for further improvements. So far a limited number of research studies were focused on cosmetic surgery tourism which justifies this study. Based on the theoretical framework, two hypotheses were developed. It was hypothesized that tourists perceive Kvarner's cosmetic

surgery services as high-quality, trustworthy, cost-effective, and low risk (H1). To examine the predictors of tourists' intention to reuse cosmetic surgery services in Kvarner, it was hypothesized that subjective norms, perceived behavioral control, attitudes together with perceived benefits and risks predicted revisit intention (H2).

3. Methodology

3.1. Data Source and Sample

A structured questionnaire was used for data collection for the purpose of this study. Its first part addressed intentions of tourists who used cosmetic surgery services in the last five years and was developed based on the study of Martin et al. (2011) which was extended by Liang et al. (2019). The second section assessed travellers' revisit intentions based on the framework developed by Alkier et al. (2019). The final section collected respondents' socioeconomic characteristics. The data was collected in 2025. Authors implemented convenience sampling method since questionnaire was distributed both online through Google docs form, and physically in the cosmetic surgery clinics. In total a 361 correctly filled questionnaire by foreign tourists was collected and used for the statistical analysis. Following the sociodemographic characteristics of the respondents are presented.

Table 1: Sample characteristics

Variable	Category	Frequency	%
Gender	Female	240	66.5
	Male	120	33.2
	Prefer not to say	1	0.3
	Total	**361**	**100.0**
Age	18–24	3	0.8
	25–34	34	9.4
	35–44	178	49.3
	45–64	141	39.1
	65+	5	1.4
	Total	**361**	**100.0**
Education level	Graduate and above	301	83.4
	Undergraduate	59	16.3
	Technical secondary school	1	0.3
	Total	**361**	**100.0**
Country of origin	Germany	106	29.4
	Italy	90	24.9
	Slovenia	75	20.8
	Austria	61	16.9
	Serbia	21	5.8
	Bosnia and Herzegovina	6	1.7
	North Macedonia	1	0.3
	Spain	1	0.3
	Total	**361**	**100.0**
Marital status	Married	186	51.5
	Unmarried / single	105	29.1
	Separated / divorced	70	19.4
	Total	**361**	**100.0**
Travel companionship	With partner	160	44.3
	Friends/acquaintances	99	27.4
	Alone	53	14.7

Variable	Category	Frequency	%
	Family members	49	13.6
	Total	**361**	**100.0**
Employment status	Employee	195	54.0
	Self-employed	161	44.6
	Retired	3	0.8
	Student	2	0.6
	Total	**361**	**100.0**
Monthly income (€)	2,501–3,000	158	43.8
	2,001–2,500	125	34.6
	3,001–3,500	41	11.4
	1,501–2,000	20	5.5
	3,501+	14	3.9
	1,001–1,500	2	0.6
	501–1,000	1	0.3
	Total	**361**	**100.0**

Source: Authors

The study was conducted on a sample of 361 foreign tourists with prior experience or interest in undergoing cosmetic surgery abroad. The sample is predominantly female (66.5%), highly educated (83.4% holding graduate or postgraduate degrees), and largely concentrated in the 35–64 age group (88.4%). Respondents originate mainly from nearby European markets, particularly Germany (29.4%), Italy (24.9%), Slovenia (20.8%), and Austria (16.9%). Over half are married (51.5%), and most travel with a partner (44.3%) or friends (27.4%). The sample is economically active and financially capable, with 54.0% employed and 44.6% self-employed. Most respondents report monthly incomes between €2,001 and €3,000 (78.4%), indicating solid purchasing power. Overall, the sample represents a mature, well-educated, and financially stable segment from proximate European markets with strong potential for elective medical tourism travel.

3.2. Variables and methods

Questions referring to intentions of tourists who used cosmetic surgery services were adapted based on the studies of Martin (2011) and Liang et al. (2019), while travellers´ revisit intentions questions were adapted based on the research of Alkier et. al. (2019). All constructs, except socioeconomic variables, were measured using a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Descriptive statistics, Cronbach's alpha reliability analysis, and Pearson correlation coefficients were used to examine respondents' perceptions, attitudes, and behavioural intentions toward cosmetic surgery services in Kvarner, ensuring the validity and internal consistency of the measurement scales. Multiple linear regression analysis was used to examine the predictors of tourists' intention to reuse cosmetic surgery services in Kvarner.

4. Results and Discussion

4.1. Descriptive statistical analysis

Descriptive statistics were used to examine respondents' subjective norms, perceived behavioral control, attitudes, perceived benefits, risk perceptions, and travel intentions regarding cosmetic surgery services in Kvarner.

Table 2: Subjective norms

Expectations of family and friends: descriptive statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
My family and friends expect me to go overseas for cosmetic medical treatment.	361	1	5	3.21	1.492
Most people who are important to me think that I should be treated overseas.	361	1	5	2.63	1.470
My family and friends encourage me to spend some time overseas for cosmetic medical treatment (surgery).	361	1	5	2.61	1.443
My close relatives and peers want me to go overseas to seek cosmetic medical treatment (surgery).	361	1	5	2.50	1.438
My family and friends encourage me to spend some time overseas for cosmetic medical treatment (surgery).	361	1	5	2.45	1.454
Valid N (listwise)	361				
Anticipated reaction of family and friends: descriptive statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
My close friends and relatives anticipate that I will go to a foreign country to receive cosmetic medical treatment	361	1	5	3.54	1.392
My family and friends predict that I will seek treatment outside my homeland.	361	1	5	3.46	1.418
My close relatives and peers will be happy if I travel overseas for cosmetic medical procedures.	361	1	5	2.91	1.479
Valid N (listwise)	361				

Source: Authors

As visible from table 2, within subjective norms were measured expectations of family and friends and anticipated reaction of family and friends. It has been registered that the results for social expectations are moderate to low, indicating that the respondents are not experiencing socal pressure from their friends and family to go abroad and seek cosmetic surgery treatments. The highest score was given to the statement relating to the expectations of family and individuals that the individual will go overseas to use cosmetic treatment (AM=3.21), followed by the statements that most individuals who are important to the individual believe that he/she should be treated abroad (AM=2.63), encouragement from family and friends that the individual spends some time abroad to use cosmetic medical treatments (surgery) (AM=2.61), the desire of close relatives and peers that the individual seek cosmetic medical treatment services abroad (AM=2.50), and and encouragement from family and friends that the individual spends some time overseas to use cosmetic medical treatments (surgery) (AM=2.45). Within the predicted reactions of family and friends, the highest rating was given to the statement relating to predictions by close friends and relatives that the individual will go to a foreign country for cosmetic medical treatment (AM=3.54), predictions by family and friends that the individual will seek treatment outside their home country (AM=3.46). Statement adrdressing that close relatives and peers will be happy if the individual travels abroad for cosmetic medical procedures (AM=2.91) was marked the lowest indicating low emotional support.

Table 3: Perceived behavioral control

Perceived ability to obtain overseas medical care: descriptive statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
I am confident I can arrange overseas trips for cosmetic medical surgery or treatment.	361	4	5	4.62	.486
In the right foreign country, I can manage to receive care to recover from a cosmetic medical procedure.	361	2	5	4.60	.524
I am capable of getting cheaper but excellent cosmetic medical care in some countries.	361	2	5	4.54	.537
If I am in the right foreign country, I can manage to get excellent cosmetic medical treatment (surgery).	361	2	5	4.52	.533
Valid N (listwise)	361				
Perceived ability to achieve a successful medical outcome: descriptive statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
I can follow my doctor's advice and receive the services needed for quick recovery after a cosmetic medical intervention overseas.	361	4	5	4.75	.436
I can communicate with overseas health care providers and get them to perform the needed procedure	361	4	5	4.68	.468
After the recovery from overseas cosmetic medical procedures, I can go home safely.	361	2	5	4.59	.640
Valid N (listwise)	361				

Source: Authors

As visible from previous table, within Perceived control authors observed participant´s perceived ability to obtain overseas medical care and their perceived ability to achieve a successful medical outcome. Findings indicate the respondents experiencing very high level of perceived control about obtaining cosmetic surgery treatments because all the elements were marked above 4,00. The highest mark was given to the statement relating to the individual's belief that they can arrange travel abroad for cosmetic medical surgeries or treatments (AM=4.60), followed by the statements relating to the individual's belief that in the right foreign country they can successfully recover from a cosmetic medical procedure (AM=4.60), that in some countries they can receive cheaper, yet excellent cosmetic medical care (AM=4.54), and the possibility of recovering from an excellent cosmetic medical treatment (surgery) if they are in the right country (AM=4.52). In terms of Perceived Ability to Achieve a Successful Medical Outcome, respondents rated the statement indicating the respondent's ability to follow their doctor's advice and the ability to obtain the services necessary for a quick recovery after a cosmetic medical procedure abroad the highest (AM=4.75), followed by the ability to communicate with foreign healthcare professionals and persuade them to perform the necessary procedure (AM=4.68), and the ability to safely return home after recovering from cosmetic medical procedures abroad (AM=4.59).

Table 4: Attitude - descriptive statistics

	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
In your opinion, medical care in Kvarner is worth the search	361	4	5	4.83	.375
In your opinion, medical care in Kvarner is very high quality	361	4	5	4.77	.421
Medical care in Kvarner is beneficial	361	4	5	4.73	.447
In your opinion, medical care in Kvarner is trustworthy	361	4	5	4.71	.452
In your opinion, medical care in Kvarner is more competent (than other compeeting destinations	361	2	5	4.67	.538
In your opinion, medical care in Kvarner is very important	361	2	5	4.65	.505
In your opinion, medical care in Kvarner is worth the cost	361	4	5	4.61	.489
Medical care in Kvarner is appealing	361	3	5	4.55	.503
Medical care in Kvarner is a bargain	361	1	5	4.10	1.084

	N	Minimum	Maximum	Mean	Std. Deviation
In your opinion, medical care in Kvarner is life saving	361	1	5	2.95	1.670
Valid N (listwise)	361				

Source: Authors

The data in Table 4 indicate that respondents have an extremely positive attitude towards cosmetic surgery treatments, given that only two statements were rated low. Respondents believe that medical care in Kvarner is worth seeking out (AM=4.83), that it is of very high quality (AM=4.77), useful (AM=4.73), reliable (AM=4.71), more competent (than other competing destinations) (AM=4.67), very important (AM=4.65), worth the price (AM=4.61), attractive (AM=4.55). The lowest rated statements are those relating to the affordability of cosmetic surgery treatment services (AM= 4.10) and that they save lives (AM=2.95). Moderate mark for the "life-saving" is not surprising considering the fact that the nature of these procedures is elective. The statement describing medical care as a "bargain" shows more variability (M = 4.10; SD = 1.084), suggesting some differences in price perceptions among respondents.

Table 5: Perceived benefit: descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
I am sure I receive better cosmetic surgery treatments in Kvarner than in my own country.	361	4	5	4.78	.418
Cosmetic surgery treatments in Kvarner is better than in my own country.	361	3	5	4.74	.444
Doctors in Kvarner are better trained in cosmetic surgery treatments better than in my country.	361	2	5	4.70	.505
I am sure I have quicker access to the cosmetic surgery treatments in Kvarner than in my own country.	361	1	5	4.59	.770
Valid N (listwise)	361				

Source: Authors

Respondents rated the perceived benefits of using cosmetic surgery services in Kvarner very highly, which is also evident from the previous table. Respondents are certain that they receive better cosmetic surgery treatments in Kvarner than in their own country (AM=4.78), that cosmetic surgery treatments in Kvarner are better than in their own country (AM=4.74), that doctors in Kvarner are better trained in cosmetic surgery treatments than in the country from which the respondents come (4.70), and they are certain that they have faster access to cosmetic surgery treatments in Kvarner than in their own country (AM=4.59).

Table 6: Perceived risk: descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
I am worried about complications happening during the cosmetic surgery treatments that would require a longer absence.	361	1	5	1.78	1.009
My doctor might not want to treat me if I had cosmetic surgery treatments in Kvarner.	361	1	5	1.29	.756
I am afraid that I might not get the same care as in my own country.	361	1	5	1.25	.681
I am not sure that I would receive good cosmetic surgery treatments in Kvarner.	361	1	5	1.17	.555
Valid N (listwise)	361				

Source: Authors

The respondents' attitudes about potential risks are very low, which is visible in Table 7. The highest mark was given to the statement that addresses the user's concern about complications that could occur during cosmetic procedures, which would require a longer absence (AM=1.78), followed by the concern that a doctor in the user's country of origin would potentially not want to treat the user (AM=1.29), the fear that the user will not receive the same care as in their own country (AM=1.25), and the feeling of insecurity about not receiving good cosmetic procedures in Kvarner. These findings indicate the respondents consider cosmetic surgery procedures in Kvarner as trustworthy, safe and reliable.

Table 7: Travel intentions: descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
I would like to use cosmetic surgery treatments in Kvarner again.	361	2	5	4.57	.518
Variety of cosmetic surgery treatments in Kvarner stimulates me to use them again.	361	4	5	4.56	.497
Uniqueness and specificity of cosmetic surgery treatments offer stimulates me to revisit Kvarner.	361	4	5	4.53	.500
Costs associated with the cosmetic surgery treatments in Kvarner are acceptable for me.	361	4	5	4.53	.499
Using cosmetic surgery treatments in Kvarner makes me feel relaxed physically and mentally.	361	1	5	4.51	.543
I intend to travel to Kvarner for cosmetic surgery treatments in next 3 years.	361	1	5	4.41	.722
I intend to travel abroad for cosmetic surgery treatments in next 3 years.	361	1	5	4.22	.989
I expect to have some cosmetic surgery treatments in a foreign country of my choice.	361	1	5	4.16	.977
Apart from cosmetic surgery treatments, uniqueness, specificity and preservation of natural resources stimulates me to revisit Kvarner.	361	1	5	3.91	1.264
Apart from cosmetic surgery treatments, uniqueness, specificity and preservation of cultural resources stimulates me to revisit Kvarner.	361	1	5	3.17	1.511
Valid N (listwise)	361				

Source: Authors

The attitudes in the previous table represent travel intentions of the respondents. The results are in line with the previous findings of this study. The respondents expressed that they would like to use cosmetic surgery treatments in Kvarner again (AM=4.57), and that they intend to travel to Kvarner for cosmetic surgery treatments in the next 3 years (AM=4.56). The decision to visit Kvarner again was motivated by the diversity of cosmetic surgery treatments (AM=4.56), the uniqueness and specificity of the cosmetic surgery treatment offer (AM=4.53), the acceptability of the costs associated with cosmetic surgery treatments (AM=4.53), using cosmetic surgery treatments in Kvarner makes them more relaxed physically and mentally (AM=4.51), and the expectation of having some cosmetic surgery treatments in a foreign country of their choice (AM=4.16). The lowest rated statements related to the impact of uniqueness, specificity and preservation of natural resources on encouraging respondents to visit Kvarner again (AM=3.91) and uniqueness, specificity and preservation of cultural resources (AM=3.17).

4.2. Instrument validity

The authors evaluated whether the subscales were reliably measured. Calculation of the total score for each construct, based on the items representing each factor was also calculated (Table 8).

Table 8: Scale statistics

Factor	Number of items	AM	SD	Cronbach's Alpha
Expectations of family and friends	5	13.40	6.75	0.958
Anticipated reaction of family and friends	3	9.91	3.96	0.914
Perceived ability to obtain overseas medical care	4	18.28	1.70	0.835
Perceived ability to achieve a successful medical outcome	3	14.01	1.25	0.718
Attitudes	10	44.57	3.87	0.686
Perceived benefit	4	18.81	1.84	0.850
Perceived risk	4	5.48	2.41	0.790
Intention to Reuse Cosmetic Surgery Services in Kvarner	10	42.57	5.06	0.778

Source: Authors

"Cronbach's alpha is a measure of reliability that ranges from 0 to 1, with values of 0.60 to 0.70 deemed the lower limit of acceptability" (Hair *et al*., 2014). As shown in Table 8, most constructs demonstrated strong reliability: *Expectations of family and friends* ($\alpha = 0.958$), *Anticipated reaction of family and friends* ($\alpha = 0.914$), *Perceived ability to obtain overseas medical care* ($\alpha = 0.835$), *Perceived ability to achieve a successful medical outcome* ($\alpha = 0.718$), *Perceived benefit* ($\alpha = 0.850$), *Perceived risk* ($\alpha = 0.790$), and *Intention to reuse cosmetic surgery services* ($\alpha = 0.778$). However, the *Attitudes* scale showed a lower reliability coefficient ($\alpha = 0.686$), falling slightly below the commonly accepted threshold. Therefore, to ensure the robustness and validity of subsequent analyses, the *Attitudes* construct was excluded from further statistical testing. This decision preserves the integrity of the findings and focuses the analysis on constructs with confirmed internal consistency.

4.3. Correlation Analysis

Authors conducted Pearson correlation coefficients analysis to test the relations between social influence, perceived control, perceived benefits and risks, and intentions to reuse cosmetic surgery services in Kvarner. The findings show a strong positive correlation between *Expectations of family and friends* and *Anticipated reaction of family and friends* ($r = 0.763$, $p < 0.01$), confirming close alignment of social expectations and anticipated reactions. Other correlations among social influence constructs and perceived ability variables are weak or nonsignificant, which indicates that social pressures play a minor role in shaping perceived control or intentions. Authors determined positive correlation of *Perceived ability to obtain overseas medical care* with *Perceived ability to achieve a successful medical outcome* ($r = 0.556$, $p < 0.01$), indicating that respondents' confidence in organizing care is closely associated with confidence in treatment success. Both of these constructs also show significant positive correlations with *Perceived benefit* ($r = 0.230$ and $r = 0.318$, respectively, $p < 0.01$) and with *Intention to reuse services* ($r = 0.322$ and $r = 0.244$, respectively, $p < 0.01$), indicating that higher perceived control and outcome expectancy are connected with stronger intentions to revisit Kvarner for cosmetic surgery. *Perceived risk* shows significant negative correlations with *Perceived ability to obtain care* ($r = -0.124$, $p < 0.05$), *Perceived ability to achieve a successful outcome* ($r = -0.201$, $p < 0.01$), *Perceived benefit* ($r = -0.221$, $p < 0.01$), and *Intention to reuse services* ($r = -0.121$, $p < 0.05$). These findings indicate that higher perceived risk is associated with lower confidence in accessing and benefiting from cosmetic surgery, as well as lower revisit intentions.

Table 9: Correlations between study constructs

Variable	1	2	3	4	5	6	7
1. Expectations of family and friends	1	.763**	.063	.028	-.031	.013	.058
2. Anticipated reaction of family and friends		1	.156**	.052	-.011	.009	-.021
3. Perceived ability to obtain overseas medical care			1	.556**	.230**	-.124*	.322**
4. Perceived ability to achieve a successful medical outcome				1	.318**	-.201**	.244**
5. Perceived benefit					1	-.221**	.320**
6. Perceived risk						1	-.121*
7. Intention to Reuse Cosmetic Surgery Services in Kvarner							1

Source: Authors' research

Overall, the correlation analysis shows that perceived ability, anticipated outcomes, and perceived benefits are positively associated with behavioral intentions, whereas perceived risks have a dampening effect. Social influence is moderately interrelated but plays a smaller role in predicting intentions.

4.4. Multiple Regression Analysis

A multiple linear regression analysis was conducted to examine the predictors of tourists' intention to reuse cosmetic surgery services in Kvarner. Six independent variables were included in the model: *Expectations of family and friends*, *Anticipated reaction of family and friends*, *Perceived ability to obtain overseas medical care*, *Perceived ability to achieve a successful medical outcome*, *Perceived benefits*, and *Perceived risk*. The *Attitudes* construct was excluded due to insufficient reliability (Cronbach's alpha < 0.70).

The overall model was statistically significant, $F(6, 354) = 14.179$, $p < 0.001$, indicating that the set of predictors jointly explains a meaningful portion of the variance in tourists' revisit intentions. The model accounted for 19.4% of the variance in intention to reuse cosmetic surgery services ($R^2 = 0.194$), with an adjusted R^2 of 0.180.

Table 10 presents the unstandardized and standardized regression coefficients for each predictor.

Table 10: Regression Coefficients

Predictor	B	Std. Error	β	t	p	VIF
Constant	15.047	3.718		4.047	.000	
Expectations of family and friends	0.170	0.055	0.228	3.071	.002*	2.418
Anticipated reaction of family and friends	-0.300	0.096	-0.236	-3.141	.002*	2.472
Perceived ability to obtain overseas medical care	0.826	0.174	0.278	4.759	.000**	1.503
Perceived ability to achieve a successful outcome	0.038	0.240	0.009	0.159	.874	1.558
Perceived benefits	0.688	0.141	0.250	4.886	.000**	1.152
Perceived risk	-0.063	0.104	-0.030	-0.612	.541	1.073

Note: *p < 0.05, **p < 0.01

Source: Authors

Collinearity diagnostics showed no multicollinearity concerns among the predictors, with all VIF values below 2.5, confirming the stability of the regression coefficients. Standardized residuals were approximately normally distributed, with no extreme outliers, supporting the adequacy of the model. *Perceived ability to obtain overseas medical care* emerged as the strongest positive predictor ($\beta = 0.278$, $p < 0.001$), indicating that tourists who feel capable of managing logistics and accessing care abroad are more likely to plan a return visit. *Perceived*

benefits also significantly predicted revisit intention ($\beta = 0.250$, $p < 0.001$), suggesting that perceived superior outcomes in Kvarner relative to home countries strongly drive revisit intention. *Expectations of family and friends* showed a significant positive effect ($\beta = 0.228$, $p = 0.002$), whereas *Anticipated reaction of family and friends* had a significant negative effect ($\beta = -0.236$, $p = 0.002$). This pattern suggests that while social expectations matter, tourists may weigh anticipated emotional reactions differently when making decisions. *Perceived ability to achieve a successful outcome* and *Perceived risk* were not significant predictors ($p > 0.05$), indicating that, when controlling for other factors, confidence in recovery and risk perceptions play a smaller role.

5. Discussion

In the previous chapter authors presented the results of the empirical research focused on determining how foreign tourists perceive cosmetic surgery services on Kvarner, what are their preferences, and what influences their travel intention. Results for subjective norms indicate moderate influence of social pressure of friends and family to go abroad and seek cosmetic surgery treatments. Decisions about cosmetic surgery abroad are largely self-driven rather than socially imposed. Our findings indicate weak to moderate average values of subjective norms, respectively the respondents are not pressured to travel abroad for cosmetic surgery, nor they are provided with emotional support. These findings indicate that despite the fact that social pressure is not strong (in the form of praise or encouragement), normative beliefs such as the perception of others' expectations and the prediction of their reactions can have an indirect but significant influence on an individual's intention to use cosmetic surgery services In comparison with the study of Liang et al. (2019), perceived social pressure may influence tourist intention in the sense of changing their attitudes about using cosmetic surgery procedures. Findings of Boguszewicz-Kreft et al. (2020) indicate subjective norms being significantly lower in Poland in relation to Turkey, indicating presence of lower perceived approval for medical tourism among relatives and friends. Our findings are also in accordance with the qualitative study of Prasad & Forsyth (2024) which states that most represented topic among the participants in the online community was them searching some form of a support as a form of a validation. Users did not use support systems to ask for an approval whether they should use cosmetic surgery services. These systems were used as a support for the decisions that were already made, as well as for determining where and by whom users may get their procedures done. Findings of Prashad and Forsyth indicate on cosmetic surgery users being strong and confident. Results for Perceived Control and Perceived Ability to Achieve a Successful Medical Outcome were both high indicating that the respondents having perceived barriers rather low in terms of medical communication as well as post-procedural care. Previously presented findings are in accordance with the study of Boguszewicz-Kreft et al. (2022) who used only one question to measure perceived behavioural control. The question addressed the ability of tourists going abroad to get medical service. Their results indicate Perceived Behavioural Control being the weakest predictor since most of the respondents (in their case students) stated that they believe that would be capable of going abroad to receive cosmetic surgery services. These findings, although valuable, might be considered with caution because the participants in the study were young students, so there is a chance that they do not fully understand the complexity of organizing such a demanding journey. Study of Lee et al. (2012) also confirms perceived behaviour control being marked high and positively affecting tourist´s intention to travel and use cosmetic procedures. Findings further indicate that respondents stated costs, information, communication, time and effort, i location being the most problematic and critical elements in decision-making process for traveling. Findings presented in the study of Liang et al. (2019),

on the other hand show weak influence of Perceived Behaviour Control on tourist´s intention to travel and use cosmetic surgery services. As a reason they state possibility of limited accessibility to adequate information and facilitators about the cosmetic surgery services which influences their weaker intention. In terms of attitudes, our findings (medical offer worth seeking, and trust and quality) were marked the highest, which is not entirely in accordance with the study of Majeed et al. (2020), in which among the analysed constructs (staff competency, medical facility, emotional attachment and trust), trust was marked with the lowest mark. This indicates that despite high perception of quality of cosmetic surgery services does not necessarily imply equal level of trust. Furthermore, our findings are in according with the study of Yilmaz et al. (2021) indicating that quality of medical service and perceived value positively influence trust as well as intention to use medical services in the future. Furthermore, the findings of our study (perception of quality and trust, as well as cost value) are in accordance with Liang et al. (2019) who indicate positive attitudes influencing intention to travel and use cosmetic surgery services. When observing perceived benefits, our data related to attitudes towards treatment quality, education of medical professionals, overall treatment, and perceived benefits of faster access to services are consistent with the findings of the study by Majeed et al. (2020), who formed a model that considers the impact of perceived quality of medical service (quality of staff and facility), and supports the key role of physician expertise and competence and high quality of medical care in making decisions about traveling and using cosmetic surgery services. Furthermore, our findings are in accordance with the qualitative study of Prasad & Forsyth (2024) which shows that participants perceiving foreign medical professionals (surgeons) having better qualifications in relation to the ones in their own country, foreign medical facility being better than the domestic one, and shorter waiting time for using cosmetic service relevant in the decision-making process. The findings of our study are consistent with Liang et al. (2019) who found that perceived benefit has a statistically significant and positive impact on subjective norms, attitudes towards tourism offerings, and perceived behavioural control. Furthermore, the findings indicate that benefits related to the quality of medical care, as well as the expertise of medical professionals and the speed of service provision are significant predictors of travel decisions. Results for risks in our study indicate low level of risk perception, which is not in accordance with the study of Nam (2020) in which respondents expressed higher level of concern regarding competences of medical professionals this way indicating higher perception of risk. What is surprising is the fact that they failed to express their level of concern in the period after returning home. The study of Boguszewicz-Kreft et al. (2022) indicates tourists perceiving cosmetic medical procedures as riskier, which is also not in accordance with our findings. Our findings for future intention indicate strong interest in using cosmetic surgery treatments again, as well as revisiting for these services within the next three years, which indicates significant level of loyalty and is in accordance with the study of Olya and Nia (2021) whose findings also indicate high level of behavioral intentions. Our findings indicating acceptability of costs is in accordance with the findings of Rahman et al. (2022), respectively they state that achieving value for money significant influences revisit intention. Sense of relaxation and recovery were marked with a high mark and as a strong predictor of revisit intention which is not in accordance with Rahman et al. (2022). Considering the non-existence of similar studies up until now, our findings are important for cosmetic surgery providers as they provide insight into the attitudes of patients who have previously visited Kvarner for cosmetic surgery services.

6. Conclusion

The purpose of our study was to determine the perceptions, preferences and travel intentions of foreign tourists for cosmetic surgery in Kvarner, an emerging destination for medical tourism. The literature focused on determining the attitudes of foreign tourists who travel motivated by cosmetic surgery services has proven to be very weak, which is somewhat contrary when discussing studies focused on medical tourism. The findings established within our study show a low influence of subjective norms on tourists' attitudes towards the use of cosmetic surgery services. In terms of perceived control, respondents feel quite confident about their abilities to organize their travel and come to Kvarner for cosmetic surgery procedures. The findings also indicate that users have extremely positive attitudes towards cosmetic surgery treatments, perceiving them as positive and minimally risky. This is in line with their positive attitudes towards returning to Kvarner in the next three years and using cosmetic surgery services. Furthermore, it is found that perceived ability to obtain overseas medical care and perceived benefits are, out of the selected predictors, the strongest drivers of revisit intention. Even though the results of empirical research can be considered satisfactory, it is necessary to consider which direction to take in terms of further improving the medical tourism offer. This research study represents a contribution to the theory considering that up until now a considerably limited number of research studies were published focusing on perceptions, preferences and travel intentions of foreign tourists for cosmetic surgery, while research studies focused on Kvarner region are non-existent. Results also have practical implications, which are valuable not only for cosmetic surgery service providers, but also for destination management. The findings, which reflect the attitudes of subjective norms, indicate that when designing marketing activities and communication methods, “social pressure” should not be emphasized due to its weak impact on respondents. Therefore, marketing campaigns should emphasize achieving personal benefits and personal goals for the tourists. Emphasis should be placed on providing better professional support when planning a trip (advice by providing accurate and precise information about procedures, checking the progress of recovery after a medical procedure, etc.). In this way, service providers will ensure that their users fully meet their needs and provide emotional support in the postoperative period, which may result in their greater loyalty. Our findings have presented that respondents show a very high perceived control in terms of their ability to organize travel, communication with medical care providers, and postoperative recovery and return home. In line with this, marketing campaigns and information packages must be designed in a way to address patient autonomy and allow them to choose the desired services in the simplest possible way. Taking into account the independence of respondents in managing the entire process and bearing in mind the development of information technology, it is recommended to introduce IT solutions in the form of online guides, checklists, online calculators that will allow users to estimate costs and a recovery time plan that will show an estimate of all phases of the stay in the medical institution (preoperative period - surgical procedure - postoperative period - return home). Such solutions will allow users to better manage the entire process. In terms of postoperative support, it is possible to implement telemedicine control services (in accordance with the wishes and preferences of the patient). It is recommended to form/improve communication protocols that will strengthen the experience of professionalism and control by the patient (which documentation to send to the doctor and which specific questions to focus on). In order to ensure successful product quality management and to strengthen the safety of patients and the medical service provider itself, it is recommended to provide all necessary information about recovery (its duration, restrictions that the patient must adhere to before and after the operation, when it is safe to go home, how to react adequately in case of complications, etc.). Such information gives patients a sense of greater

safety and control over the process itself. It is desirable to establish a protocol for returning home (a list of documents used during the stay, instructions on how to get home safely without jeopardizing the results of the medical procedure, what symptoms to pay attention to, and to know the contact points in case of complications). It is recommended to form a basic package that would contain the medical procedure, basic instructions to follow after the procedure and postoperative control. This package could be complemented with additional services that would be in line with the wishes and preferences of the patient (translation services if there is a language barrier, transfer service, additional controls and counseling). The focus must be on price transparency and quality of medical services. Therefore, it is necessary to provide information that is clear and comparable (structure of the service package). Given the positive assessment of attitudes, cosmetic surgery service providers and tourism destination stakeholders should focus more on improving the quality of services and strengthening the sense of trust of patients through a personalized approach, with special emphasis on support in the postoperative period (online/onsite), the possibility of communication in the patient's native language. Since patients perceive medical care in Kvarner as reliable and high-quality, marketing and communication activities should continue to focus on strengthening the credibility of the offer, highlighting qualifications and increasing the visibility of medical professionals by publishing public profiles of experts (the structure of their educational process, what their sub specializations are, participation in scientific research work), which contributes to the reputation of the medical institution, the existence of accreditations and quality standards, the availability of protocols that ensure impeccable provision of medical services and patient safety. Cosmetic surgery services should be presented as beneficial in terms of improving the quality of life of potential patients, and sufficiently worth coming to the medical institution and destination. It is necessary to form an offer of services that will enable minimal effort in the planning process by clearly defining all the steps that a potential patient must take before consulting with medical experts, by creating an information package that will clearly and transparently explain the entire procedure, the possibility of telemedicine meetings, the expected recovery and return home dates, and postoperative examinations. In our research, respondents expressed disagreement with the statement regarding the affordability of the offer (price), which indicates the necessity of forming and offering basic packages that patients will be able to upgrade. The implementation of the previously proposed development guidelines will contribute to improving the quality and diversity of the cosmetic tourism offer, which will enable Kvarner to take a more competitive position in the tourism market. As research limitation, it is possible to mention the size of the population that agreed to participate in our research. It is advisable to repeat the research on a larger sample to increase the possibility of generalizing the results.

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A scientific paper

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YOUTH OVEREDUCATION IN CROATIA

ABSTRACT

The paper aims to analyse the overeducation patterns of Croatian youth in the aftermath of the Great Recession. Contrary to previous findings in Croatian literature which depend on a single measure of overeducation, the paper relies on both statistical and subjective measures to provide a deeper insight. The analysis aims to provide a comparative position of Croatian youth in the European area, but also to explore predictors of youth overeducation. In the latter, special focus is put on the youth's socioeconomic background, particularly the role of parents' employment network.

To that end, Eurostat Labour Force Survey microdata have been used to analyse the evolution of subjective youth overeducation in the 2006-2023 period, as well as its predictors. The identification of predictors has been analysed based on the probit model, where the dependent variable depicts overeducated youth. The subjective overeducation measure has been identified by relying on the Cedefop European Skills and Jobs Survey.

The empirical analysis of overeducation predictors revealed a significant role of factors related to parents' employment network. However, since the results suggest that when children work in the same economic activity or occupation as their parents, the probability of overeducation is higher, it is more likely that the network is utilized to ease labour market entry. The analysis of predictors generally supported previous findings from the literature, with the exception of young females, who are significantly less likely to be overeducated in Croatia.

The analysis of subjective overeducation measure revealed a correlation with higher job dissatisfaction and higher perceived skills deficit. These negative consequences urge for a stronger policy response in improving the match between the educational system and labour market needs.

Key words: *overeducation, youth, Croatia, household effects.*

1. Introduction

While the growth of average educational attainment evident across the developed economies is welcomed in public discussions, overeducation that recently accompanies the average educational attainment growth increasingly raises concerns in the literature (Rumbergen, 1981; Duncan and Hoffman, 1981; Barone and Ortiz, 2011; Leuven and Oosterbeek, 2011; McGuinness, 2006; Capsada-Munsech and Ortiz-Gervasi, 2025). Overeducation arises from a mismatch between labour market needs and the educational attainment of jobseekers, and it is more likely to occur during periods of high unemployment. In these periods of abundant labour supply on the market, more individuals are willing to accept a job offer below their formal educational level. While early studies viewed overeducation as a stepping stone towards better matched positions (Sicherman and Galor, 1990), soon the empirical evidence

pointed to a prolonged duration of the overeducation phase (Baert, Cockx and Verhaest, 2013; Capsada-Munsech, 2017), emphasizing the lower wages of overeducated employees in comparison to better matched peers (Duncan and Hoffman, 1981; Verdugo and Verdugo, 1989; Allen and Van der Velden, 2001; McGuinness and Bennett, 2007), higher job dissatisfaction (Tsang, Rumberger and Levin, 1991; Allen and Van der Velden 2001; Ortiz-Gervasi and McGuinness, 2018) and increased labour turnover (Hersch, 1991). All these factors can significantly contribute to the aggregate loss in productivity.

Research on overeducation intensified in the aftermath of the Great Recession, with a particular focus on youth, who faced additional adversities due to their status as first-time labour market entrants (Meroni and Vera-Toscano, 2017; Erdsiek, 2021). Extant studies have documented that during the recession, an increased share of youth decided to return to education (Barr and Turner, 2015; Pompei and Selezneva, 2021), which subsequently led to an increase in overeducation (Cedefop, 2015). The phenomenon is attracting the attention of policymakers not only because of the misallocation of human resources argument (Cuesta, Navarro and Sánchez-Mangas, 2025), but also because it has been argued that it can lead to increasing dissatisfaction with university studies in general (Whelan and McGuinness, 2021).

Contrary to the well-documented overeducation problem in other countries that experienced high youth unemployment rates in the aftermath of the Great Recession, the literature on the Croatian experience is scarce. While public discussions frequently mention the mismatch between the educational system and the labour market, empirical studies are relatively rare. Bečić (2014) documents the evolution of overeducation during the 1998-2010 period based on statistical methods, Mrnjavac and Bečić (2014) explore its factors during the same period, while Matković (2011) and Obadić and Oršolić (2012) rely on subjective measure of overeducation. To supplement previous findings, the analysis in this paper specifically focuses on the overeducation of Croatian youth, as this demographic group is most affected by overeducation. The second contribution is the extension of the analysed period to include both the pandemic and post-pandemic periods, as well as a comparative analysis of overeducation using both subjective and statistical indicators. Finally, the paper contributes to the literature by emphasising the role of parents in creating a social environment important for youth educational and labour market decisions (Pérez and Benito, 2022; Legazbe, Albert and Davia, 2025).

The paper adopts the following structure. Section 2 briefly summarises relevant literature. Section 3 presents the empirical strategy and the data used. Section 4 presents the main results and discussion, while the final section provides conclusions.

2. Literature Review

The average educational attainment is increasing in European economies, and the studies indicate that this growth is not paralleled by the increase in demand for the educational system's output (Capsada-Munsech and Ortiz-Gervasi, 2025). This results in an increasing proportion of people who are not well-matched in the labour market, i.e. whose educational attainment is higher than the education level required to perform their job successfully (Capsada-Munsech, 2017). The explanation for the phenomenon has been offered within different theoretical streams, differentiated by the emphasis on the demand or the supply side of the labour market.

Analysis of the relationship between the educational system and labour market outcomes is frequently framed within Human Capital Theory (Becker, 1964), according to which an individual invests in education in order to obtain human capital, thereby increasing her employment probabilities. Overeducation in this context can occur if a person accepts a job offer beneath her educational attainment level, but this is only a temporary phase (Sicherman and Galor, 1990), as individuals are likely to seek (and find) a better matched position when the circumstances permit.

Since empirical studies (Baert, Cockx and Verhaest, 2013; Capsada-Munsech, 2017) have documented the persistence of overeducation, the Job Competition theory (Knight, 1979) suggested that employment probabilities strongly depend on employers' decisions. While potential employees still invest in their human capital, the job vacancies dictate the filling of job positions. Employers may prefer choosing an employee with higher educational attainment (beyond what is necessary for a specific position) due to perceived productivity gains. If there is a scarcity of vacancies requiring higher educational attainment, employees may remain in positions for which they are overeducated, or they may lose their employment.

Signalling Theory (Spence, 1973) suggests that employees become overeducated because they are not able to signal their knowledge and skills clearly, or they lack work experience and/or work-specific skills. This argument is highly relevant for the youth who, as first-time job seekers, are generally faced with less favourable labour market prospects (Bell and Blanchflower, 2011). According to this concept, the overeducation phase can last shorter or longer, depending on the employee's capacity to improve the presentation of her skills to current or alternative employers.

Finally, Allocation Theory (Sattinger, 1993) emphasises that both employers' and employees' decision-making processes are relevant to overeducation. Specifically, individuals generally choose a future sector of employment by deciding on their field of study. While their choices may still be guided by wage maximisation, their utility function also includes other preferences. The employers, on the other hand, when assessing the (future) employee's productivity, consider other factors beyond their educational attainment, such as the extent to which their personal characteristics are suitable for the specific position. Within this framework, both firms and individuals may find overeducation a situation that maximises their utility functions.

In empirical research, researchers are faced with the question of how to measure overeducation appropriately. The literature presents three general approaches, each with its advantages and disadvantages (Hartog, 2000; Sparreboom and Tarvid, 2017), which prompted Capsada-Munsech (2019) to advocate for studies that rely on more than one type of overeducation measure. The first group of methods, named 'objective', is data demanding and highly dependent on the underlying economic structure and seek to identify detailed skills that are required for each occupation (Rumberger, 1981). The method usually relies on national classifications, which could be more detailed in regulated professions. The second group aims to address this shortcoming by relying on workers' self-assessment of whether their educational attainment is suitable for their job (Duncan and Hoffman, 1981). While the advantage of this approach lies in the perceived ability of workers to self-identify all the nuanced requirements related to the job position, the main disadvantage stems from the subjective nature of the approach. The third group relies on statistical methods, such as the mean (Verdugo and Verdugo, 1989) or the mode (Davia, McGuinness and O'Connell, 2017) of the educational attainment distribution within a particular occupation. Within this concept,

an employee is considered overeducated if her educational attainment exceeds the statistical threshold.

Existing studies document that young workers are more likely to be exposed to overeducation (Dolton and Vignoles, 2000; Quintini, 2011), at least initially in their careers. However, some studies suggest that entering the labour market through an overeducated job position can have long-lasting effects, due to negative signalling to other potential employers and the erosion of unused skills (Baert, Cockx and Verhaest., 2013; Baert and Verhaest, 2019). This is particularly important for youth, because it suggests that the conditions of their labour market entry could have a career-long impact.

One of the reasons the youth are more likely to suffer from overeducation is related to their lack of work experience. Their job search efforts are frequently augmented by the support of their parents, whose social capital, typically correlated with their formal educational attainment (Glaeser, Laibson and Sacerdote, 2000), increases the employability of their offspring (De Schepper, Clycq and Kyndt, 2023). Recently, Pérez and Ruesga Benito (2022) have empirically verified that in the case of young workers, higher parents' educational attainment decreases the likelihood of overeducation. Furthermore, studies have documented a clear correlation between the field of study of children and that of their parents (Barone and Ortiz, 2011). Thus, the choice of field of study is not only related to perceived employability but also depends on a variety of other socioeconomic circumstances, among which family background is probably the most pronounced.

In addition to the importance of social background, empirical research has identified several predictors of overeducation. Since empirical studies frequently suggested a higher female propensity to overeducation (Leuven and Oosterbeek, 2011; Boll and Leppin, 2016; McGuinness, Bergin and Whelan, 2018), the explanation for this has been offered within the concept of the local labour market. Specifically, Frank (1978) proposed that within a couple, men are more likely to make primary labour market decisions, implying that women's choices become constrained by their partner's choices. Subsequently, women search for a job in a significantly smaller area, after their partner has made a decision canvassing a much larger area. Recently, Santiago-Vela and Mergener (2022) argue that work-from-home options reduce the risk of overeducation for women, because these job positions are not restricted by commuting time.

The characteristics of the local labour markets themselves have been relatively less frequently explored in empirical studies. However, it has been found that smaller labour markets are associated with a higher risk of overeducation (Büchel and van Ham, 2003; Jauhiainen, 2011), because the labour demand is less versatile. Recently, Fouquet and Sari (2023) suggested that increased mobility reduces the overeducation of young graduates, thus confirming the hypothesis that constrained local labour markets contribute to the problem. If the demand for specific educational profiles in local labour markets is low, individuals with that educational profile can increase their employability prospects by expanding their search area.

In addition to educational attainment itself, numerous studies have documented that specific fields of study are more prone to overeducation (Ortiz and Kucel, 2008; Verhaest, Sellami, and Van der Velden, 2017; Caroleo and Pastore, 2018), thereby indicating that overeducation is not uniformly widespread across the economy. In the Croatian case, Bečić (2014) identifies that post-graduate studies are more inclined to overeducation, while Mrnjavac and Bečić

(2014) identify agricultural economic activity as the one with the highest probability of overeducation.

Significant evidence has been compiled documenting the higher overeducation of the migrant population (Dalmonte, Frattini and Giorgini, 2024; Broschinski and Heidenreich, 2025). While a lack of experience in the local labour market makes immigrants resemble youth, studies also suggest that other factors are more relevant, such as the comparability of the educational system between the home and host countries or discrimination.

In alignment with the idea that overeducation is a temporary phase, previous research has also documented that the type of contract is an important predictor of overeducation. This is particularly important for the young people, who at the beginning of their careers are more likely to experience temporary working arrangements (Högberg, Strandh and Baranowska-Rataj, 2019). However, whether the association between temporary employment and overeducation is positive or negative differs between countries, making it an empirical issue. As Ortiz (2010) suggested, in some cases, individuals prefer the security that a permanent contract provides, regardless of whether the permanent contract is available only for overeducated positions. Institutional factors also play a role. In economies with rigid labour market institutions, employers face higher firing costs and may be more comprehensive at the point of hiring (Kawaguchi and Murao, 2014), thereby trapping the youth in overeducated positions.

3. Data and Methodology

The empirical analysis in this paper relies on two alternative measures of overeducation, utilising two alternative data sources. The methodological details are presented in two separate subsections, starting with the detail explanation of the statistical approach.

3.1. Statistical Overeducation Measure

The analysis focusing on the statistical measure of overeducation relies on the EU Labour Force Survey (EU-LFS) data for Croatia[1]. The data contain individual responses on various personal characteristics relevant to labour market outcomes and present a staple source for comparative labour market analysis across EU countries. Since the focus of the paper is on the role of parents, the sample is restricted to youth residing in the same household as their parents[2]. The dataset does not allow for the identification of parents' characteristics if the youth live in separate households. While EU-LFS for Croatia is available for earlier periods, the identification of parents is enabled since 2006, making this the starting year of the analysis. The latest year included in the analysis is 2023.

The definition of youth is not straightforward. While the 15-24 age group is frequently considered for comparative statistical purposes, in practical policy, for example, in the case of the Youth Guarantee (Botrić, 2017), Croatia has adopted extended coverage up to the age of 29. The extended definition aligns with the notion that overeducation is predominately prevalent among individuals with higher educational attainment (Cultrera, Rycx, Santosuosso

[1] More information about the EU-LFS microdata can be obtained on website: https://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey

[2] For the age group analysed in this paper, this is 64.3 percent of the sample during the whole period, the lowest in 2006 – 52.8 percent and the highest in 2022 – 77.1 percent.

and Vermeylen, 2025). To acknowledge this and to enable comparison with the subjective measure of overeducation, the EU-LFS sample is restricted to the youth aged 25-34.

To identify whether a person is overeducated, two similar 'statistical' measures have been proposed, the difference between them is the granularity of the reference occupation (3-digit or 1-digit). Specifically, a person is considered overeducated if her educational attainment, measured by the *hatlevel* variable, is higher than the modal[3] educational attainment of the newly employed (i.e. respondents employed during the last two years) in the same economic activity (1-digit NACE) and occupation[4].

Following standard practice in the literature, a probit model with sample selection has been specified (see, for example, Jauhiainen, 2011; Rubb, 2014; Boto-García and Escalonilla, 2022), with the selection equation capturing employment probability and the outcome equation reflecting overeducation probability. However, since the estimates did not imply that the selection process is significant, only the results of the probit estimates without selection are discussed in the paper.

Two probit equations are estimated, because the dependent variable - overeducation is measured by two alternative statistical measures. The choice of independent variables is guided by the relevant literature and the availability of data and varies in the estimates only in the case of one variable, which depicts the similarity of occupation with parents (i.e. whether a 1-digit or 3-digit measure is used, corresponding to the dependent variable). Other independent variables relevant to the analysis of the role of parents – similar educational fields and similar economic activities – remain the same across the specifications. In addition, estimates control for gender, migrant status and education of the respondent. Next, we include labour market conditions: larger cities usually have a larger number of vacancies, while regional employment rates depict overall labour demand. Individuals' market experience can be negatively correlated with overeducation, as a prolonged job search may result in a better match, whereas temporary positions are frequently positively correlated with overeducation. The role of household variables is to control for the potential distribution of the roles within the household (caring responsibilities, income sharing). The definition of the variables is presented in Table 1. In addition to these variables, to control for the overall business cycle, the estimates include annual dummy variables. To control for the economic activity, dummy variables, which capture economic activity at the 1-digit NACE classification level, are also included. Finally, estimates include dummy variables for the individuals' broad fields of education.

Table 1: Definition of the variables – statistical overeducation measure

Variable	**Definition**
Overedu1	=1, if a person is overeducated, measured by 1-digit ISCO
Overedu2	=1, if a person is overeducated, measured by 3-digit ISCO
Female	=1, if respondent is a female
Migrant	=1, if respondent is not born in Croatia
EduH	=1, if respondent has high level of educational attainment
Same_occup	=1, if respondent has the same occupation as at least one of her parents (there are two alternatives – 1-digit (aggregate) or 3-digit ISCO (detailed), corresponding to the dependent variable)

[3] Similar to Broschinski and Heidenreich (2025), maxmode is used.
[4] Newly employed persons have also been used by Markussen, Nareklishvili and Røed (2024).

Variable	Definition
Same_field	=1, if respondent's field of education is the same as at least one of her parents
Same_activity	=1, if respondent's job is in the same economic activity as at least one of her parents
Market_experience	= number of years since obtaining highest level of education
Temp_job	=1, if person works under fixed-term contract
Cities	=1, if respondent's residence is in a large city
Emp_rate	= regional (NUTS2) youth (25-34) employment rate
Depend_share	= share of children and persons older than 65 in respondent's household
Empl_share	= share of employed persons in respondent's household

Source: Author's systematization

3.2. Subjective Overeducation Measure

This segment of the analysis is based on the European Skills and Jobs Survey (Cedefop, 2021), which enables the analysis of individual-level data for persons aged 25 and above. To ensure comparability with the EU-LFS data, the sample is restricted to persons younger than 35. To determine whether a respondent is overeducated, we compare the respondent's educational attainment to the educational attainment required for the position, as reported by the respondent. Thus, we rely on the respondents' perceptions regarding their specific job position.

This data source does not enable analysis of the link between parents and youth. It does, however, enable insight into other important subjective aspects of job quality that are related to overeducation – job satisfaction and perceived skills deficit. While the first is already explored in the literature, the second might be somewhat puzzling at first, as it may initially be assumed that the overeducated are also overskilled. However, while the literature emphasised that this is not necessarily the case (Allen and Van der Velden, 2001), the issue has not been previously explored in Croatian literature. The perceived skills deficit is assessed by utilising the question 'To what extent do you need to further develop your overall level of knowledge and skills to do your main job even better?'. Thus, the question reflects skills rather than formal educational attainment.

To further explore the characteristics of persons who perceive themselves to be overeducated, a probit model is estimated with subjective perception of overeducation being a dependent variable and the choice of independent variables guided by the literature review and data availability (explained in detail in Table 3). In addition to the variables previously discussed as factors of statistical overeducation, here we also include size of the company and sector of employment. The rationale is that small companies are less prone to human resource investments, thereby contributing to the skills gap (Kmecová and Androniceanu, 2024), and this can be further emphasized in the public sector. The characteristics of the individual job are captured by questions related to self-perceived skills deficit and job satisfaction.

Table 3: Definition of variables – subjective education measure

Variable	Definition
Overedu_s	=1, if respondent perceives herself overeducated
Female	=1, if respondent is a female
Native	=1, if respondent's nationality is Croatian
EduH	=1, if respondent has high level of educational attainment
Urban	=1, if respondent lives in a large town or a city

Variable	Definition
Private sector	=1, if respondent is employed in private sector
Small firm	=1, if respondent's firm has less than 49 employees
Permanent contract	=1, if respondent has a permanent contract
Skills deficit	=1, if respondent believes that she needs to further develop overall knowledge and skills to a great extent
Job satisfaction	=1, if respondent is not satisfied with her job

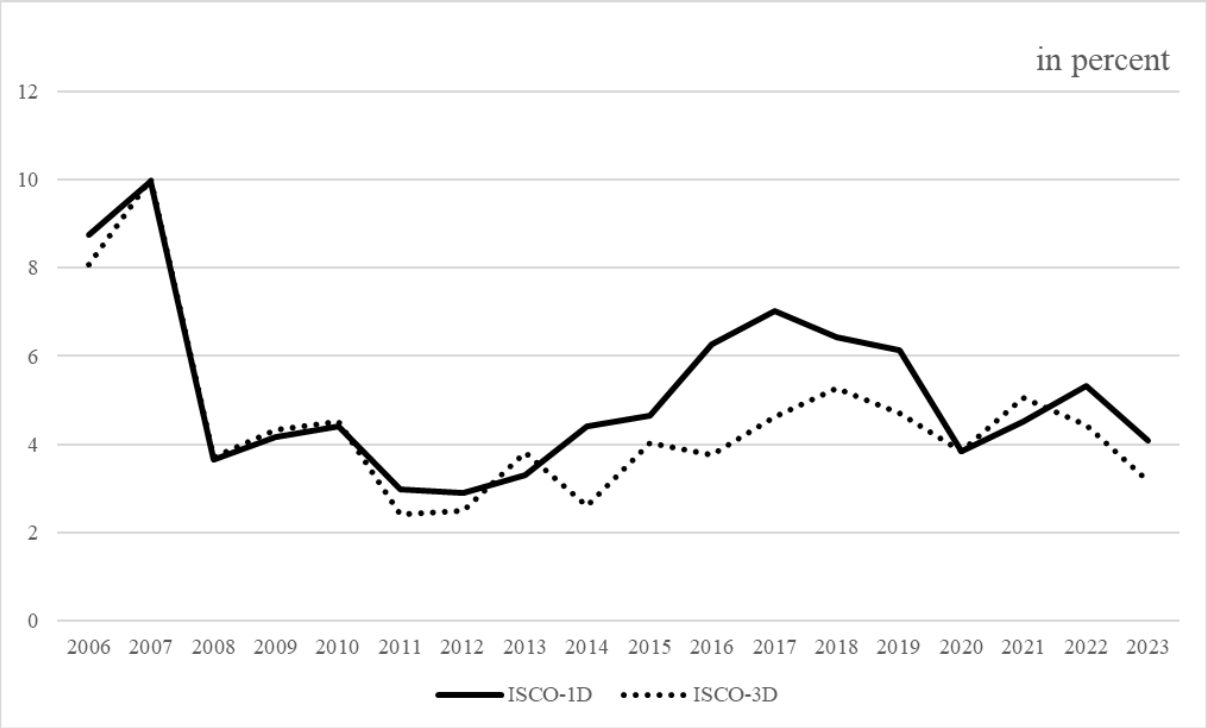
Source: Author's systematization

4. Results

4.1. Statistical Overeducation Measure

Following the methodological approach previously described, we start with the presentation of the evolution of the youth overeducation in Croatia. The data in Figure 1 presents youth overeducation based on two alternative statistical measures.

Figure 1: Youth overeducation in Croatia based on statistical measures



Source: Author's estimates based on EU-LFS

The data clearly present that in the aftermath of the Great Recession, the overeducation rate increased in Croatia. Unlike many other countries, Croatia experienced a prolonged period of recession, which particularly affected young people and increased their unemployment rate (Botrić, 2017). While prolonging or returning to education can serve as a shelter from the unfavourable labour market exposure during the recession, increased educational attainment also affects labour market outcomes during the subsequent boom phase. Thus, the Croatian data clearly corroborate the narrative that overeducation varies along the business cycle (Cuesta, Navarro and Sánchez-Mangas, 2025).

Before exploring the predictors of youth overeducation, it is essential to emphasise that, in comparison to the overeducation rates published by Eurostat and estimated based on the same data source for the age group 20-34, the rates presented here are significantly lower. The difference can be attributed to at least two factors. First is the obvious, referring to the larger age group, which is also more likely to incorporate overeducation of high-school graduates. However, more importantly, the difference lies in the reference group, where the Eurostat data considers all employees, not just the newly employed. The choice of this reference group is guided by the notion that recent employees are direct labour market competitors to young job seekers in accordance with the preferences in the recent literature. Thus, the standard Eurostat measure in this case averages all employees, which creates a lower comparative value because the average educational attainment of the population increases over time. Despite this difference, the observed pattern over time remains fairly similar.

Following the methodological approach previously described, two separate probit models were estimated, depending on whether the respondents' overeducation is estimated based on the more detailed, ISCO-3 digit level of occupation (dependent variable Overedu2) or the more aggregated, ISCO-1 digit level of occupation. Since the coefficients of the probit estimates are not particularly informative, the results presented in Table 2 include marginal effects at the sample mean. The estimates are presented in reference to newly employed population and in reference to the employed population[5].

Table 3: Marginal effects after the pooled probit estimates with two alternative measures of statistical overeducation

VARIABLES	Compared to newly employed		Compared to employed	
	Overedu2	**Overedu1**	**Overedu 2**	**Overedu 1**
Same_occup_detailed	0.020*** (0.005)		0.116*** (0.008)	
Same_occup_aggregate		0.006 (0.004)		0.041*** (0.007)
Same_field	0.002 (0.004)	0.002 (0.004)	-0.021*** (0.007)	-0.015** (0.007)
Same_activity	0.000 (0.008)	0.024*** (0.008)	0.008 (0.012)	0.035*** (0.013)
Female	-0.007* (0.004)	-0.012*** (0.004)	-0.014** (0.006)	-0.021*** (0.006)
Migrant	-0.005 (0.007)	0.009 (0.007)	-0.005 (0.011)	0.003 (0.012)
EduH	0.071*** (0.005)	0.076*** (0.005)	0.379*** (0.007)	0.357*** (0.007)
Cities	0.005 (0.003)	-0.001 (0.004)	-0.002 (0.006)	-0.003 (0.006)

[5] To capture the recent labour market conditions, we prefer estimates where youth are compared to newly employed, while we consider estimates related to the employed population as a sensitivity check.

VARIABLES	Compared to newly employed		Compared to employed	
	Overedu2	Overedu1	Overedu 2	Overedu 1
Emp_rate	0.000 (0.000)	-0.000 (0.000)	- 0.000*** (0.000)	-0.000* (0.000)
Field of study				
Education	-0.043*** (0.013)	-0.105*** (0.017)	- 0.376*** (0.023)	- 0.336*** (0.023)
Arts and humanities	-0.001 (0.014)	-0.031** (0.016)	- 0.156*** (0.025)	- 0.129*** (0.027)
Social sciences, journalism and information	-0.003 (0.009)	-0.017* (0.010)	- 0.073*** (0.016)	- 0.056*** (0.017)
Business, administration and law	-0.008 (0.009)	-0.010 (0.009)	- 0.070*** (0.015)	-0.034** (0.015)
Natural sciences, mathematics and statistics	-0.018 (0.018)	-0.030 (0.019)	- 0.287*** (0.038)	- 0.246*** (0.037)
Information and Communication Technologies	-0.017 (0.013)	-0.013 (0.013)	- 0.195*** (0.023)	- 0.181*** (0.024)
Engineering, manufacturing and construction	0.009 (0.007)	0.013* (0.007)	- 0.035*** (0.012)	-0.001 (0.013)
Agriculture, forestry, fisheries and veterinary	0.002 (0.013)	0.003 (0.013)	0.056*** (0.020)	0.079*** (0.021)
Health and welfare	-0.028** (0.012)	-0.070*** (0.015)	- 0.216*** (0.020)	- 0.220*** (0.021)
Temp_job	0.010*** (0.004)	0.009** (0.004)	0.010 (0.006)	0.019*** (0.007)
Market_experience	-0.002*** (0.001)	-0.002*** (0.001)	-0.001 (0.001)	-0.002* (0.001)
Depend_share	-0.005 (0.010)	-0.008 (0.011)	-0.020 (0.017)	-0.023 (0.018)
Employed_share	-0.016* (0.008)	-0.018** (0.009)	- 0.090*** (0.000)	- 0.061*** (0.014)
Observations	22,634	22,612	22646	22646
Log likelihood	-4766	-5271	-10400	-11074
Pseudo R^2	0.087	0.081	0.215	0.189

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates include: annual dummies, economic activity dummies.

Source: Author's estimates based on EU-LFS

The results reveal a significant influence of indicators capturing parental network effect on overeducation, although the modalities are not clear. In the case where the overeducation measure is based on a detailed occupational structure (Overedu2) and paired with the detailed parents' occupation, it appears that when the offspring shares their occupation with (one of) their parents, it increases the probability of their overeducation[6]. When overeducation is measured at the aggregate level of occupation, the link to the parents' network is established through the significant positive effect of the same economic activity. In both cases, the results suggest that parents' networking is more likely to be associated with overeducation, indicating that networking is more likely to be utilised to secure a position, rather than a well-matched position. However, these results should be interpreted with caution, as other important household characteristics, such as tangible and intangible resources or individual preferences have not been included in the analysis.

It is also interesting to note that individuals who graduated in the fields of *Education* or *Health and welfare* are significantly less likely to be overeducated[7], regardless of the measure used. These findings corroborate results in other countries, where the low probabilities of overeducation in health and technical fields have been documented (Acosta-Ballesteros, Osorno-del Rosal and Rodríguez-Rodríguez, 2018; Aina and Pastore, 2020).
In relation to other variables, they largely corroborate previous findings. Thus, higher educational attainment is associated with a higher likelihood of overeducation (Ponds, Marlet, van Woerkens and Garretsen, 2016), temporary employment is a positive predictor of overeducation (Ortiz, 2010), and longer labour market experience supports getting a better-matched position. It is also interesting to note that the higher the share of employed household members, the lower the youth overeducation. This could be partially attributed to the within-household learning mechanisms, where youth gain indirect job search experience from household members. However, it could also be the case that the ability to draw from the shared income enables youth to prolong their job search and focus on getting a well-matched position. To that end, the results align with the story, where more generous family backgrounds enable a prolonged search for well-matched positions (Bürmann, 2023).

Finally, it is interesting to note that in Croatia young females are less likely to be statistically overeducated. This finding is contrary to those in other countries (McGuinness, Bergin and Whelan, 2018) and also contradicts the subjective perception of overeducation[8]. Possible explanation for this finding could be sought in the differences in male and female decision-making processes. Studies frequently find women to be risk-averse investors (Harjoto, Laksmana and Lee, 2015; Powell and Ansic, 1999). If education is considered an investment, opting for educational pathways leading to more predictable careers would provide a consistent framework for our results. Another possible explanation can be found in the literature related to gender differences in promotion (Huang, Mayer and Miller, 2024), frequently finding that men are more likely to get promotion and subsequently end in

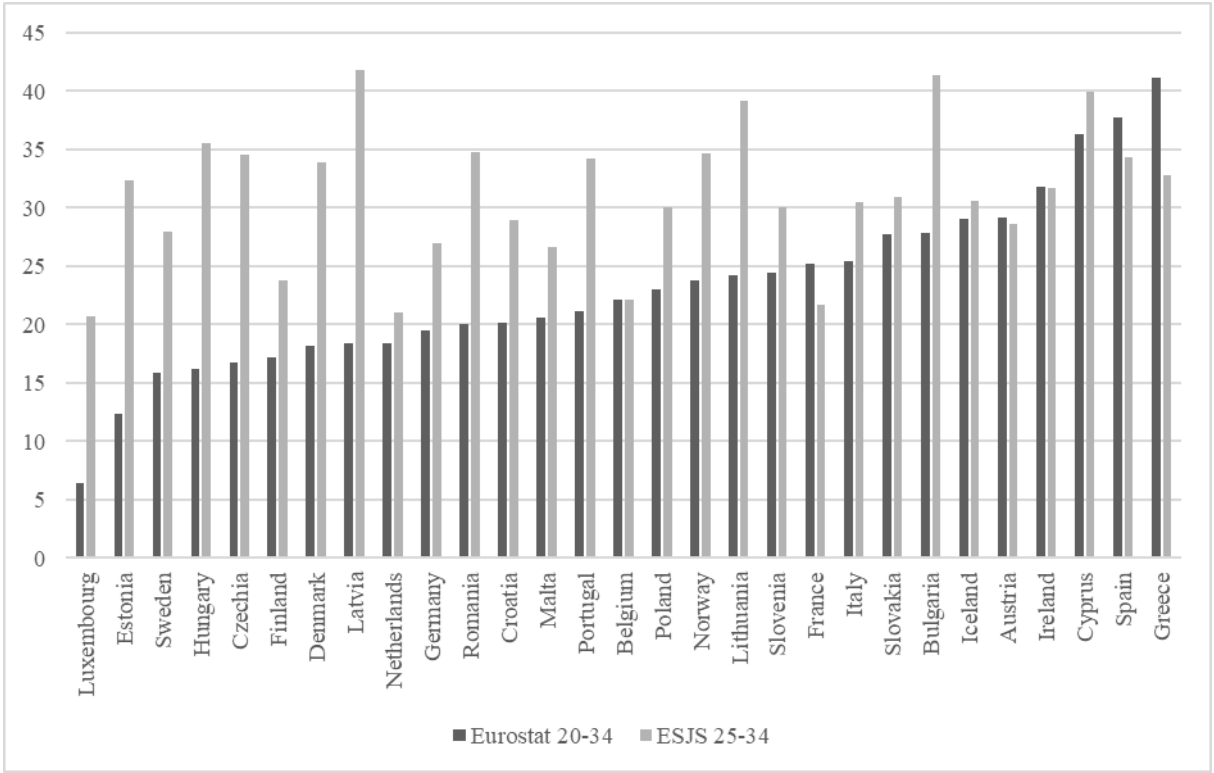
[6] It is interesting to note that our sensitivity analysis also supports this relationship when aggregate measure of the same occupation is applied. The sensitivity analysis in general points to a high degree of corresponding results in key variables of interest when the sign of the relationship is considered. The most pronounced differences are, as expected, found in relation to the field of study which reflects the different structure of the newly employed to general employed population.
[7] The analysis based on subjective measure of overeducation in the following section revealed that the youth perceive the highest overeducation in the field of *Natural sciences, mathematics and statistics*, followed by *Education* and *Business, administration and law*. However, these statistics do not control for other factors and may reveal the structure of the sample.
[8] Analysis of overeducation based on subjective measure indicated higher rates for female respondents.

overeducated positions. However, the details on precise mechanism affecting gender differences in overeducation in Croatia is left for future research.
It has to be emphasised that these results are based on a sample restricted to youth living with their parents. The characteristics of youth overeducation for the overall sample could be significantly different, as the individual preferences of youth could be significantly guided by the composition of their household. For example, the literature has clearly demonstrated that labour market decisions are not made on an individual level. Even within the group of youth co-residing with their parents, further heterogeneities could be explored, related to whether their co-residence is permanent or temporary, voluntary or involuntary. However, exploration of these effects is left for future research efforts.

4.2. Subjective Overeducation Measure

Figure 2 compares the subjective and statistical measures of youth overeducation across the countries. The data clearly reveal that Croatia belongs to a group of countries with significantly higher subjective than statistical youth overeducation rates. This pattern is evident in all post-socialist economies. The highest subjective youth overeducation rates are recorded for Latvia, Bulgaria and Lithuania. It is also interesting to note that in the countries most frequently analysed in the youth overeducation literature (Spain, France), the subjective overeducation rate is actually lower than the statistical one.

Figure 2: Subjective and statistical measures of youth overeducation, 2021

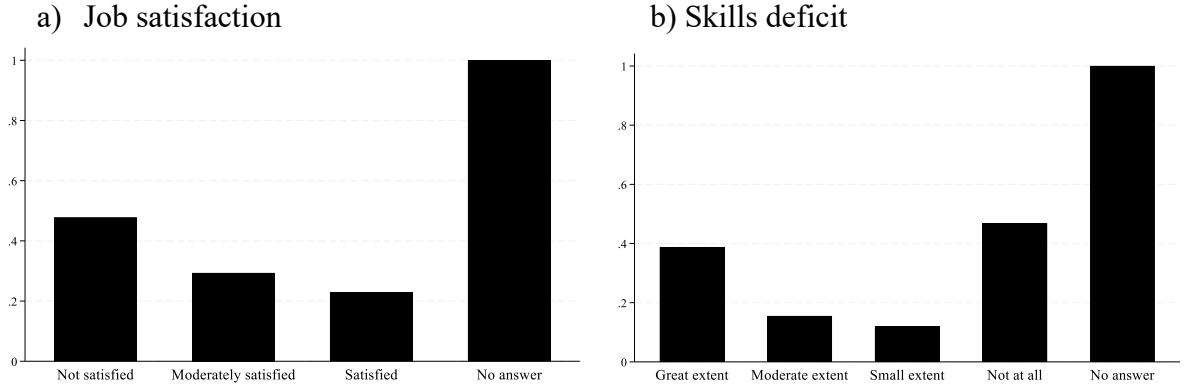


Source: Eurostat and author based on Cedefop (2021)

In accordance with the stepping-stone hypothesis, youth may accept overeducated positions because they consider them as temporary positions leading to a better match job in the future. While the data source does not enable clear identification of whether the overeducated position is voluntary or not, it does allow for the analysis of job satisfaction and perceived

skills deficit relative to the overeducation. The data in Figure 3 report the average overeducation propensity according to different levels of self-perceived job satisfaction or skills deficit.

Figure 3: Perceived job satisfaction and skills deficit



Source: Author based on Cedefop (2021)

The data reveal that in both cases, most individuals who do not provide an answer to these questions have the highest percentage of subjective overeducation. This could indicate a negative general perception of their job position, which may have a lasting impact on their productivity. When asked about job satisfaction, those who are not satisfied also have the highest rates of overeducation, in accordance with previous findings in the literature (Ortiz-Gervasi and McGuinness, 2018). However, related to the perception of a skills gap, there is a polarisation. Most youth who do not perceive a skill gap have high overeducation rates, but a large percentage also perceive that their skills are inadequate to a great extent.

Table 4: Marginal effects after the probit estimates, subjective measure of overeducation

Variable	**Overedu_s**
Female	-0.062 (0.055)
Native	-0.198 (0.189)
EduH	0.379*** (0.055)
Urban	-0.064 (0.053)
Private sector	0.097* (0.058)
Small firm	0.075 (0.056)
Permanent contract	-0.067 (0.057)
Skills deficit	0.003 (0.055)
Job satisfaction	0.189* (0.088)
Observations	252
Log likelihood	-128.8
Pseudo R^2	0.151

Notes: *** p<0.01, ** p<0.05, * p<0.1.

Source: Author's estimates based on Cedefop (2021)

The results of the probit estimates confirm the positive association between the subjective overeducation and job dissatisfaction. However, the results do not implicate that there is a significant association between the self-perceived skills gap and self-perceived overeducation, suggesting that the youth can clearly differentiate between the formal education and the demand for skills in the labour market. It can be also noticed that, similar to statistical overeducation, subjective overeducation is higher among young people with higher educational attainment. The results also point to positive association between self-perceived overeducation and employment in the private sector. The results presented here should be, however, taken with caution as they are analysed based on a relatively small sample and the dataset that captures only a single year.

5. Conclusions

The analysis in the paper provided important insight into the youth overeducation in Croatia. First, it was established that, according to the statistical measure published by Eurostat, youth overeducation (although significantly higher than the overeducation of the overall population) is lower than the EU-average. However, the subjective measure indicates significantly higher overeducation among Croatian youth. This finding is important because higher subjective overeducation can be associated with a large number of adverse labour market outcomes.

The second contribution of the paper is that it reveals a cyclical overeducation pattern in Croatia, with an extensive increase in overeducation in the aftermath of the Great Recession. The third contribution is related to revealing the importance of indicators aiming to capture parents' networks on overeducation. The empirical analysis of overeducation predictors revealed that when children work in the same economic activity or same occupation as their parents, the probability of overeducation is higher. While the results are interesting, further research is needed to explore the underlying mechanisms.

Finally, it was established that the subjective measure of youth overeducation is associated with higher job dissatisfaction and higher perceived skills deficit. This implies that although youth's formal education is higher than required by their job positions, their skills are not adequate for the same position. The results are subsequently supporting the evidence of a mismatch between the outcomes of the educational system and labour market demand, calling for a policy intervention.

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A scientific paper

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EXPLORING THE RELATIONSHIP BETWEEN QUALITY OF LIFE AND THE DEGREE OF INTERNATIONALISATION OF THE ECONOMY: EVIDENCE FROM PORTUGAL (2005-2022)

ABSTRACT

This study explores the complex, bidirectional relationship between internationalisation and quality of life, a topic previously explored mostly from a one-sided perspective. While past research has emphasized how internationalisation can influence well-being, this study address a gap in the literature by also investigating how a country's quality of life might affect its degree of internationalisation. Using a quantitative approach, the research analyses annual data from 2005 to 2022, focusing on key indicators such as the degree of economic openness, the well-being index, and set of control variables. The methodological framework includes multiple regression models, aiming to identify key determinants and assess the strength and direction of the relationships among variables. The findings show that internationalisation does exert a direct, significant impact on well-being, instead, life expectancy is found to be the primary driver of quality of life. Conversely, quality of life does not appear to directly influence internationalisation, with Gross Domestic Product (GDP) per capita emerging as the most significant explanatory variable. These results suggest that the relationship between internationalisation and quality of life is influenced by underlying economic and structural factors, highlighting the importance of integrated public policies that concurrently advance both social welfare and international economic engagement.

Key words: *Globalisation; Internationalisation; Quality of Life; Well-Being.*

1. Introduction

International trade has historically played a central role in shaping social, cultural, and economic dynamics, a role that continues in today's increasingly interconnected world. In recent decades, many of these transformations have been intensified by the process of globalisation. While several studies have explored how global economic integration influences growth and efficiency (Dreher et al., 2008), relatively limited attention has been given to its implications for broader measures of social well-being.
The internationalisation of trade is often regarded as a driver of economic development and, by extension, a potential contributor to improvements in quality of life (Mullen et al., 2009).

However, the relationship between a country's degree of internationalisation and the well-being of its population remains insufficiently explored. Existing research tends to focus primarily on macroeconomic performance, and findings regarding the link between internationalisation and quality of life are fragmented and sometimes contradictory (Majeed, 2018).

Thus, this study addresses a critical gap in the literature by investigating the bidirectional relationship between the economy's degree of internationalisation and quality of life. Accordingly, this research is guided by the following research questions: *What is the nature of the relationship between the degree of internationalisation of the economy and the level of quality of life? How do these variables influence one another over time?* To address these questions, we adopt a quantitative methodology based on secondary data provided by the Instituto Nacional de Estatística (INE), covering the period from 2005 to 2022.

To strengthen the conceptual foundation of the study, the relationship between internationalisation and quality of life is conceptualised as multifaceted and potentially bidirectional, operating through several theoretical channels. On the one hand, internationalisation may enhance quality of life by promoting economic growth, improving access to goods and services, facilitating technological transfer, and generating employment, as emphasized in neoclassical and globalisation-oriented frameworks. On the other hand, critical perspectives highlight that these benefits are not always evenly distributed and may lead to adverse outcomes, such as income inequality, labour market instability, and environmental pressures, making the overall impact dependent on institutional quality, public policies, and redistributive capacity.

Conversely, higher levels of quality of life, associated with stronger institutions, better social conditions, and greater human development, can foster a more attractive and competitive environments for international engagement. Overall, this study adopts the view that the relationship between internationalisation and quality of life is complex, context-dependent, and influenced by structural factors (Kibria & Toufique, 2024; Naz, 2023; Ndofirepi, 2024; Omri et al., 2025), and therefore explores both directions of association within the Portuguese context.

2. Literature review

2.1. Internationalisation

The distinction between internationalisation and globalisation is notable. Internationalisation is generally understood as the expansion of cross-border activities while maintaining the relevance of national boundaries (Ramírez & Rodriguez-Medina, 2023). Conversely, globalisation refers to the intensification of worldwide social, political, and economic interactions, resulting in a complex scenario of interconnected events and processes (Anthony, 1990; Kibria & Toufique, 2024).

Oman (1996) characterizes globalisation as the significant rise in economic activity across national and regional political borders. This is evidenced by increased movements of goods, services, property rights, and people, facilitated by the reduction of governmental barriers and technological advancements. Held and McGrew (1998) emphasizes the global integration of trade, highlighting the increasing ease with goods and services move across borders through

imports and exports. Thus, globalisation emerges as a multidimensional concept that includes economic, social, political, and environmental dimensions (Keohane & Nye, 2003).

On the other hand, internationalisation is seen as a firm-level process involving the extension of activities, such as research, development, production, and sales into foreign markets (Hollensen, 2011). It is often framed as a gradual, step-by-step engagement with international markets, implying growth and development. Over time, this sustained involvement contributes not only to firm-level benefits but also to broader economic development at national and local levels (Campos et al., 2018).

The conceptual foundations of internationalisation originate from Coase's (1960) transaction cost theory, which was applied to multinational firms by Buckley and Casson (1976). Several theoretical models have since been developed to explain the motivations strategies behind internationalisation (Francischini & Lima, 2022). Among them, the Uppsala model by Johanson and Vahlne (1977) conceptualizes internationalisation as a learning-based, incremental process, typically beginning in markets that are geographically and culturally closer. Internalization theory, by contrast, posits that firms internationalize to better control operations and reduce transaction costs (Buckley & Casson, 1976). The Resource Based View (RBV) adds another layer by asserting that firms leverage their unique internal resources and capabilities to gain competitive advantages in international markets (De Moraes et al., 2006).

At the macroeconomic level, the internationalisation of an economy is often assessed using indicators such as the degree of openness, typically measured by the ratio of total exports and imports to a country's Gross Domestic Product (GDP) (Gräbner et al., 2021). This metric reflects the extent of a country's integration into the global economy and serves as key reference point for analysing the effects of trade on national competitiveness, income distribution, and overall economic development (Mroczek-Dąbrowska, 2016).

Understanding the scope and dynamics of internationalisation is crucial for exploring its broader socioeconomic consequences. One of the most important aspects of this analysis involves its potential relationship with quality of life (QOL) – a multidimensional construct including health, income, education, and overall well-being – which is examined in the following section.

2.2. Quality of Life

The concept of quality of life (QOL) has been widely analysed across disciplines, resulting in varied and sometimes divergent interpretations. At its core, QOL reflects the multifaceted conditions of human existence and is often associated with terms such as well-being, life satisfaction, happiness, living standards, and development. It is a multidimensional concept including both objective indicators (e.g., income or life expectancy) and subjective dimensions (e.g., personal satisfaction and perceived well-being) (Ahmad et al., 2023; Matarrita-Cascante, 2010).

Some scholars treat QOL as synonymous with health, while others argue that health is only one component within a broader conceptual framework (Fleck et al., 1999). Day and Jankey (1996) identified four primary perspectives of QOL: economic, biomedical, psychological, and general. The economic view prioritizes material indicators such as income and employment. In contrast, the psychological perspective focuses on individual subjective

experiences. Biomedical approaches link QOL directly to health outcomes, whereas general frameworks highlight its comprehensive, multidimensional nature (Day and Jankey, 1996). This multidimensionality is shaped by a variety of internal and external factors, including individual traits, socioeconomic conditions, and environmental influences. Sen (1997) emphasized the importance of basic material and social elements – such as housing, safety, healthcare access, and income – in achieving well-being. Similarly, Ryff (1998) stressed the role of social interactions and civic engagement in fostering emotional resilience and enhancing collective welfare. Environmental factors such as pollution and public safety also influence individuals' perceptions of their QOL (Carson, 2015).

Equity, particularly in health and education, is essential in promoting QOL across populations. Braveman et al. (2011) highlight health equity as a foundational element for reducing disparities and improving social well-being. Education similarly empowers individuals to understand and improve their conditions, contributing directly to both personal development and social progress (Brondos, 2022).

Workplace dynamics also contribute significantly to QOL. Motivational factors, job satisfaction, and work-life balance are key components in achieving holistic well-being (Bevins, 2018). Broader social and economic stability further support autonomy and individual fulfilment, while their absence constrains opportunity and decreases QOL (Corbridge, 2002).

Given its multifaceted nature, QOL must be analysed as a socially constructed phenomenon shaped by both measurable factors, such as income, education, and health, as well as personal perceptions of life satisfaction (Sinha, 2019). Objective indicators include metrics such as GDP per capita, life expectancy, access to health care, and employment rates (McGillivray & Clarke, 2006), while subjective aspects involve emotional well-being, happiness, and meaning in life (Veenhoven, 2007).

The Human Development Index (HDI) developed by the United Nations Programme (UNDP, 2010) represents one of the most well-known attempts to quantify QOL, focusing on life expectancy, education, and income. However, its reliance on aggregate data can hide inequalities and marginalize disadvantaged groups (Stiglitz, 2012). In response, the Inequality-Adjusted Human Development Index (IDHAD) was established to account for disparities, though its methodology has drawn criticism and led to calls for incorporating subjective inequality measures (Scherbov & Gietel-Basten, 2020).

While GDP per capita remains a widely used proxy for QOL (Dollar & Kraay, 2002), it has clear limitations. It does not reflect income distribution, which is a critical determinant of individual well-being, nor does it account for non-market contributions such as unpaid domestic work, which significantly enhance overall welfare (Folbre, 2008). Therefore, a holistic understanding of QOL requires contributions from multiple disciplines to continually refine and contextualize the concept.

Closely linked to QOL is the notion of well-being (Omri et al., 2025), often used interchangeably in broader discussions. Well-being refers to a favourable life experience but does not always define the specific attributes that make life favourable (Diener, 2010). It is typically framed as a subjective evaluation of happiness, fulfilment, and contentment, aligning closely with broader definitions of QOL and requiring a similarly integrated analytical approach (Kiefer, 2008).

The Instituto Nacional de Estatística (INE, 2019) defines well-being as achieving the highest standard of QOL, incorporating not just material conditions but also broader factors such as environmental quality, health, education, time management, civic engagement, and cultural participation. This expansive view highlights that well-being includes more than economic or consumer satisfaction – it involves strong social ties, personal safety, and life purpose (Grinstein et al., 2022). Standardized indicators as physical health, infant mortality, and life expectancy enable comparative assessment across countries (Mukherjee & Krieckhaus, 2012).

However, to monitor well-being effectively, it is essential to consolidate relevant data into a multidimensional indicator that offers clarity and policy relevance. No single metric can fully capture the complexity of individual well-being (Boncinelli & Casini, 2014). Addressing this need, the INE developed a well-being index to periodically report on social progress and individual welfare. This index has two dimensions – material living standards and overall QOL – and includes ten domains such as economic well-being, work-life balance, health, education, environmental conditions, personal safety, civic engagement, and subjective well-being (INE, 2019).

3. Hypotheses development

Well-being, recognized as essential for long-term economic development, is widely regarded as a central objective of national policy (Mukherjee & Krieckhaus, 2012; Omri et al., 2025). This aligns with the perspective that, as nations have become increasingly integrated into the global economy, public expectations and levels of well-being have risen significantly (Stiglitz et al., 2009).

Nevertheless, the effects of internationalisation on well-being are still contested. While dependency theory argues that international trade and foreign direct investment (FDI) perpetuate inequalities (Asongu, 2014), the neoliberal perspective emphasizes the role of open markets in promoting human prosperity (Sirgy et al., 2004).
International trade directly impacts QOL by driving economic growth, creating jobs, and increasing access to goods and services. These economic shifts, enhanced by globalisation, influence income levels and living standards (Adhikari, 2018). In support of this view, recent studies have shown that international trade contributes to both subjective and objective well-being indicators, including improvements in the HDI (Tahir & Majeed, 2021; Wang et al., 2023).

From a political perspective, internationalisation is linked to increased economic freedom and reductions in corruption, both of which positively affect human well-being (Majeed, 2018). In this context, participation in international organizations, driven by national interest, can also produce outcomes that enhance well-being (Mukherjee & Krieckhaus, 2012).
Despite this, progress in well-being has not been evenly distributed. While internationalisation is positively associated with well-being in developing countries, it has often led to a widening of social inequalities in developed nations (Gaston & Gulasekaran, 2009).

Greater economic openness – characterized by specialization, economies of scale, enhanced competitiveness, and innovation incentives – is considered vital for economic growth and poverty reduction (Agénor, 2004). Accordingly, the prevailing view emphasizes the positive effects of internationalisation on QOL, though access to technology, knowledge transfer, and

development support (Mukherjee & Krieckhaus, 2012). However, these benefits require complementary policies to ensure their equitable and sustainable distribution (Krueger, 2020).

The debate over free trade reflects these tensions. Proponents argue that freed trade enhances consumer and producer efficiency, while critics highlight its environmental costs and tendency to disproportionately benefit multinational corporations (Mullen et al., 2009). Neoclassical theory holds that export-led growth can jeopardize QOL when prices increase for domestically essential goods, reducing affordability for local consumers (Mullen et al., 2009).

However, exports, when backed by sound industrial policies, can foster job creation, economic diversification, and resilience, all of which positively impact QOL (Haussmann, 2020; Rodrik, 2018). Furthermore, export-led growth promotes domestic efficiency through economies of scale and supports higher employment (Sirgy et al., 2004).

On the imports side, increased access to goods can alleviate scarcity, intensify competition, and reduce prices, enhancing customer welfare (Mullen et al., 2009). Although imports can have short-term negative impacts, their long-term effects often include higher personal income and employment, together with technological advances in healthcare, education, and industry (Sirgy et al., 2004; Tahir & Majeed, 2021).

Therefore, increased imports play a crucial role in improving social and health welfare by boosting tax revenues, which, in turn, translate into better public services. According to Sirgy et al. (2004), increased tax collection allows governments to increase public spending in several areas, such as health, education, and public security. Based on these arguments, the following relationship can be established:

Hypothesis 1: *The higher the degree of internationalisation of an economy, the higher the level of quality of life.*

Conversely, the QOL of a country can also influence its degree of internationalisation. Countries with high living standards often provide stable and attractive environments for investment, aligning with Dunning's eclectic theory, which highlights ownership, location, and internalization advantages (Dunning, 1980). Therefore, it is suggested that countries with high standards of living provide more stable and attractive environments for foreign investment.

Institutional quality plays a key role in this process. Strong institutions enhance the effectiveness of national resources and facilitate international engagement (Li, 2018). In turn, underdeveloped institutional environments can either hinder internationalisation or motivate firms to expand into more developed markets to offset domestic constraints (Cuervo-Cazurra & Ramamurti, 2017). Institutional factors such as national income, robust institutions, trade openness, and the availability of venture capital positively impact internationalisation (Ndofirepi, 2024).

Countries with high standards of living tend to attract FDI, improve production efficiency, and create environments conducive to innovation and international collaboration (Sölvell, 2015). These countries also tend to wield soft power – the ability to influence others through cultural and institutional appeal rather than coercion – which further boosts their global presence (Nye, 2004). Social trust and institutional legitimacy are also important. Trust

between citizens and institutions supports both economic growth and the smooth integration of national economies into international markets (Putnam, 2000).
From a comparative advantage theory, countries with higher living standards are more likely to specialize in high-value goods and services, contributing to their deeper participation in international trade (Senga et al., 2017). Similarly, Krugman (2018) argues that advanced economies engage in sophisticated trade patterns, while economic geography theories suggest these countries are better integrated into global value chains due to their superior infrastructure, technology, and skilled labour (Coe et al., 2008). Therefore, it is expected that:

Hypothesis 2: *The higher the level of quality of life, the greater the degree of internationalisation of the economy.*

4. Methodology

4.1. Data collection and sample

The research adopts a quantitative approach, relying on secondary data gathered from the Instituto Nacional de Estatística (INE). The sample consists of a time series for Portugal covering the period from 2005 to 2022, yielding 18 observations for each variable. This period was chosen to ensure the continuous availability and consistency of data, enabling a reliable longitudinal analysis. Prior to analysis, the dataset was carefully examined, and no missing values were identified. Given the aggregated nature of the data, no extreme outliers required removal or transformation beyond standard adjustments to meet regression assumptions.
A consolidated database was subsequently developed, organised by reference year to ensure temporal alignment and completeness. The dataset contains no omissions or inconsistencies. As the data are aggregated at the national level, the sample does not include individual-level or subjective responses but instead reflects macro-level trends derived from standardized economic and social indicators (INE, 2019).
Table 1 presents the correlation matrix for the variables under study. The results reveal positive and statistically significant correlations between the well-being index (IBE) and several key variables, including the degree of openness (GA), GDP per capita (PIB), life expectancy (EV), and average years of schooling (AME). Conversely, a negative and statistically significant correlation is observed between IBE and inequality (GINI).

Table 1. Correlation matrix

Variables	1	2	3	4	5	6	7
1. IBE	1.000						
2. GA	0.744***	1.000					
3. PIB	0.890***	0.698**	1.000				
4. TD	-0.446	-0.323	-0.603**	1.000			
5. EV	0.927***	0.824***	0.849***	-0.374	1.000		
6. AME	0.928***	0.858***	0.861***	-0.386	0.989***	1.000	
7. GINI	-0.932***	-0.675**	-0.809***	0.114	-0.880***	-0.863***	1.000

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. IBE = well-being index, GA = degree of openness, PIB = GDP per capita, TD = unemployment rate, EV = life expectancy, AME= average years of schooling, GINI = inequality.
Source: Authors

4.2. Variables

The study employs a bidirectional model to analyse the relationship between the degree of internationalisation (DOI) of an economy and quality of life (QOL). In hypothesis 1, QOL is positioned as the dependent variable. The IBE, developed by the Instituto Nacional de Estatística (INE, 2019), is a multidimensional composite index including ten domains – such as, health, education, social relations, and work – offering a comprehensive representation of QOL.

The independent variable in this hypothesis is DOI, proxied by GA, calculated as the sum of exports and imports relative to Gross Domestic Product (GDP). Widely adopted in the literature, this metric effectively captures a country's level of internationalisation (Gräbner et al., 2021; Mroczek-Dąbrowska, 2016) and reflects Portugal's exposure to foreign markets.
Conversely, hypothesis 2 treats QOL as the independent variable and DOI as the dependent variable. This approach is grounded in theoretical perspectives emphasizing the role of institutional quality and well-being in facilitating international integration and economic expansion (Ndofirepi, 2024; Sölvell, 2015).

To ensure analytical rigor, the model includes a set of control variables that account for other structural factors potentially influencing the target variables. Despite its limitations – particularly its insensitivity to income distribution (Stiglitz, 2012) – GDP per capita (PIB) remains a widely recognized indicator of national wealth. Higher income levels are generally associated with enhanced living conditions (Dollar & Kraay, 2002) and greater capacity for international engagement through innovation and investment.

The unemployment rate (TD) is included as a control for labour market conditions, given its established link with economic vulnerability and diminished well-being. High unemployment constrains income generation and social mobility, adversely affecting both QOL and the potential for economic competitiveness (Braveman et al., 2011).

Life expectancy at birth (EV), a key indicator of public health and human development, is also incorporated. Its relevance extends beyond medical advancements, serving as a reflection of broader living conditions and access to essential services (Braveman et al., 2011). Thus, it captures an essential dimension of well-being that may influence a country's international economic capacity.

Average years of schooling (AME) represents educational attainment, a foundational element of human capital formation. Higher levels of education contribute to individual empowerment, improved QOL, and increased national productivity, reinforcing international competitiveness (Brondos, 2022). For this reason, AME is an important control variable for both hypotheses.

Finally, inequality is accounted for through the Gini coefficient (GINI), which measures income distribution. Elevated levels of inequality decrease social cohesion and hinder equitable development, negatively impacting overall well-being (Stiglitz, 2012). Including GINI in the model allows for a more nuanced understanding of the redistributive effects of internationalisation and QOL.

5. Results

The statistical analysis was conducted using the R software via the JASP interface (Jeffreys's Amazing Statistics Program), a free and open-source platform. To test hypothesis 1, a multiple linear regression was conducted, using the well-being index (IBE) as the dependent variable representing quality of life (QOL). The independent variable was the degree of openness (GA), serving as a proxy for the degree of internationalisation (DOI), while the remaining variables (PIB, TD, EV, AME, and GINI) were included as controls to isolate the specific effect of internationalisation on quality of life.

The analysis adopted a stepwise approach, beginning with a comprehensive model that included all selected variables. Successive refinements were applied to meet the assumptions of multiple linear regression, such as linearity, homoscedasticity, and normality of residuals, as recommended by Marôco (2021). These adjustments were both statistically and theoretically grounded, with each stage of the model development outlined in Table 2.

Table 2. Adjustment process for regression model (hypothesis 1)

Model	Included variables	Issues identified	Adjustments made	Adjusted R^2	Assumptions met
Initial	IBE, GA, PIB, EV, TD, AME, GINI	High multicollinearity	Removed TD and GINI	0.965	No
Adjusted	IBE, GA, PIB, EV, AME	Heteroscedastic residuals	Log and squared-root transformations	0.968	Partially
Final	IBE, GA, TD, EV	Final adjustments to reduce redundancy	Final optimized and adjusted model	0.970	Yes

IBE = well-being index, GA = degree of openness, PIB = GDP per capita, EV = life expectancy, TD = unemployment rate, AME= average years of schooling, GINI = inequality.

Source: Authors

In the final model, two variables remained statistically significant: unemployment rate (TD) ($\beta = -0.433$; $p < 0.001$), and life expectancy at birth (EV) ($\beta = 0.944$; $p < 0.001$) (Table 3). These results reinforce the notion that improved health outcomes are positively associated with well-being, while high unemployment rate acts as a significant constraint on quality of life

Interestingly, the degree of openness (GA) showed a negative but non-significant effect on QOL ($\beta = -0.074$; $p < 0.259$), suggesting that the degree of internationalisation, as measured in this model, does not exert a statistically meaningful influence on quality of life (Table 3). While the model is statistically robust (adjusted $R^2 = 0.970$), the lack of a significant effect of DOI on QOL suggests that hypothesis 1 is not empirically supported by the data.

Table 3: Regression coefficients (hypothesis 1)

Model		Unstandardized	Standard Error	Standardized	t	p	95% CI		Collinearity Statistics	
							Lower	Upper	Tolerance	VIF
M_0	(Intercept)	37.122	1.595		23.270	< 0.001	33.757	40.488		
M_1	(Intercept)	-410.283	26.879		-15.264	< 0.001	-467.933	-352.633		
	GA	-0.082	0.070	-0.074	-1.178	0.259	-0.233	0.068	0.453	2.209
	TD	-0.825	0.083	-0.433	-9.939	< 0.001	-1.002	-0.647	0.932	1.073
	EV	5.766	0.375	0.944	15.376	< 0.001	4.962	6.570	0.469	2.134

GA = degree of openness, TD = unemployment rate, EV = life expectancy.

Source: Authors

To test hypothesis 2, a second multiple linear regression was conducted, with degree of internationalisation serving as the dependent variable. The aim was to determine whether a nation's quality of life, along with a set of control variables (PIB, TD, EV, AME, and GINI), helps explain the extent of its international economic integration.

Following Marôco (2021), the model was iteratively refined to enhance statistical reliability and ensure that all key regression assumptions were fulfilled (Table 4). The model demonstrated a strong overall fit, with an adjusted R^2 of 0.774, suggesting that the included variables explain a substantial portion of the variation in DOI during the study period.

Table 4: Adjustment process for regression model (hypothesis 2)

Model	Included variables	Issues identified	Adjustments made	Adjusted R^2	Assumptions met
Initial	IBE, TD, EV, PIB, AME, GINI	Severe multicollinearity; non-normal residuals	Removed EV and AME due to high correlation	0.799	Partially
Adjusted	IBE, TD, PIB, GINI	Heteroscedastic residuals; residual multicollinearity	Further variable simplification	0.641	Improved, but still limited
Final	IBE, TD, PIB	Lack of significance for IBE	Removed redundant variables	0.774	Yes

IBE = well-being index, TD = unemployment rate, EV = life expectancy, PIB = GDP per capita, AME= average years of schooling, GINI = inequality.

Source: Authors

The final model retained three variables: quality of life (IBE) ($\beta = -0.429$; $p = 0.128$), GDP per capita (PIB) ($\beta = 1.426$; $p < 0.001$), and the unemployment rate (TD) ($\beta = 0.397$; $p < 0.05$) (Table 5). The results show that both GDP per capita and unemployment have a positive and statistically significant effect on DOI. Conversely, QOL shows a negative but non-significant effect, indicating that higher levels of quality of life do not appear directly influence the internationalisation of the Portuguese economy. Therefore, hypothesis 2 is not supported by the empirical data.

Table 5: Regression coefficients (hypothesis 2)

	Model	Unstandardized	Standard Error	Standardized	t	p	95% CI		Collinearity Statistics	
							Lower	Upper	Tolerance	VIF
M_0	(Intercept)	61.000	1.423		42.854	< 0.001	57.997	64.003		
M_1	(Intercept)	-0.754	8.945		-0.084	0.934	-19.938	18.430		
	IBE	-0.383	0.237	-0.429	-1.618	0.128	-0.891	0.125	0.189	5.290
	TD	0.675	0.235	0.397	2.872	0.012	0.171	1.178	0.697	1.435
	PIB	3.859	0.771	1.426	5.007	< 0.001	2.206	5.512	0.164	6.089

IBE = well-being index, TD = unemployment rate, PIB = GDP per capita.

Source: Authors

It is worthwhile noting that, although the study adopts a bidirectional analytical framework, the empirical approach is based on multiple linear regression, which identifies statistical associations rather than causal relationships. Thus, the two hypotheses should not be interpreted as establishing causality in opposite directions, but rather as exploring whether significant relationships exist when the roles of dependent and independent variables are reversed. This approach allows for a more comprehensive understanding of the interaction between internationalisation and quality of life, while acknowledging the methodological limitations in capturing causal dynamics.

6. Discussion and conclusion

Regarding hypothesis 1, which proposed that more internationalized economies tend to exhibit higher levels of quality of life, the empirical results do not offer direct support. In the final adjusted model, the degree of internationalisation – proxied by the degree of openness – was not statistically significant ($\beta = -0.074$; $p = 0.259$). This contrasts with existing literature that often relates economic openness with improved well-being through increased investment, access to goods, technology transfer, and job creation (Mukherjee & Krieckhaus, 2012; Rodrik, 2018; Sirgy et al., 2004). The findings from this study suggest that the relationship between internationalisation and quality of life is not straightforward or universally applicable, particularly in economies with structural vulnerabilities.

One plausible explanation lies in the mediated nature of this relationship. The positive effects of internationalisation may depend on intermediary factors such as institutional quality, income distribution, and social investment (Adhikari, 2018; Stiglitz, 2012). In the Portuguese context – characterized by economic volatility, labour marked rigidity, and regional disparities – these mediating factors can constrain the extent to which international openness translates into tangible improvements in well-being. Furthermore, asymmetries in the distribution of benefits from international trade may increase social and economic inequalities, potentially offsetting gains in aggregate well-being.

Thus, although internationalisation is frequently highlighted as a driver of development (e.g., Haussmann, 2020; Rodrik, 2018), the lack of a statistically significant effect in this study emphasizes the importance of contextual and structural conditions. Rather decreasing the relevance of economic openness, these findings suggest that its influence on quality of life is potentially indirect, nonlinear, and contingent upon complementary policies such as social protection, employment generation, and equitable wealth distribution.
In this regard, it should be noted that, the unemployment rate showed a negative and statistically significant association with quality of life ($\beta = -0.433$; $p < 0.001$), which

corroborates the literature that consistently links unemployment with decreased well-being, mental health deterioration, and reduced access to opportunities (McGillivray & Clarke, 2006; Braveman et al., 2011). This finding highlights the central role of employment in promoting well-being, especially in countries like Portugal that were heavily impacted by economic downturns such as the 2008 financial crisis and subsequent austerity measures.

Life expectancy at birth emerged as the most influential variable in the model ($\beta = 0.944$; $p < 0.001$), confirming its strong positive association with quality of life. This aligns with the literature that regards longevity as a core dimension of well-being and human development (Mukherjee & Krieckhaus, 2012). In Portugal, the access to a universal public healthcare system and improvements in public health over the past two decades have contributed significantly to longer life spans, thus enhancing overall well-being.

With regard to hypothesis 2, which suggested that higher levels of quality of life promote greater economic internationalisation, the results also fail to provide empirical support. In the final model, quality of life was not statistically significant ($\beta = -0.429$; $p = 0.128$), indicating that better living conditions do not directly translate into a higher degree of internationalisation. This is consistent with research suggesting that the relationship between well-being and internationalisation may be indirect and mediated by institutional factors such as governance quality, innovation capacity, and education systems (Mukherjee & Krieckhaus, 2012; Nye, 2004). The Portuguese case may exemplify this pattern, where improvements in quality of life do not necessarily lead to stronger export performance or higher foreign investment, especially in sectors not closely tied to international trade.

Interestingly, the unemployment rate was positively and significantly associated with the degree of internationalisation ($\beta = 0.397$; $p < 0.05$), a result that may appear counterintuitive. However, this can be explained by the dual nature of internationalisation: while openness facilitates growth in competitive sectors, it can also expose domestic industries to increased external competition, leading to job losses in less competitive segments (Adhikari, 2018). Consequently, in contexts marked by economic vulnerability, higher degrees of openness may be accompanied by higher unemployment, particularly during periods of economic adjustment or industrial restructuring.

The most substantial contributor to this model was GDP per capita, which showed a positive and highly significant effect on the degree of internationalisation ($\beta = 1.426$; $p < 0.001$). This aligns with the view that economic performance enhances international competitive, enabling countries to participate more actively in global trade and investment flows (Coe et al., 2008; Rodrik, 2018). Higher income levels support investments in infrastructure, technological innovation, and production upgrading – all of which facilitate export growth and foreign market entry. In the Portuguese contexts, improvements in GDP per capita have corresponded with integration into global value chains and expanded trade relationships.

Building upon the above, the rejection of both hypotheses does not invalidate the theoretical relevance of the bidirectional relationship between the degree of internationalisation and quality of life. Rather, it suggests that this relationship is likely mediated by multiple structural factors, including labour market dynamics, health outcomes, economic performance, and institutional capacity. These findings highlight the need for contextualized and multidimensional analyses when examining the intersections between internationalisation and quality of life. However, they should be interpreted with caution, particularly given the methodological limitations associated with using multiple regression in a time-series context.

While the results reveal significant associations, they do not establish causal links between internationalisation and quality of life. This limitation may partly explain why the bidirectional hypotheses were not supported, as the interaction between these variables is likely dynamic and shaped by lagged and structural effects that the current model does not capture.

6.1. Theoretical and practical implications

This study presents several theoretical and practical implications. From a theoretical perspective, the findings contribute to the refinement of existing literature by questioning overly deterministic interpretations of the relationship between internationalisation and quality of life. While much of the literature emphasizes the positive effects of internationalisation on living standards (e.g., Rodrik, 2018; Sirgy et al., 2004), this study provides empirical evidence that such effects may not be automatic or uniform. Instead, outcomes appear to be highly contingent on national structural conditions, such as institutional capacity, health care quality, and labour market resilience. This finding echoes the warnings in more critical globalisation literature, which stresses the benefits from economic openness are often asymmetrically distributed (Adhikari, 2018).

The practical implications of these results are also multifaceted. First, they emphasize the need for firms and business leaders to recognize that international competitiveness does not guarantee improvements in social welfare. For instance, multinational enterprises expanding into small open economies like Portugal may benefit from improved market access but still operate in contexts where quality of life indicators remain stagnant or even deteriorate. Therefore, socially responsible business strategies, such as local investment in workforce development and fair labour practices, become crucial in aligning the internationalisation with broader social goals.

Second, for policymakers, the findings underline the need for integrated and multidimensional development strategies. Economic polies aimed at enhancing internationalisation (e.g., trade liberalization or export promotion) must be accompanied by robust social policies that support healthcare, education, employment, and social protections. For example, policies that promote export growth in high-value sectors should be matched with investments in human capital to ensure that the population can benefit equitably from international integration. Similarly, public health infrastructure must be reinforced to sustain life expectancy gains that, as shown in this study, have a significant bearing on quality of life.

6.2. Limitations and future research

While this study provides valuable contributions, it is important to acknowledge its limitations, which open avenues for future research. First, the analysis is confined to the Portuguese context and is based on a relatively small number of observations, which is typical of time-series based on annual data. This limitation constrains the generalizability of the findings. Future research could address this by conducting cross-country comparative analyses and incorporating institutional variables to evaluate whether the observed patterns hold across different national settings.

A second key constraint concerns the use of composite proxies. Quality of life was measured via a broad well-being index that integrates ten distinct dimensions, including both material conditions of living and quality of life. While this multidimensional approach is

comprehensive, it can hide more direct effects of internationalisation on specific aspects of quality of life. Similarly, the degree of openness used to measure the degree of internationalisation, calculated as the sum of exports and imports over GDP, captures economic integration but no other relevant dimensions such as FDI, technological exchange, or institutional integration. Future research should consider using more target indicators for internationalisation and quality of life to isolate more precise causal mechanisms.

Another major limitation involves the statistical technique employed. Multiple linear regression, while useful for identifying associations and controlling for confounding variables, is inherently limited in its capacity to capture temporal ordering and bidirectional causality. Because the variables are treated as contemporaneous or averaged over time, the technique cannot ascertain whether changes in the degree of internationalisation precede changes in quality of life or vice-versa. To overcome this, future studies should adopt longitudinal analytical frameworks, particularly cross-lagged panel model (CLPM). CLPM is a structural equation modelling technique designed to test reciprocal effects across time points. It includes both autoregressive paths (accounting for the stability of each variable over time) and cross-lagged paths (capturing how one variable at time *t* predicts changes in another at time *t+1*), allowing for more rigorous testing of directionality and potential causal precedence.

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APPLICATION OF ARTIFICIAL INTELLIGENCE IN SOCIAL CARE: OPPORTUNITIES, CHALLENGES AND FUTURE DIRECTIONS

ABSTRACT

This paper provides a systematic qualitative synthesis of the integration of Artificial Intelligence (AI) into the social welfare system, highlighting its potential to improve efficiency, personalization and accessibility of services. Advances in machine learning, natural language processing and sensor technologies have enabled the automation of administrative tasks, advanced data analysis and more precise risk assessment, transforming traditional work practices.
The aim of this paper is to explore the current state of AI implementation in the social welfare system and to answer key research questions: what is the frequency and scope of AI implementation in the social welfare system, what are the main advantages and disadvantages of its implementation and what are the directions of investment and strategic priorities in the social welfare sector?
The paper provides an overview of successful international projects, such as risk prediction platforms in the Netherlands, chatbots in Sweden and sensor systems in Canada. The results show that AI significantly reduces administrative burden, enables early detection of vulnerabilities and extends the reach of services to remote areas. However, challenges such as data security, algorithmic bias and ethical issues require strict regulation and compliance with legal frameworks. In conclusion, responsible adoption of AI tools, along with the development of digital literacy and transparent algorithms, can promote social justice and improve the quality of support for users and professionals.

Key words: *Artificial Intelligence, Social Care, Ethical Challenges.*

1. Introduction

Artificial Intelligence itself is nothing new to the world technology, having become officially recognized as an academic field way back in 1956. What is new is the way people think about and experience Artificial Intelligence (Xu et al., 2024). We now recognize the virtually functional uses of intelligent machines, because we interact with them on a daily basis, often in life routine, not being aware of AI around us. Over the past decades, the development of artificial intelligence (AI) technology has driven profound changes across many sectors of society, including social care, social care is a complex, human-centered field that requires a high degree of sensitivity, ethical rigor along with individualized approaches (Chen et al., 2021, 345-359). The deployment of AI opens opportunities for automating administrative processes, analyzing datasets, personalizing services and crisis response, all of which can improve the

efficiency and accessibility of social services (European Commission, 2021). However, these advances also challenge data privacy protection, data security, algorithmic fairness and inclusion of all social groups calling for careful consideration of ethical principles and legal aspects. According to European Union statistics, social services sectors have recorded an annual growth rate of approximately 8% in the adoption of digital technologies, with particular emphasis on AI solutions that improve resource management and service delivery (Eurostat, 2023). In the United States, data from the National Association of Social Workers indicate that nearly 65% of social workers use some form of automated tool or AI system for needs assessment or case management (NASW, 2023). This paper will perform an analysis of AI's technological foundations, showcase examples of best practices, discuss the benefits and implementation challenges, and explore future development directions in the context of social care.

2. Methodology

The aim of this paper is to explore the current state of application of artificial intelligence (AI) in the social welfare system through a systematic qualitative synthesis of existing literature and secondary data and to attempt to answer the key research questions:
1. What is the application of artificial intelligence in the social welfare system?
2. What are the main advantages and disadvantages of its application?
3. In what direction are investments and strategic priorities in the social welfare sector moving in the future?
In order to fulfill the objective of the paper and answer the research questions, the study uses a desk research methodology, with an emphasis on the identification, synthesis and qualitative description of secondary sources. The research was conducted between October 2025 and January 2026 and included a search of all relevant scientific and professional papers in the databases Scopus, Web of Science, PubMed, IEEE Xplore and Google Scholar, which included keywords and combinations such as: "artificial intelligence", "social care", "social service technology", "digital health", "machine learning", "ethics in artificial intelligence", "privacy in artificial intelligence", "chatbots", "big data analytics" and other related terms. The review includes peer-reviewed papers, institutional reports (e.g. European Commission, NASW, Eurostat) and documented pilot projects from the last five years. The selection criteria focused on the relevance of the described applications of artificial intelligence, their impact on target groups and their compliance with the social care context. The review did not include papers older than five years, papers containing only theoretical or speculative discussions without concrete applications. The collected papers and data were assessed according to the quality criteria of clarity of methodological descriptions, transparency of sources, level of empirical evidence and ethical compliance. To move beyond descriptive reporting, the collected data were subjected to thematic analysis. This involved categorizing findings into three analytical dimensions: operational efficiency, user-centric personalization, and ethical-legal constraints. Projects from the Netherlands, Sweden, and Canada were selected as primary case studies for a comparative synthesis to identify international best practices and common systemic challenges. The paper was written and the research was conducted in Croatian. For the purposes of translating parts of the literature from English to Croatian and vice versa, the artificial intelligence tools for machine translation of primary sources ChatGPT version 4.0 (OpenAI, 2024) were used, while the Grammarly tool (Premium version, 2025) was used for grammatical correction, language checking and style formatting. All translations and grammatical suggestions were subsequently reviewed and approved by the author to ensure accuracy and academic style of the work.

3. Technological Foundations and Applications of AI in Social Care

In this chapter, we will undertake an examination of the definition and forms of Artificial Intelligence, alongside its applications within social care, emphasizing underlying technological principles and their implications for enhancing service quality and efficiency.

3.1. Definition and Forms of Artificial Intelligence

The world of artificial intelligence (UI) consists of different branches, such as natural language processing, robotics and sensor systems (EITC, 2025). It is machine learning (ML) that is key because it enables systems to learn directly from data and make decisions independently, which is evident in applications such as predictive risk assessments (Shelley and Shaw, 2024). Unlike classic programs, these systems are constantly being adapted and refined through work, often using assisted learning processes in autonomous systems to become more precise and efficient over time (Buckman, 2023). AL and ML algorithms are designed to execute four major tasks: 1. Predict outcomes, to provide answer to questions. 2. Reduce dimensionality to understand the personalities and preferences of clients. 3. Understand language. 4. Cluster and classify data (Zhu and Mazumder, 2023). Deep Learning (DL) employs multi-layer neural networks to handle high-dimensional, unstructured inputs (images, time series, text). DL models achieve state-of-the-art results in perception tasks—e.g., automated case-note summarization—by learning hierarchical feature representations (Goldkind and Wolf, 2021). Deep Learning networks typically deal with Big Data – hundreds of billions of data points, enough to yield useful information about human behaviors. Natural Language Processing (NLP) equips machines to interpret and generate human language. Modern NLP leverages deep transformer architectures to support chatbots and report automation (Goldkind and Wolf, 2021). This feat is accomplished by way of analyzing Big Data to process written or spoken “keywords” to formulate an answer. Many companies that deal in customer service these days incorporate some sort of NLP Chatbot component into their business practices. Chatbots sound like humans. Robotics integrated with AI uses physical actuators to perform tasks in the real world, such as assistive robots that facilitate mobility or robotic arms that carry out repetitive duties in care homes, thereby increase safety and operational functionality (Obi, Ishmatova and Iwasaki, 2020). Sensor Systems (e.g., ambient-assisted living sensors, wearable devices) collect in-time data on client activities or vital signs. When combined with AI analytics, they enable active monitoring and early intervention in critical incidents (Obi, Ishmatova and Iwasaki, 2020). Together, these AI forms technological foundation for more efficient, personalized, and accessible services, while also takin into considerations data governance, transparency, and deployment. In the context of social care, artificial intelligence (AI) supports four principal functions (Zhu and Mazumder, 2023):

Big-Data Analysis and Interpretation

AI methods such as association rule mining and unsupervised learning uncover patterns in large, fragmented social care datasets. For example, a co-designed solution processed over 100,000 holistic needs assessments for persons affected by cancer. By applying association-rule mining and machine-learning–driven visualizations, frontline professionals identified pressure points and reallocated resources more effectively (Kang et al., 2025).

Autonomous Decision-Making

Clinical decision-support systems (CDSS) in social and palliative care employ predictive

models to recommend interventions—automatically flagging high-risk cases or suggesting tailored care pathways without human prompting. A recent scoping study mapped AI tools that forecast symptom trajectories, guide prognostic evaluations and trigger timely clinical actions in palliative settings. (Silva-Ferreira et al., 2025)

Interactive Communication Tools

Immersive, game-engine–powered interfaces and interactive dashboards translate complex rule sets into intuitive visual models. One system rendered association-rule graphs in real time—using Boolean filters and force-directed layouts—to let social-care professionals explore relationships among risk factors and service outcomes through "playable mechanics" (Kang et al., 2025).

Decision Support for Human Workers

AI augments human judgment by delivering timely alerts, summarizing case histories and generating evidence-based recommendations. Integrated platforms combine ML-driven insights with user-friendly visualizations, enabling care teams to make informed, data-grounded decisions under time pressure improving outcome and making working environmental to more focus on critical points. (Kang et al., 2025)

3.2. Applications of Artificial Intelligence in Social Care

Artificial intelligence (AI) has been integrated into social care through a variety of innovative functions, including:

Personalized Support and Risk Assessment (User-centric Personalization)

AI-driven risk-prediction models employ machine-learning algorithms to analyze client data (e.g., demographics, service history, sensor readings) and identify early indicators of potential institutionalization or social isolation. For instance, Li et al. (2020) reported a 30% reduction in assessment time and an improvement in the accuracy of vulnerable-group identification. Such systems enable targeted interventions and more efficient allocation of resources, improving overall service responsiveness. The "Intelligent Social Welfare" framework shows us how predictive analytics optimize resource allocation across social assistance, elderly care and healthcare, improving efficiency and equity (Sun, 2025).

Chatbots and Virtual Assistants (User-centric Personalization and Accessibility)

Natural language–processing (NLP) tools power conversational agents such as "Mira" and "Emma" that handle common inquiries, triage requests, and draft routine documentation. NLP-driven chatbots handle routine inquiries, perform basic needs assessments, triage requests and draft case-notes available 24/7, in multiple languages or modalities (Kumar & Singh, 2022). In Sweden, deployment of an elder-care chatbot increased older adults' access to information by 45%. Beyond basic Q&A, these agents can be designed to escalate complex cases to human professionals.

Supportive research on AI-driven chatbots in mental-health settings highlights both their potential and limitations. Emotionally Intelligent Robots (EIRs) monitor user mood, respond empathetically and can initiate social-engagement games or reminders (Moylan & Doherty, 2025; Sindhu, 2025).

Automation of Administrative Workflows (Operational Efficiency)

Case-management platforms equipped with AI automate labor-intensive tasks such as report generation, document classification and appointment scheduling. According to OECD (2021), such automation can reduce social-worker administrative burden by up to 50%, thereby liberating more time for direct client engagement and quality-driven care. In the UK's NHS and social-care settings, AI-driven triage platforms prioritize interventions for urgent cases, reducing referral delays. Robotic process automation (RPA) and AI-based document classifiers streamline report generation, scheduling and inter-agency referrals freeing social workers for direct client engagement (Shetty et al., 2025).

Big-Data Analytics for Vulnerability Identification (Operational Efficiency and Risk Mitigation)

Advanced analytics fuse large, heterogeneous datasets wearable sensors, medical records and social-service logs to detect at-risk cohorts and emergent patterns of need. For example, the "Elderly Care AI" platform leverages sensor data to predict fall risk and medical emergencies, achieving a 25% reduction in adverse incidents (Li et al., 2020). This function supports monitoring and early-warning systems that can pre-empt crises.
Through integration of these applications' prediction, conversation, robotics, decision-support, monitoring, automation and personalization AI can affect the efficiency, accessibility and performance of social-care services. Continued interdisciplinary research, ethical guidance and stakeholder co-design are essential to realize these benefits responsibly.

Table 1: Comparative Analysis of AI Implementation Models in Social Care

Country	AI Application Type	Target Group	Key Benefit	Ethical/Technical Challenge
Netherlands	Predictive Risk Platforms	Families at risk	Early intervention & prevention	Data privacy & algorithmic bias
Sweden	NLP Chatbots	General public	24/7 Accessibility & efficiency	Lack of human empathy in crisis
Canada	Sensor Systems (IoT)	Elderly/Disabled	Independent living support	High cost & technical reliability
Synthesis	**Hybrid Integration**	**Multi-level**	**Resource optimization**	**Algorithmic transparency**

Source: Author's own elaboration

4. Key Statistics

According to the latest IDC report (2023), the global market value of AI solutions in the social services sector has reached $3.2 billion, with an expected annual growth of 12% until 2026. This reflects significant interest and investment in this area. A KPMG study (2022) shows that social services that have implemented AI systems for risk assessment and case management have achieved a reduction in case processing times by 35-45%, enabling faster response and better allocation of resources. In the "AI Outreach" project in South Korea, the use of AI chatbots and virtual assistants increased the availability of social information and services for people with disabilities and those over 60 by 50%, especially in rural areas where traditional

resources are limited (Korea Institute for AI, 2022). The "AI for Social Good" project in the UK has developed algorithms for automatic needs assessment in social care systems, with the aim of reducing bias and increasing transparency. The results showed a 20% increase in accuracy of estimates and a 15% reduction in discretionary bias (UK Department for Digital, Culture, Media and Sport, 2022). The "Data-Driven Care" project in the Netherlands using big data and machine learning made it possible to predict service needs in the field of elderly care, reducing reaction times by 25% and increasing the quality of services through personalized interventions (Dutch Ministry of Health, Welfare and Sport, 2023).
The "AI-Assist" platform in Spain uses NLP and chatbots to provide support and information to users, with a special focus on risk groups such as the homeless and migrants. In the pilot phase, there was a 60% increase in the availability of information, and a 30% reduction in waiting times for services (Madrid Social Services, 2023). Modern projects and initiatives at the global level; "AI for Inclusive Societies" (EU Horizon 2020 project) focuses on the development of algorithms that minimize biases and ensure inclusiveness in social programs. The project involved collaboration with local communities, social workers and academic institutions, and developed a set of guidelines for the ethical use of AI in social care (European Commission, 2022); "SmartCare" in Canada uses IoT sensors and AI analytics to monitor and support older people in their homes. The results showed a 35% reduction in emergency interventions and an increase in the sense of security of users (Canadian Institute for Advanced Research, 2023).
According to a Eurostat report (2022), 37% of social services in the EU already use AI or automated systems, with an expected growth of 12% per year. In the US, 65% of social workers use AI tools for needs assessment or case management (NASW, 2023). In Australia, the integration of AI into social services has increased the availability of services in rural areas by 50% (Australian Social Services Report, 2022), which supports the accelerated growth trend in the breadth of application of AI systems in the social care sector. According to a survey by the World Economic Forum (2023), 78% of social workers believe that AI technologies will play a key role in the future in ensuring equal access to services, especially for vulnerable and marginalized groups. A survey by the Pew Research Center (2022) shows that 65% of citizens in Europe and the US believe that the transparency of AI systems is essential for trust in social services, while 52% are concerned about the possibility of discrimination and bias.

5. Technological Solutions and Innovations in AI for Social Care: Advantages and Disadvantages

Artificial Intelligence (AI) is revolutionizing social care by introducing advanced technologies that improve efficiency, personalization and accessibility (Zaccheus, 2024). This chapter examines five key categories of AI-driven solutions: machine learning, natural language processing, big data analytics, case management platforms, and IoT and sensor systems, presenting their strengths and weaknesses. While these innovations offer transformative potential, they also introduce challenges related to data quality, privacy, cost, and regulatory compliance. Effective management and continuous evaluation are key to sustainable adoption.

Machine learning (ML) and deep learning (DL)

The use of machine learning (ML) and deep learning (DL) enables the identification of at-risk individuals and the prediction of care needs supporting timely and personalized interventions, reduces the time of manual assessment by quickly detecting complex patterns in large data sets, and platforms such as Silver Companion use advanced ML/DL models to provide proactive

social engagement, improving the inclusion and well-being of the elderly (Çaylı, 2024). Machine learning requires large, representative datasets because biased or incomplete data can skew the results, and significant investments in hardware and continuous retraining increase the overall cost of maintenance. The "black box" nature limits interpretability, reducing trust among practitioners and service users. The advantages of machine and deep learning include predictive accuracy, automated pattern detection, and practical application, while the disadvantages are high costs, large database requirements, and model opacity (Saeed, Ahmed and Joseph, 2024, p. 5).

Natural Language Processing (NLP)

Natural language processing through Chatbots and virtual assistants efficiently processes routine queries, triage, and documentation, is accessible and applicable to different user groups, and is available in different languages, and emotion-aware dialogue systems, such as those in Silver Companion, encourage meaningful interactions. The advantages of natural language include 24/7 availability, multilingual capabilities, and empathetic responses; the disadvantages are mainly related to misinterpretation as dialect, cultural nuances, and context can lead to incorrect responses or failure to escalate emergencies, and therefore require continuous monitoring (Shrivastava et al. 2025).

Big Data Analytics

Big data analytics integrates all user documentation; medical records, social service records, and sensor data to uncover hidden needs, enable risk stratification, and predict demand for productive resource allocation. Studies show that integrated analytics can reduce unwanted incidents by up to 25%. The problem can be sharing data between institutions, which requires anonymity and compliance, and interoperability issues between legacy systems that hinder integration. The advantages of big data analytics are therefore comprehensive insights, resource optimization, and proven impact, while the disadvantages are privacy challenges and data fragmentation (Pham et al. 2024).

Case Management Platforms

Case management platforms streamline scheduling, reporting, and referrals by reducing manual workload by up to 50%, and unified dashboards improve coordination across multidisciplinary teams. Aligning case management platforms with local workflows can be costly and time-consuming, and compliance and validation requirements often delay implementation (SS&C Blue Prism, 2025).

IoT and Sensor Systems

IoT and sensor systems monitor vital signs, mobility, and environmental conditions in real time, enabling early warnings, and pilot projects using the system have reported a reduction in emergency interventions of up to 35%, greatly improving outcomes. Such systems require high sensor and connectivity maintenance costs, while security risks are also present, requiring strong encryption and continuous monitoring. AI-based solutions – predictive modelling, conversational interfaces, advanced analytics, workflow automation, and real-time monitoring – offer significant opportunities for improving social care. However, these technologies introduce risks such as data bias, privacy violations, regulatory delays, and cost barriers. To ensure successful implementation, organizations must adopt robust governance frameworks,

foster interdisciplinary collaboration, and maintain ongoing evaluation (Satyanarayana et al., 2024).

Table 2: AI Solutions in Social Care – Advantages and Disadvantages

Technology	Advantages	Disadvantages
Machine Learning & Deep Learning	- Predictive accuracy for identifying at-risk individuals and forecasting care needs, timely interventions. - Automated pattern detection across complex datasets, reducing manual assessment time.	- Requires large, representative datasets; biased or sparse data can skew outcomes. - "Black-box" opacity limits interpretability, reducing trust. - High compute and maintenance costs increase total cost of ownership.
Natural Language Processing (NLP)	- 24/7 conversational support via chatbots and virtual assistants for inquiries, triage, and documentation. - Multilingual capabilities improve accessibility. - Emotion-aware dialogue systems foster empathetic engagement.	- Misinterpretation risk due to dialect, nuance, and context. - Requires ongoing supervision to prevent model drift and maintain accuracy.
Big Data Analytics	- Insights by integrating medical records, social-service logs, and sensor data. - Resource optimization through risk stratification and demand forecasting.	- Data fragmentation and interoperability challenges across legacy systems. - Privacy and governance hurdles require robust anonymization and compliance.
Case-Management Platforms	- Automates administrative tasks (scheduling, reporting, referrals), reducing manual workload -- Unified dashboards enhance collaboration among multidisciplinary teams.	- Complex customization to align with local workflows can be costly. - Regulatory and validation burdens often delay deployment.
IoT & Sensor Systems	- Real-time monitoring of vital signs, mobility, and environmental conditions for early-warning alerts.	- High infrastructure costs for sensors, connectivity, and maintenance. - Security vulnerabilities require strong encryption and oversight.

Source: Compiled by authors based on Çaylı (2024); Pham et al. (2024); Saeed, Ahmed and Joseph (2024); Satyanarayana et al. (2024); Shrivastava et al. (2025); SS&C Blue Prism (2025)

Artificial Intelligence (AI) in social care is increasingly supported through a diverse ecosystem of funding mechanisms that combine public, private, and community resources to accelerate innovation and ensure ethical deployment. European programs such as Horizon Europe and Horizon 2020 have become central pillars for advancing inclusive, ethics-driven pilots like "AI for Inclusive Societies," which value fairness, transparency, and accessibility in digital transformation projects. These initiatives often include rigorous evaluation frameworks, stakeholder engagement strategies, and cross-border collaborations to harmonize standards across member states. National and regional governments in countries such as Germany, the United Kingdom, the Netherlands, and Sweden allocate substantial budgets to modernize social services, upgrade digital infrastructure, and foster innovation in care delivery, recognizing that technology-driven solutions can alleviate systemic pressures and improve service quality. Private–nonprofit partnerships between technology firms and NGOs are also instrumental, blending technical expertise with social impact objectives to co-finance pilot implementations and scale successful models. Additionally, social-innovation funds and crowdfunding campaigns play a vital role by targeting solutions for vulnerable populations including homeless individuals, migrants, and persons with disabilities ensuring equity, accessibility, and responsiveness to multiple needs. The success of these initiatives depends on interdisciplinary teams that integrate a wide range of expertise: social workers and policy specialists define user needs, ethical guidelines, and operational workflows; data scientists and engineers develop predictive models, ensure data integrity, and maintain technical robustness; ethicists and legal

advisors safeguard compliance with fairness, privacy, and human-rights standards; while psychologists and specialists validate usability, accessibility, and emotional acceptability to ensure that technology is in accordance with human-centered principles. Collaboration occurs across interconnected phases, beginning with problem identification and goal setting, followed by prototype development and fairness testing, real-world piloting with iterative feedback loops, and continuous improvement at scale to adapt systems based on performance metrics and improving societal needs. Co-design with end users, including vulnerable groups, is essential for equity and transparency throughout the lifecycle, supported by governance frameworks that uphold ethical safeguards and accountability. The advantages of AI in social care are substantial, encompassing efficiency gains that reduce administrative workloads by up to half, enabling professionals to dedicate more time to direct client engagement; rapid crisis detection and response through predictive analytics and automated alerts, which have lowered mortality rates in pilot programs; personalized interventions that improve satisfaction and outcomes by tailoring services to individual needs; and expanded service reach through digital platforms that connect remote and underserved communities, thereby making sure that everyone is included and treated fairly. However, implementation carries notable risks such as data privacy and security concerns, with breaches in social-care settings rising sharply in recent years; algorithmic bias that can lead to discriminatory outcomes and exacerbate inequalities; high infrastructure costs for IoT deployments and advanced analytics, which demand reliable connectivity and significant maintenance budgets; and change-management challenges stemming from staff anxiety, limited digital literacy, and crisis-driven organizational cultures that resist preventive, AI-enabled models. Balancing these opportunities and risks through strong governance, interdisciplinary collaboration, and user-centered design ensures that AI can meaningfully augment social-care professionals, strengthen service delivery, and deliver better outcomes for vulnerable populations while retaining trust, accountability, and ethical integrity.

6. Challenges and Ethical Aspects

6.1. Privacy and Data Security

Social-care systems operate within a highly sensitive data environment, routinely collecting and processing extensive personal information such as health records, living conditions, psychosocial histories, and behavioral patterns. These datasets are critical for delivering individualized and successful care but simultaneously bring significant privacy and security challenges. Under the stringent requirements of the European Union's General Data Protection Regulation (GDPR) and guidance from the European Data Protection Board (2020), principles such as user control, data minimization, and secure encryption are not optional—they are foundational to lawful and ethical data governance. Compliance demands that organizations implement advanced technical and organizational measures to safeguard confidentiality while enabling legitimate data use for service improvement. Despite these regulatory frameworks, the sector has experienced a worrying escalation in cyber threats: between 2020 and 2023, reported security breaches in social-care contexts increased by approximately 35%, highlighting systemic vulnerabilities and the urgent need for continuous risk assessment, proactive threat modelling, and comprehensive staff training in information security protocols. This trend reveals that technical safeguards alone are insufficient without a culture of security awareness and accountability across all organizational levels. Answer to these challenges, Carmichael et al. (2024) present an innovative approach through Spy derisk, an automated privacy-risk modelling tool designed to simulate potential vulnerabilities and assess mitigation strategies before deployment. By leveraging simulation-based analytics, Spy derisk enables decision-

makers to evaluate trade-offs between innovation and confidentiality, supporting safe cross-domain data sharing without compromising compliance or ethical standards. Such tools exemplify the emerging paradigm of "privacy by design," where risk modelling and predictive security assessments are integrated into the development lifecycle, ensuring that technological progress in social care aligns with principles of trust, transparency, and human rights (Carmichael et al., 2024).

6.2. Fairness and Inclusion

Algorithmic decision-making in social care represents a critical juncture for equity, fairness, and the ethical allocation of resources. These systems increasingly influence decisions about eligibility, prioritization, and intervention strategies, meaning that errors or biases can have profound consequences for vulnerable populations. When training data is inadequate, incomplete, or unrepresentative, algorithms risk perpetuating and even amplifying historic injustices embedded within social systems. The OECD (2025) report on artificial intelligence in social care warns that poorly designed models may misallocate scarce resources, misidentify individuals in need, or systematically disadvantage marginalized groups, thereby undermining the very principles of social protection. Recent empirical evidence reinforces these concerns: a comprehensive scoping review by Singhal et al. (2024) reveals that up to 42% of health- and social-care algorithms exhibit measurable demographic bias, disproportionately affecting outcomes for minority and socioeconomically disadvantaged populations. These biases often stem from structural imbalances in data collection, such as underrepresentation of certain age groups, ethnic communities, or rural populations, which skew predictive accuracy and fairness. Singhal et al. further survey a range of computational strategies designed to detect and mitigate such effects, including reweighting techniques that adjust sample distributions, adversarial debiasing methods that introduce fairness constraints during model training, and post-processing approaches that recalibrate outputs to align with equity objectives. While these technical interventions show promise, they are not panaceas; their effectiveness depends on rigorous validation, transparent reporting, and integration with broader governance frameworks that value accountability and stakeholder oversight. The literature increasingly advocates for a multi-layered approach combining algorithmic audits, participatory design involving affected communities, and continuous monitoring to ensure that predictive systems in social care advance inclusion rather than entrench inequality. In this context, algorithmic fairness is not merely a technical challenge but a socio-political imperative requiring interdisciplinary collaboration and sustained ethical vigilance (Singhal et al., 2024).

6.3. Ethical Considerations

Embedding transparency, human oversight, and accountability from the earliest stages of AI development is widely recognized as a cornerstone of responsible innovation, functioning as a multilayered system that bridges legal requirements and technical limitations (Kiseleva, Kotzinos and De Hert, 2022). These principles are not merely aspirational—they are essential safeguards against unintended consequences, systemic bias, and erosion of public trust. Dodig-Crnkovic et al. (2023) advocate for an "ethical by design" lifecycle, a structured approach that systematically maps core values such as safety, privacy, and explainability onto every phase of AI system development, from initial conceptualization and data acquisition to algorithmic modelling, deployment, and post-implementation monitoring. This framework emphasizes that ethical considerations should not be retrofitted after technical design but integrated proactively, ensuring that fairness and accountability are embedded in both architecture and governance. Explainability, for instance, is critical for enabling practitioners and end-users to understand

decision-making processes, while privacy safeguards protect sensitive data and uphold compliance in according with legal standards. Complementing this perspective, Bhatti et al. (2023) highlight the evolving legal and ethical dilemmas posed by increasingly autonomous AI systems, which challenge traditional notions of liability, consent, and control. As AI technologies mature and exhibit greater decision-making autonomy, static regulatory models become insufficient, necessitating adaptive governance structures that can respond to emerging risks and societal expectations. Bhatti et al. call for multi-stakeholder governance frameworks that bring together policymakers, technologists, ethicists, civil society actors, and end-users to co-create dynamic oversight mechanisms. Such collaborative models ensure that governance remains flexible, inclusive, and responsive to technological evolution, while reinforcing democratic accountability and human rights. Taken together, these contributions underscore a paradigm shift toward anticipatory ethics and participatory governance, positioning transparency and oversight not as optional features but as integral components of sustainable AI ecosystems (Dodig-Crnkovic et al., 2023; Bhatti et al., 2023, 1–7).

7. Future Directions

Future directions for AI in social care emphasize the need for systemic, ethical, and technological advancements that align innovation with inclusivity and trust. Regulatory harmonization remains a top priority, requiring internationally aligned standards for data governance, algorithmic transparency, and ethical auditing. Building on the European Commission's 2021 proposals, scholars and policymakers advocate for frameworks that ensure interoperability across jurisdictions while maintaining rigorous accountability for fairness and privacy. These harmonized regulations would enable cross-border collaboration and reduce fragmentation, advancing a global ecosystem of responsible AI deployment. Equally critical is the advancement of privacy-preserving techniques, which allow institutions to leverage data-driven insights without compromising confidentiality. Emerging methods such as federated learning, secure multi-party computation, and differential privacy are gaining traction as viable solutions for enabling cross-institutional analytics without centralized data transfer, thereby mitigating risks associated with large-scale data aggregation. These approaches represent a paradigm shift toward decentralized intelligence, where sensitive information remains locally protected while contributing to collective knowledge generation. Another strategic priority involves the development of holistic toolchains that integrate AI capabilities with existing digital infrastructures, including case-management platforms, telemedicine modules, and mobile applications. Such integration supports end-to-end client journeys, ensuring continuity of care and seamless coordination among multidisciplinary teams. Beyond technical innovation, digital literacy and co-design emerge as foundational pillars for sustainable adoption. Investments in training programs for practitioners and service users are essential to bridge knowledge gaps and advancing confidence in AI-enabled systems. Furthermore, embedding representatives of vulnerable groups in design sprints, governance bodies, and evaluation committees ensures that inclusivity is not an afterthought but a guiding principle throughout the development lifecycle. This participatory approach strengthens trust, enhances usability, and aligns technological solutions with real-world needs. Collectively, these future directions point out a vision for AI in social care—one that balances innovation with ethics, prioritizes human-centered design, and builds resilient governance structures capable of adjusting to evolving societal and technological landscapes.

8. Discussion

The comparative analysis of international AI applications reveals a significant shift from traditional social work towards a data-driven paradigm. However, the synthesis of secondary data highlights a "technological paradox": while AI tools, such as the predictive platforms in the Netherlands, demonstrably improve administrative efficiency, they simultaneously introduce risks of "automated inequality" through algorithmic bias.

Unlike previous descriptive reports, this study identifies that the effectiveness of AI in social care is not merely a function of technical complexity, but of human-in-the-loop integration. For instance, while Swedish chatbots enhance 24/7 accessibility, they lack the emotional intelligence (EQ) required for complex psychosocial assessments. This suggests that AI should be viewed as an *augmentative* rather than a *reconstructive* tool in social welfare.

Furthermore, a critical gap identified in this synthesis is the lack of standardized ethical protocols across different jurisdictions. While Canadian sensor systems prioritize physical safety, European models focus heavily on data protection (GDPR). This study concludes that for AI to be scientifically and ethically viable in social care, it must transition from isolated pilot projects toward a unified framework of algorithmic transparency. Future research should prioritize the impact of AI on the professional identity of social workers and the long-term trust of service users.

9. Conclusion

Artificial Intelligence (AI) holds transformative potential for reshaping social care by advancing efficiency, enabling personalized interventions, and expanding accessibility to underserved populations. Its promise lies in the automating routine tasks, deliver predictive insights, and support active care models that improve outcomes for vulnerable individuals. However, realizing this potential requires more than technological sophistication it demands a foundation of rigorous data security, active bias mitigation, and ethically grounded development practices that prioritize human dignity and social justice. The deployment of AI in social care must be guided by principles of transparency, accountability, and inclusivity, ensuring that systems complement rather than replace professional judgment. Sustained interdisciplinary collaboration is essential, bringing together social workers, data scientists, ethicists, legal experts, and end users to co-design solutions that reflect real-world needs and uphold fundamental rights. Such collaboration fosters trust and ensures that AI systems are not only technically robust but socially responsible. Continuous research must focus on developing secure, transparent, and inclusive AI architectures that integrate fairness audits, explainability mechanisms, and privacy-preserving techniques into every stage of the lifecycle. These efforts should be coupled with adaptive governance frameworks capable of responding to evolving ethical and legal challenges posed by autonomous systems. Ultimately, the goal is to create AI-enabled social care ecosystems that amplify human expertise, strengthen equity, and deliver measurable benefits for society’s most vulnerable populations while safeguarding the principles of accountability and ethical integrity. By synthesizing international case studies, this paper provides a conceptual foundation for future empirical research into the balanced integration of AI tools within human – centric social services.

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A scientific paper

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RETHINKING AGE FOR A LONG-LIVED SOCIETY

ABSTRACT

Population ageing is restructuring labour markets and entrepreneurial ecosystems in advanced economies*. Although policies encourage active ageing and longer working lives, considerably less attention has been devoted to how younger generations (future labour-market decision-makers) assess the economic legitimacy of older workers. This article seeks to investigate the attitudes of university students, that is, prospective labour market participants, toward older adults' contribution to work, and what cognitive evaluations inform these perspectives. Using cross-sectional survey data from 118 university students, we constructed three composite indices: Social Valuation, Adaptability, and Perceived Work Impact. One-sample t-tests show that students rate older adults' work impact significantly above the scale midpoint, while rating adaptability significantly below the midpoint, r*evealing a pattern of ambivalent legitimacy. *Pearson correlations indicate positive associations between perceived work impact, social valuation, and adaptability. Hierarchical multiple regression* analyses showed *that Social Valuation ($\beta = .267$, $p = .006$) and Adaptability ($\beta = .238$, $p = .009$) were significant predictors, whereas intergenerational contact and prior work experience were not significantly predictors of perceived work impact. The final model explains 15% of the variance ($R^2 = .150$, $p < .001$). These findings suggest that* competence-based perceptions, particularly signals of adaptability, play a central role in conferring economic legitimacy *within* innovation-driven contexts. *By integrating ageism theory with human capital and ecosystem perspectives, the* paper advances a micro-foundational account of how intergenerational perceptions may condition macro-level regional competitiveness in ageing societies.

Key words: *Age-based stereotyping; Entrepreneurial Ecosystems; Regional competitiveness; Adaptability; Economic Legitimacy; Extended Working Lives.*

1. Introduction

Population ageing is one of the largest structural changes to contemporary society, specifically as we look to Europe and beyond. Sustained fertility decline coupled with an uptick in life expectancy has led to a world nearly unprecedented demographic transition that is unprecedented in both speed and scale in modern history, with the 60+ population rising rapidly (United Nations, 2023; OECD, 2024). Projections suggest that by 2050 the global population aged 60 or older will approximately double to about 2.1 billion. This transition intensifies challenges for labour supply, pension sustainability, productivity growth, and

social cohesion. In response, the active ageing framework advocates maximising opportunities for health, participation, and security across the life course (World Health Organization, 2002). Within this framework, extended labour-market participation becomes not only an economic imperative but also a social and developmental response, reinforced by international agendas such as the UN Decade of Healthy Ageing 2021–2030 (United Nations, 2021). Importantly, the economic consequences of demographic ageing are not mechanically determined by age structure itself, but by how effectively institutions mobilise and retain human capital across the life course.

Evidence suggests that post-retirement employment decisions reflect a complex interplay of individual and organisational determinants, including professional identity, motivation, financial necessity, and health status, alongside flexible work arrangements, HR systems, and age-responsive organisational cultures (Kooij et al., 2008; Wang & Shultz, 2010; Phillipson, 2013). Older workers can contribute with accumulated tacit knowledge, reliability, mentoring capacity, and problem-solving expertise (Posthuma & Campion, 2009; Truxillo et al., 2015). Research on executive decision-making and ambidexterity further indicates that experience can support adaptive judgement and strategic balance (Rosenbusch et al., 2011; Mom et al., 2019).

Despite this potential, older workers continue to encounter ageist stereotypes—commonly framed as assumptions of lower productivity, reduced adaptability, or technological resistance (Butler, 1969; North & Fiske, 2012). Such stereotypes can distort recruitment, training investment, promotion pathways, and exit strategies (Posthuma & Campion, 2009), undermining both individual careers and organisational performance. From a legitimacy perspective, these stereotypes shape whether older workers are perceived as economically future-relevant or primarily valued for past contributions. Accordingly, HR scholars emphasise age-inclusive strategies such as phased retirement, flexible scheduling, mentoring, and skills updating (Armstrong-Stassen & Templer, 2005; Kooij et al., 2014; Van Dalen et al., 2015). However, organisational practices are not formed in a vacuum: they are shaped by managerial cognition and broader societal narratives about competence and value across the life course.

University students represent a strategically important group in this context. As future managers, entrepreneurs, HR professionals, and policymakers, their present perceptions can become tomorrow's decision rules. Prior research indicates that young adults' attitudes towards older adults are influenced by intergenerational contact, educational experiences, and sociocultural narratives (Allan & Johnson, 2008; Macfarlane, 2018; Xu et al., 2021). Yet comparatively little is known about how younger cohorts evaluate older adults' labour-market contribution through competence-related lenses, particularly in relation to innovation capacity and adaptability. In particular, the cognitive mechanisms through which perceived social valuation and perceived adaptability shape economic legitimacy judgments, remain underexplored. In doing so, the study advances a theoretically grounded account of how intergenerational perceptions may influence broader regional competitiveness dynamics in ageing societies.

2. Literature review

2.1. Demographic ageing and structural economic transformation

Population ageing is one of the deepest structural changes of modern economies of today. As underscored by the OECD (2024), increases in longevity in tandem with declines in fertility rates are restructuring the dynamics of labour supply, social protection systems, and

productivity paths in advanced economies. The World Health Organization (2021), likewise, emphasises that ageing is not just a demographic product but a social change needing to be institutionalised and integrated across all sectors. Demographic ageing in the Portuguese and overall European context has been recognised as a sustainability challenge as well as a social and development opportunity (Rediteia, 2020; Universidade Católica Portuguesa, 2024). Instead of looking at ageing only in terms of fiscal stress, recent trends in the literature have focused on the potential economic and social value of ageing when participation, inclusion and lifelong learning are encouraged. The OECD report Enhancing Productivity and Growth in an Ageing Society has further argued that productivity in ageing societies depends less on age structure itself and more on how institutions manage human capital over the life course. This shifts the debate away from demographic inevitability and towards policy and organizational responsiveness.

2.2. Active ageing and extended working lives

Active Ageing has been described as a conceptual framework and is a cornerstone of effective and informed contemporary ageing policy (World Health Organization 2002). According to the World Health Organization, active ageing is about maximizing opportunities for health, participation, and security to raise one's quality of life as one ages. This definition moves beyond biomedical narratives of decline and positions older adults as active economic and social agents. Ilmarinen (2006) argues the concept of work ability should be understood dynamically in the labour market. It is not monolithic but integrated - health, competence, motivation, and work environment are integrated into its definition. Similarly, Truxillo, Cadiz, and Rineer (2015) maintain that chronological age alone is a poor predictor of work performance; and that stereotypes often distort expectations by managers. Posthuma and Campion's (2009) research systematically documents age-related stereotypes in organizational settings, showing that older workers are often regarded as resistant to change yet reliable and loyal. Such an ambivalent stereotype structure influences HR practices and promotion pathways. In agreement, Kooij et al. (2013) show that age-sensitive HR practices have major impacts on engagement and retention. Furthermore, retention strategies (Armstrong-Stassen & Templer, 2005; Templer et al., 2010) for older workers require tailored motivational approaches rather than uniform career models (Wong & Tetrick, 2017; Zhang & Li, 2025)

2.3. Ageism: conceptual foundations and labour-market implications

Ageism, as formulated by Butler (1969), was later developed by Nelson (2002, 2005; 2015; 2016), who identifies it as prejudice, stereotyping, or discrimination. Nelson argues that ageism is uniquely insidious because of the social normalization of ageism compared to other forms of prejudice. Intergenerational opposition and stereotypes can provide significant force behind age-based bias, as described by North and Fiske (2012), especially when young individuals believe that older generations are transgressing expectations concerning succession and the flow of resources. Allan and Johnson (2009) find implicit age attitudes related to judgments of competence, and Iecovich and Biderman (2013) found that contact with older adults significantly predicts positive evaluations. With reference to the Stereotype Content Model, Cuddy, Norton, and Fiske (2005) contend that the average older adult is seen as high in warmth but low in competence, an ambivalent stereotype which, though positive in appearance, rationalizes exclusion from high-responsibility roles. From a labour economics viewpoint, Gruber and Wise (1999) argue that institutional settings affect retirement behaviour, pointing out that withdrawal from the labour market is often policy driven, not ability driven (Aaron, 2010, Gustman & Steinmeier, 2015, Lalive et al., 2023)

2.4. Intergenerational contact and stereotype reduction

Despite all the evidence for the theory, Allport's (1955) Contact Hypothesis still plays a central role in explaining how organized interaction reduces intergroup prejudice. In ageing, this theory posits that sustained, meaningful intergenerational contact can help reduce ageist stereotypes. There is compelling empirical evidence to support this. Both the quality and frequency of contact with older adults are linked to lower levels of ageist attitudes (Allan and Johnson, 2008; Apriceno & Levy, 2023; Iecovich and Biderman, 2013; Kwong & Yan, 2023;) They further argue for weaker prescriptive age stereotypes when intergenerational interaction diminishes perceived competition (North and Fiske, 2012). In terms of how these factors are embedded in labour market attitudes, exposure to older people living in cooperative contexts (family, community, workplace) emerges as a determining variable.

2.5. Older workers, innovation, and ambidexterity

While there may be deficit narratives, older workers in knowledge-heavy contexts are increasingly being prioritized as strategic assets in research. Ilmarinen (2006, 2012) points to the centrality of accumulated tacit knowledge and organizational memory as assets. Executive competency and individual ambidexterity research (e.g. Mom et al., 2019) suggests experience drives balance of exploration–exploitation that is significant in entrepreneurial ecosystems. Czaja and Lee (2019) illustrate how technological adaptability of older adults is not determined by age, but much by access to training and self-efficacy. This result undercuts deterministic accounts of digital incompetence (Jin, 2025). In terms of regional development, the OECD (2024) and WHO (2021) claim that the older workers' shared experience builds resilience and social capital, two central tenets of sustainable entrepreneurship ecosystems.

2.6. Perceived threat and intergenerational competition

According to Esses, Jackson, and Armstrong (1998), perceived economic competition increases negative intergroup attitudes. So, now we see it being applied to ageing, where younger cohorts might see extended working lives as a restriction of their own job opportunities. Most empirical findings, of course, go against zero-sum assumptions. Studies of employment participation (e.g., studies from a Canadian perspective like the one of Colcher (2025), for example) show that intergenerational complementarities often dominate displacement effects. North and Fiske (2012) also suggest that notions of *succession violation* account for reluctance to provide continued participation to older workers, further emphasizing the psychological as opposed to the economic nature of perceived threat.

2.7. Higher education as a strategic intervention point

The Universities operate as the normative institutions that are affecting managerial cognition and future leadership performance (Dieguez et al., 2024; Godonoga & Sporn, 2023; Loureiro et al, 2022). Early adult beliefs about ageing also continue into later work life unless critically challenged (Ackerman & Kanfer, 2020; Nelson, 2005; Scheibe & Kooij, 2024). Today's students, maybe the entrepreneurs, leaders and policymakers of the future, will likely be in the position to affect those perceptions of older adults. Indeed, age-inclusive education strategies might not only be acts of social justice; they might also represent mechanisms of regional competitiveness. Intergenerational collaboration also contributes towards the creation of the innovation ecosystem by reinforcing mentorship networks, tacit knowledge transfer, and social cohesion from the regional entrepreneurship perspective (OECD, 2024; WHO, 2021).

3. Hypotheses development

3.1. From Demographic Transition to Perceptual Mechanisms

Although demographic ageing has generally received more attention at the macroeconomic and institutional levels (OECD, 2024; WHO, 2001), micro-level perceptual processes that shape young people's perception of older adults and their economic contribution have received less attention. But those perceptions matter. Future managers, entrepreneurs, and policymakers would decide on the hiring, retention, investment in innovation, and intergenerational cooperation in a manner that relies not only on objective data, but also on cognitive assessments of competence and value. The literature reviewed shows three perceptual domains which have specific relevance: (i) perceived social valuation of older adults, (ii) perceived adaptability, and (iii) intergenerational contact experience. These dimensions collectively provide a cognitive framework through which economic legitimacy is constructed. Therefore, we present a model whereby perceptions of social valuation and adaptability predict perceived work impact of older adults, whilst intergenerational contact and prior work experience serve as contextual variables.

3.2. Social Valuation and Perceived Work Impact

Perceived social valuation indicates to what extent older adults are considered respected, experienced, and socially significant contributors. Stereotype content theory suggests that warmth and competence perceptions shape judgments of group contribution (Cuddy et al., 2005). Older persons are increasingly viewed as legitimate participants in organizational and economic life if society treats them as such. Previous studies on stereotypes around age in the workplace suggest that recognizing experience and reliability positively influences perceptions (Beier et al., 2022; Posthuma & Campion, 2009; Truxillo et al., 2015) of productivity and trustworthiness. Legitimacy perceptions are important in entrepreneurial ecosystems as they influence inclusion through collaborative networks and innovation processes (Fernandes & Ferreira, 2022; Quin, 2026). Therefore, when students perceive older adults as socially valuable, they are more likely to attribute positive work impact to them (Kim et al., 2017; Penick et al., 2014).

H1: Perceived social valuation of older adults is positively associated with perceived work impact.

3.3. Adaptability as a Competence Signal

For employability at work and performance in innovation, adaptability is central. Flexibility, learning capacity, and technological responsiveness act as indices of productivity in dynamic economies (Ilmarinen, 2006; Nilsson, 2016; Muneeb et al., 2023). Yet older workers are frequently characterized as change-averse (Cutcher et al., 2022, Nelson, 2002; North & Fiske, 2012). Empirical evidence (Czaja & Lee, 2012; Kooij et al., 2013; Mazumdar et al., 2023) contradicts determinate assumptions for decreasing adaptability. Rather, adaptability is determined by access to training, organizational environment, and motivation. However, perceptions of adaptability are strong predictors of economic evaluation. If older adults are shown to be adaptable, they are less likely to be considered as economically obsolete and more likely as contributors to innovation and productivity (Gonzales et al., 2015; Waddell et al., 2025).

H2: Perceived adaptability of older adults is positively associated with perceived work impact.

3.4. Intergenerational Contact and Experience

Intergroup contact theory (Allport, 1955) states that meaningful interaction decreases prejudicial attitudes and improves intergroup attitudes. Age-related research supports the finding that regular and positive encounters with older adults diminish ageist stereotypes (Allan & Johnson, 2008; Iecovich & Biderman, 2013; Knight et al., 2022). Likewise, direct working experience with older individuals could offer evidence that contradicts stereotypical expectations. This exposure enhances credibility evaluations and improves levels of perceived competence. Therefore, it is anticipated that increased contact and work experience with older adults will enhance individuals' perception of their labour market contribution (Börsch-Supan et al., 2021; Vodopivec et al., 2019).
H3: Intergenerational contact with older adults is positively associated with perceived work impact.
H4: Prior work experience with older adults is positively associated with perceived work impact.

3.5. Control Variable: Gender

The literature on social psychology also notes that differences in empathy and social perception exist between the sexes (Eagly et al., 2012; Löffler & Greitemeyer, 2023). Although research on ageism produces mixed results regarding the influence of gender, using gender as a control variable makes it possible to investigate some possible perceptual differences. Therefore, gender is included as a control variable in the empirical model.

3.6. Integrated Research Model

The proposed model suggests that social valuation and adaptability function as primary perceptual predictors of perceived work impact, while intergenerational contact and prior work experience serve as contextual variables, and gender operates as a control variable. This structure enables the examination of whether cognitive evaluations explain perceived labour market impact beyond exposure-based variables.

4. Methodology

4.1. Research Design

In this study, we performed a cross-sectional quantitative research design to study the perceptual determinants of older adults' perceived work impact among university students. A formalised questionnaire for collecting primary data was employed, allowing the researcher to empirically test anticipated associations among social valuation, perceived adaptability, intergenerational contact, and perceived economic contribution. This design enables explanatory analysis conducted by hierarchical multiple regression to examine both bivariate associations and incremental predictive power.

4.2. Sample and Data Collection

Data were collected from 118 university students who were in higher education programs. We chose students as the target population as they provide insight into how the perceptions of future professionals, managers, and entrepreneurs from various disciplines shape organizational and regional development practices. Participation was voluntary and anonymous. Participants completed the survey in a structured manner with Likert-scale items and categorical demographic variables. It was distributed in Google Forms, with responses taken between November 2025 and January 2026. There were three main sections of the questionnaire. The first section consisted of demographic variables and history (e.g., gender, intergenerational contact, prior work experience with individuals aged 60+). The second section measured cognitive and attitudinal views of older people, using Likert scale to assess perceived social valuation and adaptability. The third section dealt with perceived work impact - students' assessments of the contributions of older people to the performance of organization and economy. These perceptual items were all assessed on multi-item scales and eventually grouped into composite indices, namely (Social Valuation, Adaptability, and Perceived Work Impact) by the criteria of theoretical coherence and internal consistency. The responses were coded numerically and prepared for statistical analyses with SPSS. Before hypothesis testing, preliminary screening was performed to confirm completeness and consistency of the dataset.

4.3. Measures

4.3.1. Social Valuation

Social valuation was measured using a composite index derived from Likert-scale items assessing perceptions of older adults' experience, social contribution, and relevance. Items were aggregated using mean scores. Higher values indicate stronger perceived social valuation.
Descriptive statistics:
M = 3.69, SD = 0.69
Internal consistency was acceptable (Cronbach's alpha ≈ .76).

4.3.2. Adaptability

Adaptability was measured through items assessing perceptions of older adults' flexibility, openness to change, and capacity to adapt to new professional contexts. Items were aggregated using mean scores.
Descriptive statistics:
M = 2.64, SD = 0.73
Internal consistency was moderate (alpha ≈ .53), which is acceptable given the limited number of items and exploratory nature of the construct.

4.3.3. Perceived Work Impact

Perceived work impact was operationalized through a composite index reflecting students' evaluation of older adults' positive contribution to labour market performance and organizational productivity.
Descriptive statistics:
M = 4.21, SD = 0.86
Internal consistency was moderate (alpha ≈ .54), appropriate given the short scale length.

4.3.4. Intergenerational Contact

Intergenerational contact was measured as a binary variable indicating whether respondents reported regular interaction with individuals aged 65 or older.

4.3.5 Prior Work Experience with Older Adults

Respondents indicated whether they had previous work experience involving individuals aged 60 or older (binary variable).

4.3.6. Gender

Gender was included as a control variable and coded dichotomously.

4.4. Analytical Strategy

The analysis proceeded in four stages:

1. Descriptive statistics to examine distribution and central tendencies.
2. One-sample t-tests against the theoretical midpoint (3) to assess whether perceptions significantly deviated from neutrality.
3. Pearson correlations to examine bivariate relationships among key constructs.
4. Hierarchical multiple regression analysis to test hypotheses regarding predictors of perceived work impact**.**

The regression model was specified in two steps:

- Model 1: Control variables (intergenerational contact and prior work experience).
- Model 2: Addition of primary perceptual predictors (social valuation and adaptability).

This approach allows assessment of incremental explanatory power (ΔR^2) and examination of whether perceptual constructs explain variance beyond demographic exposure variables. Multicollinearity was assessed using Variance Inflation Factors (VIF), with all values below 1.21, indicating no collinearity concerns. Statistical significance was evaluated at the conventional threshold of $p < .05$.

5. Results

5.1. Sample Characteristics

The final sample comprised 118 university students enrolled in higher education programs. Gender distribution was relatively balanced, with 52% coded as category 1 (Female) and 48% as category 0 (Male), indicating no substantial gender imbalance (Figure 1).

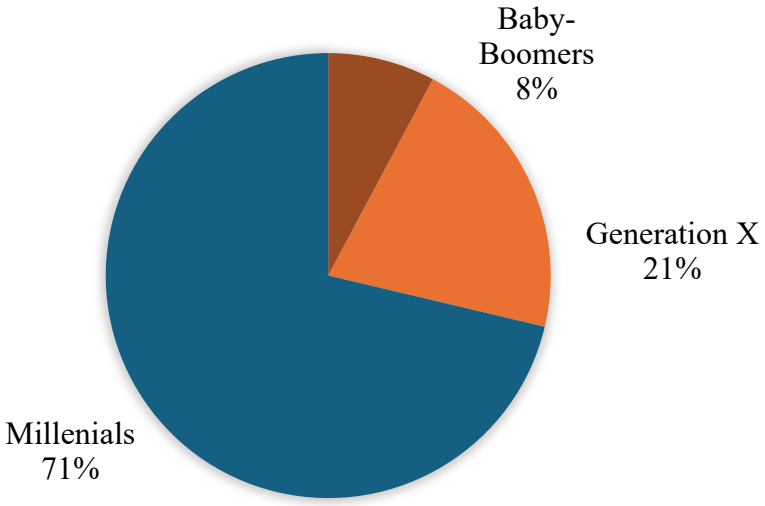
Figure 1: Gender distribution of the sample



Source: Authors

Regarding year of birth, the majority of respondents (71.3%) were concentrated in category 2 (born between 1997 and 2010), suggesting a predominantly homogeneous age cohort typical of traditional university populations: Millenials (Figure 2). Only 2.5% of responses were missing for this variable.

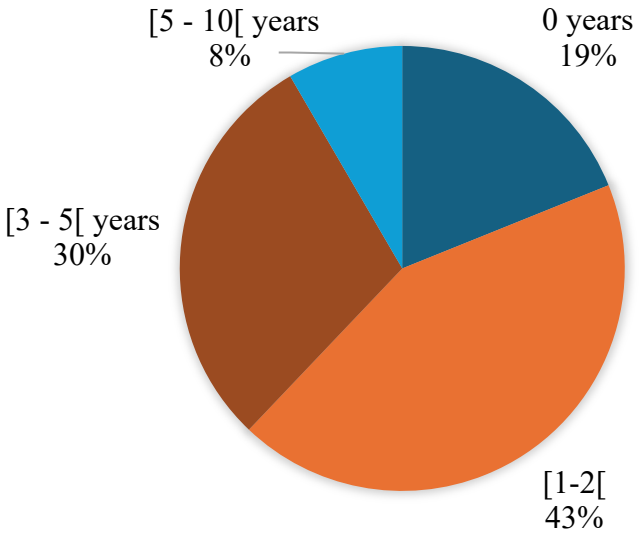
Figure 2: Generation of the respondents



Source: Authors

Professional experience showed greater dispersion. Among valid responses (n = 95), 43.2% were coded in category 1 (between one and two years of experience), followed by 29.5% in category 2 (between three and five years of experience) and 18.9% in category 0 (no experience at all). A smaller proportion (8.4%) fell into category 3 (between five and ten years of experience) (Figure 3). Missing responses represented 19.5% of the total sample.

Figure 3: Professional experience of the respondents



Source: Authors

Overall, the sample reflects a relatively young and academically homogeneous population, with moderate variability in professional experience, which is consistent with the study's focus on university students as future labour market participants and potential contributors.

5.2. Descriptive Overview

The sample comprised 118 valid responses. Descriptive statistics reveal a differentiated perception pattern regarding older adults. Participants reported high perceived work impact of older adults ($M = 4.21$, $SD = 0.86$), indicating strong recognition of their economic contribution. In contrast, perceived adaptability scored below the neutral midpoint ($M = 2.64$, $SD = 0.73$), suggesting some skepticism regarding flexibility and adjustment capacity. Social valuation was moderately positive ($M = 3.69$, $SD = 0.69$), indicating general respect and recognition of experience.
This distribution already suggests a perceptual asymmetry: older adults are acknowledged as valuable contributors, yet their adaptability is more cautiously evaluated.

5.3. Deviation from Neutrality

To assess whether perceptions significantly diverged from neutrality, one-sample t-tests were conducted using 3 (scale midpoint) as the reference value.

- Social Valuation was significantly above neutrality,
  $t(117) = 10.841$, $p < .001$,
  Mean difference = 0.693,
  95% CI [0.567, 0.820],
  Cohen's $d = 0.998$ (large effect).
- Adaptability was significantly below neutrality,
  $t(117) = -5.295$, $p < .001$,
  Mean difference = −0.356,

95% CI [−0.489, −0.223],
Cohen's d = −0.487 (small-to-moderate effect).

- Work Impact was significantly above neutrality,
  t(117) = 15.286, p < .001,
  Mean difference = 1.208,
  95% CI [1.051, 1.364],
  Cohen's d = 1.407 (very large effect).

These findings confirm that students strongly recognize the economic relevance of older adults while maintaining reservations regarding adaptability.

5.4. Correlational Analysis

Pearson correlation analysis revealed consistent positive associations among the main constructs.

- Social Valuation correlated positively with Work Impact (r = .311, p < .001).
- Adaptability correlated positively with Work Impact (r = .289, p = .001).
- Social Valuation and Adaptability were modestly correlated (r = .212, p = .021).

These results suggest that both valuation and adaptability perceptions are meaningfully connected to how students assess the labour market contribution of older adults. Importantly, the moderate magnitude of correlations indicates that the constructs remain distinct dimensions rather than redundant measures.
Contact variables showed weaker associations, suggesting that exposure alone may not fully account for economic evaluation patterns.

5.5. Group Differences

Independent samples t-tests were conducted to examine differences based on intergenerational contact.
A significant difference emerged for Social Valuation**,**
t(116) = 3.853, p < .001,
Mean difference = 0.469,
95% CI [0.228, 0.710].
However, no statistically significant differences were observed for Adaptability (p = .057) or Work Impact (p = .143).
This indicates that contact may strengthen recognition of social value, yet it does not appear sufficient to substantially alter perceptions of economic impact or adaptability.

5.6. Hierarchical Regression Analysis

To test the hypotheses, hierarchical multiple regression was performed with Perceived Work Impact as the dependent variable.

5.6.1. Model 1: Contact and Work Experience

The first model included intergenerational contact and prior work experience as predictors.
This model was not statistically significant:
$R^2 = .022$
F(2,115) = 1.279
p = .282
Thus, exposure variables alone explain only 2.2% of variance in perceived work impact.

5.6.2. Model 2: Addition of Perceptual Variables

When Social Valuation and Adaptability were added, the model improved significantly:
$R^2 = .150$
Adjusted $R^2 = .120$
$F(4,113) = 5.004$
$p < .001$
$\Delta R^2 = .129$
$\Delta F(2,113) = 8.561, p < .001$
The addition of perceptual variables explained an additional 12.9% of variance.
In the final model:

- Social Valuation ($\beta = .267$, $p = .006$) was a significant positive predictor.
- Adaptability ($\beta = .238$, $p = .009$) was also a significant positive predictor.
- Contact and prior work experience were not significant.
- Gender showed no significant effect.

Multicollinearity diagnostics indicated no issues (VIF < 1.21).

5.7 Summary of Empirical Findings

The results provide support for:
✓ H1: Social valuation positively predicts perceived work impact.
✓ H2: Adaptability positively predicts perceived work impact.
H3 and H4, regarding contact and prior work experience, were not supported in the regression model.
Overall, perceived economic legitimacy of older adults appears to be driven primarily by cognitive evaluations rather than mere exposure.

6. Discussion

6.1. Main Findings and Interpretation

This study examines university students' perceptions of the economic contribution of older adults and identifies the perceptual mechanisms through which such evaluations are formed. The findings contribute to the demographic ageing debate by shifting attention from macroeconomic pressures to micro-level cognitive appraisals. While international organisations emphasise the structural necessity of extending working lives, the present results indicate that economic legitimacy is not determined solely by demographic realities but is shaped by how future labour-market actors perceive older adults' adaptability and social value.
The high evaluation of perceived work impact suggests that students recognise older adults as valuable contributors to the labour market. However, the significantly lower scores on adaptability reveal a competence-based reservation. This dual pattern reflects the ambivalent stereotype structure identified in prior research, in which older adults are perceived as high in warmth but comparatively lower in competence. Thus, recognition of accumulated value coexists with conditional assumptions about future-oriented capability.
Importantly, adaptability emerges as a key predictor of perceived work impact. In innovation-driven and entrepreneurial contexts, adaptability functions as a signal of economic relevance. When older adults are perceived as adaptable, they are more likely to be cognitively included in future-oriented economic models. Conversely, when adaptability is questioned, their legitimacy becomes conditional. This finding extends ageism literature by demonstrating that

economic evaluations are shaped less by overt prejudice and more by competence-based judgments of future utility.

6.2. Theoretical and Practical Implications

The findings offer several theoretical contributions. First, they connect ageism theory with entrepreneurial ecosystem scholarship by introducing a perceptual mechanism into discussions of regional development. Second, they demonstrate empirically that competence-based perceptions—particularly adaptability—play a more decisive role in economic evaluation than exposure-based variables such as intergenerational contact. Third, the results contribute to a reconceptualisation of ageism in economic contexts as a form of conditional legitimacy, where inclusion depends not on chronological age but on perceived capability.

From a practical perspective, the findings suggest that improving intergenerational contact alone may not be sufficient to alter economic evaluations of older adults. Instead, interventions should focus on strengthening and making visible signals of adaptability and ongoing competence. Higher education institutions can play a central role by integrating intergenerational project-based learning, showcasing technologically proficient senior professionals, and fostering mixed-age innovation environments.

Organisations should emphasise skill renewal among older workers and frame retention strategies not merely as social responsibility initiatives but as mechanisms for enhancing competitiveness. Likewise, regional policymakers should position active ageing as a driver of innovation capacity and promote visible examples of successful senior participation in entrepreneurial ecosystems. These actions may help reduce competence-based biases and support more inclusive labour-market dynamics.

6.3. Limitations and Future Research

This study is subject to several limitations. The use of a cross-sectional design limits the ability to draw causal inferences, and the reliance on a student sample constrains generalisability to broader populations. Although university students represent a relevant group as future decision-makers, their perceptions may not fully reflect those of current managers or policymakers.

Future research should extend this work by comparing different generational cohorts and examining whether similar perceptual patterns emerge across age groups. Longitudinal and experimental designs would help clarify causal relationships between intergenerational contact, competence perceptions, and economic evaluations. Additionally, future studies could explore behavioural outcomes, such as hiring intentions or investment decisions, to assess how perceptions translate into action. Cross-national comparisons would also be valuable in identifying how cultural and institutional contexts shape ageing-related perceptions.

6.4. Final Reflection

The findings suggest that economic legitimacy in ageing societies is not automatically granted but conditionally constructed. Older adults are recognised as valuable contributors, yet their perceived adaptability determines whether this value translates into economic relevance.

Bridging this perceptual gap may be essential for fostering inclusive, innovation-driven entrepreneurial ecosystems. In this sense, the challenge of demographic ageing is not only structural but also cognitive: it depends on how future generations interpret competence, adaptability, and value across the life course.

7. Conclusion

Demographic ageing is frequently framed as a structural burden on labour markets and regional economies. The present study challenges this deterministic interpretation by demonstrating that the economic legitimacy of older adults is not inherently age-determined, but socially constructed through perception. Among future labour-market actors, older adults are widely recognised as valuable contributors. However, their perceived capacity to adapt significantly determines whether this recognised value translates into perceived economic impact.

Legitimacy, therefore, is not automatic. It is conditional. While students attribute high work impact to older adults, their evaluations remain sensitive to perceptions of adaptability. Economic inclusion appears to depend less on demographic realities or mere exposure and more on competence-based judgments.

By empirically demonstrating that cognitive appraisals of adaptability and social valuation explain perceived work impact beyond contact and experience variables, this study introduces a micro-level perceptual mechanism into debates on regional entrepreneurship and ageing societies. In this sense, sustainable regional development in ageing contexts depends not only on retaining older workers, but also on reshaping competence perceptions.

The findings suggest that policy and educational practices should move beyond symbolic inclusion and instead reinforce visible adaptability, skill renewal, and intergenerational innovation. In doing so, ageing may be reframed not as a demographic constraint but as a potential asset within entrepreneurial ecosystems.

Ultimately, the trajectory of regional competitiveness in ageing societies may depend less on the number of older workers participating in the labour market and more on whether they are perceived as adaptable, competent, and economically future-relevant.

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APPENDIX A – Statistical Results

A1. Sample Size

Total valid cases: **N = 118**

A2. Descriptive Statistics

Table A1: Descriptive Statistics of Composite Variables

Variable	Mean	Std. Deviation	N
Social Valuation	3.693	0.695	118
Adaptability	2.644	0.730	118
Perceived Work Impact	4.208	0.858	118

These values support the descriptive claims regarding the relative positioning of each construct on the 5-point Likert scale.

Source: Authors

A3. Reliability Analysis

Table A2: Internal Consistency

Scale	Cronbach's α
Social Valuation	.76
Adaptability	.53
Perceived Work Impact	.54

Note: Reliability levels reflect the limited number of items per construct and the exploratory nature of the analysis.

Source: Authors

A4. One-Sample t-Tests (Test Value = 3)

Table A3: One-Sample t-Test Results

Variable	t	df	p (2-tailed)	Mean Difference	95% CI Lower	95% CI Upper	Cohen's d
Social Valuation	10.841	117	< .001	.693	.567	.820	.998
Adaptability	-5.295	117	< .001	-.356	-.489	-.223	-.487
Perceived Work Impact	15.286	117	< .001	1.208	1.051	1.364	1.407

These tests confirm statistically significant deviation from neutrality for all three constructs.

Source: Authors

A5. Pearson Correlation Matrix

Table A4: Correlations Among Main Variables

Variable	1	2	3
1. Social Valuation	1		
2. Adaptability	.212*	1	
3. Perceived Work Impact	.311***	.289***	1

*p < .05, ***p < .001*
All reported correlations are statistically significant and support the hypothesized associations.
Source: Authors

A6. Independent Samples t-Test (Intergenerational Contact)

Table A5: Group Differences by Contact

Variable	t	df	p	Mean Difference	95% CI
Social Valuation	3.853	116	< .001	.469	[.228, .710]
Adaptability	1.923	116	.057	.262	[-.008, .532]
Perceived Work Impact	1.473	116	.143	.217	[-.074, .509]

Only Social Valuation differed significantly by contact group.
Source: Authors

A7. Hierarchical Multiple Regression

Model 1 – Control Variables Only
Predictors:

- Intergenerational Contact
- Previous Work Experience

R^2	F	p
.022	1.279	.282

Model not statistically significant.

Model 2 – Full Model
Predictors:

- Social Valuation
- Adaptability
- Intergenerational Contact
- Previous Work Experience

R	R^2	Adjusted R^2	F	ΔR^2	ΔF	p
.388	.150	.120	5.004	.129	8.561	< .001

The addition of perceptual variables explains an additional 12.9% of variance.

Regression Coefficients (Final Model)

Table A6: Standardized Coefficients

Predictor	B	β	t	p
Social Valuation	.330	.267	2.804	.006
Adaptability	.280	.238	2.641	.009
Intergenerational Contact	-.066	-.036	-.401	.689
Previous Work Experience	.016	.009	.097	.923
Gender	-.005	-.003	-.032	.975

Source: Authors

A8. Multicollinearity Diagnostics

All predictors in the final model presented:

- Tolerance > .80
- VIF < 1.21

Indicating no multicollinearity concerns.

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BEYOND COMPLIANCE: CO-CREATING GENDER-INCLUSIVE UNIVERSITIES IN EUROPE

ABSTRACT

Gender equity remains a structural challenge in European higher education, despite the widespread adoption of Gender Equality Plans (GEPs) and EU-level regulatory frameworks. This paper investigates the compliance–implementation gap within a transnational European University Alliance and examines whether participatory Equity, Diversity, and Inclusion (EDI) methodologies can strengthen institutional capacity for culturally embedded reform.
The analysis draws on Work Package 5 of the COLOURS European University Alliance and integrates three complementary strands: (1) structured analysis of Gender Equality Plans and EDI frameworks; (2) Group Concept Mapping (GCM) involving 348 staff members; and (3) IDEATE design-thinking workshops with 392 students. While the broader dataset is alliance-wide, this paper presents Josip Juraj Strossmayer University of Osijek (UNIOS) as the primary institutional illustration, with alliance-level GCM and IDEATE findings used for contextualisation. The study combines document analysis, multivariate clustering techniques, and reflexive thematic analysis to enable triangulation across structural, organisational, and experiential levels.
Findings indicate that while formal EDI frameworks are institutionally established, available evidence remains stronger regarding policy architecture than measurable structural outcomes. Alliance-level GCM analysis identifies six thematic clusters, with training and curriculum reform rated as highly important and feasible, while governance-level reforms are rated as important but less feasible, indicating perceived structural constraints. IDEATE workshops highlight the importance of participatory engagement in identifying barriers and co-creating solutions. The findings demonstrate that participatory mapping can make structural constraints visible and enhance the legitimacy of institutional reform agendas.

***Key words**: Gender Equality, Higher Education, EDI Policy, Participatory Methods, Institutional Culture.*

1. Introduction: Gender Equality Between Regulation and Transformation

Over the past two decades, gender equality has shifted from a marginal concern within European higher education to a formally institutionalised policy priority embedded in supranational governance frameworks, national legislation, and university-level strategies. This transformation has been strongly shaped by developments within the European Higher Education Area (EHEA) and the European Research Area (ERA), where equity and inclusion

are increasingly framed as preconditions for academic excellence and democratic legitimacy (Rome Communiqué, 2020; Tirana Communiqué, 2024). In parallel, the European Commission's introduction of mandatory Gender Equality Plans (GEPs) as an eligibility criterion for Horizon Europe funding has significantly strengthened the regulatory architecture surrounding gender equality in research-performing organisations (European Commission, 2021).

Recent EU monitoring reports further demonstrate that gender equality is no longer treated solely as a matter of social justice but as a structural dimension of research quality, innovation capacity, and institutional performance (European Commission, 2025; European Commission/EACEA/Eurydice, 2022). Similarly, UNESCO's Global Education Monitoring Report emphasises that inclusive higher education systems are central to achieving sustainable development and social cohesion (UNESCO, 2020). Within this policy landscape, European University Alliances have been positioned as laboratories of institutional innovation, expected to integrate equity and inclusion into governance, teaching, and research missions.

However, the formal institutionalisation of gender equality does not automatically guarantee its translation into everyday academic practice. Decades of feminist organisational research have shown that institutions can adopt equality policies while leaving underlying power structures intact (Acker, 1990). Formal compliance—measured through policy documents, reporting procedures, or indicator systems—may coexist with persistent structural inequalities. Empirical evidence across Europe continues to demonstrate gender imbalances in leadership positions, disparities in disciplinary participation (particularly in STEM fields), unequal research recognition, gendered distributions of administrative and care-related academic labour, and enduring patterns of sexual harassment and microaggressions (European Commission, 2025).

Moreover, gender inequality rarely operates as an isolated axis of disadvantage. Intersectional scholarship has convincingly demonstrated that gender interacts with race, ethnicity, socio-economic status, disability, migration background, and sexual orientation, generating layered and context-specific forms of marginalisation (Crenshaw, 1989). Within higher education, these intersections shape not only access and progression but also epistemic visibility, belonging, and recognition. As feminist institutionalism suggests, institutional change requires more than the addition of equality measures; it demands transformation of organisational norms, informal networks, and decision-making cultures (Krook & Mackay, 2011).

Against this backdrop, this paper examines how gender inequality is reproduced and challenged within a transnational higher education setting—the COLOURS European University Alliance—and investigates whether participatory Equity, Diversity, and Inclusion (EDI) methodologies can support movement beyond regulatory compliance toward culturally embedded transformation. The central argument advanced here is that while supranational regulatory frameworks such as mandatory GEPs establish necessary structural conditions for reform, they remain insufficient without participatory mechanisms that generate institutional ownership, contextual sensitivity, and collective accountability.

While the broader study was conducted within the COLOURS European University Alliance, this paper focuses analytically on Josip Juraj Strossmayer University of Osijek (UNIOS) as an institutional illustration. This approach enables a more precise examination of how formal EDI policy frameworks—such as monitoring structures and reporting mechanisms—and participatory methodologies interact within a specific organisational context, while alliance-level findings are used selectively for contextualisation.

The study is guided by three interrelated research questions. First, what structural and cultural gender-related barriers persist within institutional contexts despite the existence of Gender Equality Plans and formal EDI commitments? Second, how do staff and students prioritise institutional measures aimed at improving gender equity when invited to participate in structured co-creation processes? Third, can participatory methodologies—specifically Group Concept Mapping (GCM) and design-thinking workshops—strengthen institutional capacity for evidence-based policy development and enhance the legitimacy of gender equality initiatives?

By integrating comparative policy mapping with participatory quantitative and qualitative techniques, this paper contributes to scholarship in three interrelated fields. First, it extends feminist institutionalist analyses by examining how regulatory frameworks interact with organisational cultures within a European university alliance context. Second, it integrates intersectional concerns into participatory governance analysis. Third, it advances methodological debates on participatory reform by demonstrating how co-creation processes can function not merely as consultative exercises but as instruments of institutional reflexivity and transformation.

In doing so, the paper situates European University Alliances not only as administrative networks but as potential sites of democratic institutional experimentation, where equity is repositioned from compliance requirement to shared organisational project.

2. Theoretical Framework: Gender, Institutions, and Participatory Transformation

This study is grounded in feminist institutional scholarship, intersectionality, and participatory governance theory, which together provide a focused analytical framework for examining the relationship between formal equality policies and institutional practice. Feminist institutionalism rejects the view of institutions as neutral rule-administering structures and instead conceptualises them as historically sedimented systems of power that reproduce social hierarchies (Acker, 1990; Mackay, Kenny & Chappell, 2010; Krook & Mackay, 2011). Universities, despite their self-understanding as meritocratic spaces, are embedded in gendered norms, disciplinary hierarchies, and organisational routines that shape access to authority, recognition, and epistemic legitimacy.

Acker's (1990) theory of gendered organisations is particularly central to this analysis. Gender is not an individual attribute added onto institutional processes but is embedded within job design, career expectations, and evaluation criteria, as well as in the implicit figure of the "abstract worker"—a subject presumed to be continuously available and unencumbered by care responsibilities. In academic contexts, this norm materialises through expectations of uninterrupted productivity, international mobility, and competitive grant acquisition, disadvantaging those whose life trajectories diverge from this model (Benschop & Brouns, 2003).

Feminist institutionalism further distinguishes between formal rules and informal norms. While regulatory frameworks may proclaim equality, informal practices—such as mentorship allocation, authorship hierarchies, and nomination procedures—often reproduce advantage (van den Brink & Benschop, 2012; Nielsen, 2016). Socio-legal scholarship similarly demonstrates that formal equality regimes frequently address individual bias while leaving structural asymmetries intact (Thornton, 2007; Fredman, 2011). Ahmed's (2012) notion of

diversity policies as "non-performatives" captures how institutional commitments may signal compliance without transforming underlying power relations. Together, these perspectives provide the conceptual foundation for analysing the compliance–implementation gap addressed in this study.

Intersectionality deepens this analytical lens by challenging single-axis understandings of inequality. Crenshaw (1989) demonstrated how legal and policy frameworks often fail to capture compounded discrimination, while subsequent scholarship emphasises that systems of power intersect to produce qualitatively distinct experiences (Collins, 2000; Cho, Crenshaw & McCall, 2013; Walby, Armstrong & Strid, 2012). In higher education, reliance on gender-disaggregated statistics alone may obscure disparities affecting racialised, migrant, disabled, or LGBTQIA+ scholars and students. Intersectionality therefore highlights the need for disaggregated data practices and context-sensitive interventions.

Participatory governance theory complements these perspectives by addressing the question of how institutional change may occur in practice. Rooted in deliberative democratic theory (Habermas, 1996; Fung & Wright, 2003), participatory approaches position stakeholders as co-creators of institutional reform rather than passive recipients. Organisational learning theory further suggests that such processes can foster reflexivity by surfacing tacit norms and challenging underlying assumptions (Argyris & Schön, 1978). However, as Arnstein (1969) cautions, participatory mechanisms risk tokenism if they are not connected to decision-making authority.
Additional strands of scholarship further illuminate specific dimensions of institutional inequality. Research on academic careers highlights cumulative disadvantage across career stages, often described through the "leaky pipeline" metaphor (Ceci & Williams, 2011; Valian, 1998). Small disparities in evaluation, sponsorship, teaching allocation, or citation recognition can accumulate over time, producing pronounced gender imbalances in senior positions. These processes are reinforced by institutional evaluation systems privileging uninterrupted productivity (Williams, 2000; Moss-Racusin et al., 2012), as well as by gendered distributions of academic labour (Misra et al., 2012; Guarino & Borden, 2017) and homosocial reproduction in leadership selection (Kanter, 1977; van den Brink & Benschop, 2014).

Similarly, organisational and socio-legal research highlights how equality measures may be layered onto existing institutional logics without altering underlying structures (Mahoney & Thelen, 2010; Mackay et al., 2010), and how formal alignment may result in decoupling between policy and practice (Meyer & Rowan, 1977). Broader debates on diversity and equity further emphasise that representation alone does not dismantle structural inequality (Ely & Thomas, 2001; Dobbin & Kalev, 2016), while equity-oriented approaches foreground redistribution, recognition, and accountability (Fraser, 2008). Within the European higher education context, the introduction of Gender Equality Plans under Horizon Europe reflects this shift toward regulatory conditionality (European Commission, 2021).

Finally, feminist epistemology draws attention to the epistemic dimension of inequality, highlighting how institutional norms shape what counts as legitimate knowledge (Harding, 1991). Fricker's (2007) concept of epistemic injustice further illustrates how credibility deficits and marginalised interpretive resources affect scholars and students from subordinated groups. Taken together, these perspectives demonstrate that gender inequality in universities operates across structural, cultural, and epistemic dimensions. For the purposes of this study, three concepts are analytically central: (1) the distinction between formal rules and informal norms (feminist institutionalism), (2) the compliance–implementation gap (neo-institutional theory),

and (3) participatory reflexivity as a mechanism of institutional learning. The framework adopted in this study therefore serves to analyse how formal regulatory frameworks interact with institutional practices, and how participatory methodologies may contribute to moving beyond symbolic compliance toward more embedded transformation.

3. Methodology: A Multi-Method Participatory Design

This study adopts a multi-method participatory research design embedded within Work Package 5 of the COLOURS European University Alliance. The design was developed to capture gender inequality as simultaneously structural, organisational, and experiential. The methodological architecture integrates document analysis, participatory mixed-method mapping, and qualitative co-creation workshops, reflecting a convergent multi-method design (Creswell and Plano Clark, 2017).

The broader COLOURS Work Package 5 framework involved nine European partner universities: Josip Juraj Strossmayer University of Osijek (UNIOS), University of Paderborn (UPB), University of Le Mans (Le Mans Université), University of Ferrara (UNIFE), University of Castilla-La Mancha (UCLM), University of Kristianstad (HKR), Jan Długosz University in Częstochowa (JDU), Ventspils University of Applied Sciences (VUAS), and University of St Kliment Ohridski Bitola (UKLO). However, for the purposes of this conference paper, the analysis is presented through the case of Josip Juraj Strossmayer University of Osijek (UNIOS) as an institutional illustration. The UNIOS case is used as an illustrative institutional example rather than a fully developed case study based on in-depth institutional data. Alliance-level data are used selectively to contextualise institutional findings, rather than to provide a full comparative analysis across universities. This approach enables a more focused examination of how formal EDI frameworks and participatory methodologies interact within a specific organisational setting.

Data collection adhered to institutional ethical standards across partner institutions. Participation in both the Group Concept Mapping (GCM) and IDEATE workshops was voluntary, informed consent was obtained prior to participation, and all materials were anonymised prior to analysis. No personally identifying information was retained. Workshop facilitation protocols were developed within the COLOURS framework to ensure comparability across sites while allowing limited contextual adaptation.

The first strand consisted of a structured analysis of Gender Equality Plans (GEPs) and related EDI frameworks. The documentary corpus included GEPs, recruitment and promotion regulations, anti-harassment procedures, accessibility policies, and strategic development plans. For the purposes of this paper, particular attention is given to institutional documentation relevant to the UNIOS case.

A structured qualitative document analysis (Bowen, 2009) was conducted using a coding framework informed by feminist institutionalism and neo-institutional theory. Coding focused on the presence of measurable targets, allocation of responsibility, monitoring mechanisms, reporting timelines, resource allocation, and accountability provisions. Particular attention was paid to potential decoupling between declarative commitments and implementation depth (Meyer & Rowan, 1977). Coding was discussed among the research team to enhance analytical consistency. In this paper, the document analysis is presented through the institutional evidence

available for UNIOS within the broader WP5 evidence base, rather than as a full re-analysis of all alliance documents.

The second strand employed Group Concept Mapping (Trochim, 1989; Kane & Trochim, 2007) with 348 staff members across the alliance. Participants represented academic and administrative roles across career stages. The GCM process followed four standard stages: (1) brainstorming, where participants responded to the prompt "What should our university do to improve equity, diversity, and inclusion?"; (2) sorting of statements into conceptually meaningful groups; (3) multidimensional scaling (MDS), which generated a two-dimensional point map; and (4) hierarchical cluster analysis (Ward's method), through which a six-cluster solution was selected based on conceptual interpretability and internal coherence.
Participants additionally rated each statement on importance and feasibility. This dual-rating structure enabled identification of perceived gaps between normative priorities and institutional capacity. While GCM provides statistical aggregation of participant sorting patterns, ratings reflect perceived feasibility rather than objectively measured implementability. In this paper, GCM findings are presented at the alliance level and used as contextual evidence for interpreting institutional dynamics at UNIOS.

The third strand consisted of IDEATE design-thinking workshops involving 392 students across partner institutions. Workshops followed a structured sequence of empathy mapping, problem definition, ideation, and preliminary prototyping. Workshops were conducted in local institutional languages. To ensure cross-site comparability, outputs were summarised using standardised templates and subsequently translated into a common analytical format. Facilitators followed shared guidelines developed within the COLOURS framework, reducing interpretive variability while allowing limited contextual adaptation.

Data included written reflections, collaborative boards, and facilitator notes. Materials were analysed using reflexive thematic analysis (Braun & Clarke, 2006; 2019). Thematic analysis followed an iterative coding process: initial codes were developed inductively from workshop materials and subsequently refined through team discussions to enhance analytical consistency. Analytical interpretation was informed by feminist institutionalism and intersectionality.
Methodological triangulation (Denzin, 1978) operated across three levels: structural (policy mapping), organisational (staff GCM priorities), and experiential (student workshops). The integration of these strands enabled identification of alignment and tension between formal commitments, organisational perceptions, and participatory insights.ž

Several limitations must be acknowledged. Participation was voluntary, potentially introducing self-selection bias. GCM feasibility ratings reflect perceived rather than empirically measured institutional constraints. Document analysis captures formal institutional architecture but cannot directly access informal power dynamics. Furthermore, while the broader dataset is comparative, the present paper does not provide a full cross-institutional analysis but focuses on a single institutional case. The study also does not measure longitudinal reform outcomes; rather, it analyses institutional configurations and stakeholder priorities at a defined temporal moment.

Despite these limitations, the triangulated design enhances interpretive robustness and supports a systematic examination of the relationship between regulatory compliance, institutional frameworks, and participatory processes.

4. Findings

The findings integrate insights from document analysis, Group Concept Mapping (GCM) with staff (n = 348), and IDEATE workshops with students (n = 392). In line with the analytical focus of this paper, institutional findings are presented through the case of UNIOS, while alliance-level results are used as contextual evidence. Across all strands, the results reveal a consistent pattern: while formal EDI frameworks are well established, evidence of their translation into measurable structural outcomes remains limited. Analytically, this distinction between the presence of institutional frameworks and the absence of outcome-level evidence is central to interpreting the compliance–implementation gap examined in this study. While outcome-level indicators remain limited in the available dataset, the combination of structured policy analysis, quantified GCM outputs, and participatory student evidence provides a multi-layered empirical basis for analysing institutional dynamics beyond formal documentation.

Formal EDI Infrastructure at UNIOS

At UNIOS, the formal EDI framework is institutionally structured through the Gender Equality Committee (UNIOS GEC), which is responsible for collecting gender-disaggregated data across multiple domains, including leadership positions. This indicates the presence of an established monitoring infrastructure. However, the available data do not provide sufficiently detailed institutional information to assess the extent of gender distribution in leadership roles within the scope of this paper.

In addition to monitoring structures, UNIOS has adopted a policy addressing harassment and bullying. This framework includes clearly defined procedures for reporting incidents, designated institutional contact points, and a structured support system for victims. The institutional infrastructure is further supported by the reporting tool “Your voice”, which enables reporting of violations of academic integrity and academic freedom. These mechanisms are embedded within a formally articulated zero-tolerance approach to harassment and bullying.

Taken together, these elements indicate that the formal policy architecture at UNIOS is well developed, particularly in relation to reporting mechanisms and institutional commitments to safe environments. At the same time, the available data primarily document the existence of frameworks rather than their measurable outcomes. This reflects a broader pattern across institutions, where strong formal commitments to equality coexist with challenges in their implementation in everyday institutional practice.

Staff Reform Priorities (GCM)

The following GCM findings are presented at the alliance level and serve as contextual evidence for interpreting institutional dynamics at UNIOS.
The GCM process involved 348 staff members across nine universities and was based on 329 initial statements generated during brainstorming, which were subsequently synthesised into 79 statements prior to sorting and rating. This structured reduction ensured both conceptual richness and analytical clarity.

The six-cluster solution captures distinct domains of institutional intervention, including training and education, governance and leadership, reporting and accountability, organisational culture, student support, and data and monitoring.

Participants evaluated each statement using two four-point Likert scales measuring importance and feasibility. Across the alliance, the cluster "Providing Training and Education" received the highest combined ratings. This cluster includes measures such as mandatory EDI training, integration of gender perspectives into curricula, inclusive teaching practices, and awareness-raising initiatives.

Cluster-level ratings demonstrate a clear pattern: importance scores reach values of approximately 3.26, while feasibility ratings are consistently lower, in some cases falling below 2.5. This divergence indicates that while staff perceive many reforms as highly important, they simultaneously recognise institutional constraints that limit implementation. Read in relation to the UNIOS case, this divergence is particularly significant, as it suggests that even where institutional structures are formally established, perceived barriers to implementation persist at the organisational level.

In the UNIOS-specific cluster ratings reported in the policy report, the highest feasibility value visible in the summary is 3.08, alongside an importance rating of 3.41. These values are consistent with the broader alliance-level pattern, in which training-and-education-oriented measures are perceived as both necessary and relatively implementable.

By contrast, clusters related to governance reform, leadership transparency, and structural accountability are consistently rated as highly important but less feasible. Overall, the GCM results reveal a dual dynamic: a broad alignment of normative priorities on the importance of structural reform, combined with a pragmatic prioritisation of pedagogical and training-based interventions.

Student Workshop Insights (Alliance-Level Context)

The IDEATE workshops involved 392 students across partner institutions and provide an experiential layer to the analysis. In line with the scope of this paper, these findings are used as contextual evidence rather than institution-specific results.
A key finding across the workshops is that, for many participants, engagement in these activities represented their first substantial encounter with EDI concepts within higher education. This points to significant gaps in prior curricular exposure to issues of equity, diversity, and inclusion. Within the logic of this study, this is analytically important, as it indicates that participatory processes are not only diagnostic but also compensatory in contexts where formal curricular exposure to EDI remains limited.
The workshops further highlight the transformative potential of participatory, human-centred approaches in fostering awareness, reflection, and engagement with institutional change processes. Students not only articulated existing barriers but also actively contributed to the co-creation of potential solutions.

Students emphasised stronger integration of gender and diversity perspectives into teaching, clearer and more accessible reporting mechanisms, and increased visibility of institutional commitment to safe environments.

Intersectional concerns were also raised, particularly in relation to recognition of diverse identities and accessibility in learning environments. These findings suggest that existing institutional approaches do not yet fully address the complexity of lived experiences across different social positions.

Evidence from alliance-level data further indicates that experiences of harassment and discrimination persist within academic environments. For example, one institutional survey (at JDU) found that 27.3% of doctoral students reported having experienced such issues, underscoring the continued relevance of effective reporting and support mechanisms.
Proposed solutions articulated by students closely mirror staff priorities identified in the GCM results, particularly in the areas of training, curriculum reform, and reporting transparency. However, students additionally emphasise campus culture and informal social environments as key sites of inclusion or exclusion.

Synthesis Across Strands

Across all three methodological strands, a consistent pattern emerges. Formal EDI frameworks are clearly present and institutionally articulated, yet evidence of their translation into measurable structural outcomes remains limited. Staff identify structural reform as necessary but difficult to implement, while students highlight gaps in everyday institutional experience and curricular exposure.

At the alliance level, a strong normative consensus underpins EDI efforts, reflected in widely shared values of respect, inclusion, and recognition of diversity. However, this consensus coexists with practical and organisational constraints that shape the implementation of equality measures.

Taken together, the findings demonstrate that while regulatory compliance has been achieved at the level of policy architecture, participatory evidence reveals ongoing structural, organisational, and cultural challenges in embedding equality within institutional practice. This suggests that participatory data do not merely complement policy analysis but reveal dimensions of institutional functioning that remain invisible within formal documentation.

5. Discussion

5.1. The Compliance–Implementation Gap

The findings illustrate a dynamic anticipated in both neo-institutional and feminist institutionalist theory: formal alignment with regulatory frameworks does not necessarily translate into measurable structural transformation. The case of UNIOS demonstrates that formal EDI infrastructures—such as monitoring mechanisms, reporting procedures, and institutional policy commitments—are clearly established. However, the available evidence remains stronger with regard to policy architecture than to demonstrable structural outcomes.
From a neo-institutional perspective, this pattern reflects decoupling between formal structures and operational practice (Meyer & Rowan, 1977). Feminist institutionalism deepens this interpretation by foregrounding the interaction between formal rules and informal norms (Mackay, Kenny & Chappell, 2010). The presence of institutional mechanisms—such as gender equality committees and reporting procedures—indicates the institutionalisation of equality as a formal objective, but does not in itself demonstrate redistribution of organisational power or transformation of everyday practices. This pattern is consistent with feminist institutionalist insights on the persistence of formal–informal gaps within organisations (Acker, 1990; Mackay et al., 2010).

The GCM findings provide organisational-level insight into this dynamic. The observed divergence between importance and feasibility ratings—where highly valued reforms are simultaneously perceived as difficult to implement—indicates that institutional actors recognise both the necessity of structural change and the constraints that shape its implementation. This divergence empirically reflects institutional decoupling between formal commitments and their perceived implementability (Meyer & Rowan, 1977). This aligns with substantive equality theory, which emphasises that formal equality frameworks cannot compensate for structurally embedded inequalities (Fredman, 2016; Valian, 1998).

The findings related to reporting mechanisms further reinforce this interpretation. While institutional procedures and support systems are clearly defined, participatory insights suggest that their effectiveness depends not only on their formal existence but on their perceived accessibility, trustworthiness, and practical usability. Evidence of continued experiences of harassment within academic environments further underscores the gap between formal provision and lived experience.

In the UNIOS case, this is visible in the coexistence of clearly defined reporting structures and the absence of outcome-level evidence on their use or effectiveness, illustrating how formal institutionalisation does not necessarily translate into measurable change.

Taken together, the findings do not indicate regulatory failure, but rather the limits of regulatory conditionality in the absence of deeper institutional embedding. Gender Equality Plans and related frameworks establish necessary structural foundations; however, their transformative potential depends on their translation into everyday institutional practice and measurable outcomes.

5.2. Participatory Methods as Structural Catalysts

While structural limitations remain evident, the findings also highlight the reflexive potential of participatory methodologies. Participatory governance theory posits that inclusive deliberation can enhance institutional legitimacy and surface tacit assumptions embedded within organisational practice (Fung & Wright, 2003). In this study, both Group Concept Mapping and IDEATE workshops function not only as data collection instruments but as structured processes through which institutional priorities, constraints, and gaps are articulated. The convergence between staff and student priorities—particularly in relation to training, curriculum integration, and reporting transparency—indicates a shared recognition of key areas for intervention. This alignment strengthens the evidentiary basis for reform by demonstrating that concerns are distributed across organisational levels rather than confined to a single stakeholder group.

Importantly, student workshop findings suggest that participatory engagement itself constitutes a form of institutional intervention. For many participants, these workshops represented their first substantial engagement with EDI concepts, indicating gaps in formal curricular provision. At the same time, the workshops demonstrated the potential of participatory, human-centred approaches to foster awareness, reflection, and engagement with institutional change processes.

From an organisational learning perspective, the articulation of feasibility constraints in the GCM results suggests the emergence of reflexive awareness (Argyris & Schön, 1978). Participatory processes make visible the gap between normative aspirations and perceived institutional capacity, thereby enabling a form of institutional self-observation. In this sense,

participatory mapping does not resolve institutional decoupling but renders it empirically visible.
A feminist institutionalist reading further highlights the significance of this process. By rendering implicit institutional constraints—such as perceived barriers to governance reform or limitations of reporting mechanisms—explicit, participatory mapping challenges the taken-for-granted character of organisational routines. However, as Arnstein (1969) cautions, participation alone does not guarantee redistribution of authority. Reflexivity becomes transformative only when integrated into decision-making structures and accountability mechanisms.

The findings therefore suggest that participatory EDI processes can contribute to institutional reflexivity and legitimacy-building. Their capacity to act as structural catalysts depends on their integration into governance frameworks rather than remaining project-based or consultative exercises.

5.3. From Symbolic Commitment to Cultural Embedding

The case examined in this study illustrates both the potential and the limits of current EDI approaches within European higher education. While formal frameworks—such as monitoring structures, reporting procedures, and policy commitments—are increasingly institutionalised, moving from symbolic commitment to cultural embedding requires additional conditions. In this study, these conditions emerge not abstractly, but from the observed combination of established institutional frameworks, limited evidence of measurable outcomes, and convergent staff–student reform priorities.

First, accountability mechanisms remain central. The presence of monitoring structures does not automatically imply their effective use; linking institutional commitments to measurable indicators and transparent processes is essential for assessing progress.

Second, intersectional data practices require further development. While intersectionality is conceptually central to this study, the available empirical data do not allow for a fully developed intersectional analysis, pointing to an important direction for future research. As highlighted in the theoretical framework, reliance on gender-disaggregated data alone may obscure compound forms of disadvantage. Strengthening data practices is therefore necessary for more precise and context-sensitive interventions (Walby, Armstrong & Strid, 2012).

Beyond structural and data-related limitations, the findings also point to the normative and epistemic dimensions of institutional inequality. From a critical justice perspective, gender equality in higher education cannot be reduced to formal inclusion or representation, but must also address questions of redistribution, recognition, and participation (Fraser, 2008). While institutional frameworks analysed in this study emphasise procedural compliance, less attention is given to how institutional practices shape whose knowledge and experiences are recognised as legitimate.

From the perspective of feminist epistemology, institutions are not neutral sites of knowledge production but actively structure what counts as valid knowledge and who is recognised as a credible knower (Harding, 1991). In this context, the limited integration of EDI into curricula identified in student workshops can be interpreted as an epistemic limitation of institutional practice. Furthermore, persistent barriers related to reporting, recognition, and inclusion may reflect forms of epistemic injustice, where individuals experience diminished credibility or lack

access to shared interpretive resources (Fricker, 2007). Participatory methodologies partially address these limitations by creating spaces for articulating and validating marginalised perspectives, although their transformative potential depends on their integration into institutional decision-making processes.

Third, curriculum integration emerges as a key area of convergence between staff and student priorities. The prominence of training and education within the GCM results—supported by high importance and relatively higher feasibility ratings—indicates that pedagogical interventions are perceived as both necessary and implementable. At the same time, student findings highlight existing gaps in curricular exposure to EDI, reinforcing the importance of systematic integration.

Fourth, trust in reporting mechanisms must accompany procedural development. The existence of formal reporting structures, as observed in the UNIOS case, represents an important institutional step. However, their effectiveness depends on perceived accessibility, transparency, and protection against negative consequences, particularly in contexts where experiences of harassment persist.

The findings indicate that participatory approaches, when combined with formal policy frameworks, function as mechanisms for rendering institutional constraints visible and thereby create conditions for more embedded forms of change. However, this requires their integration into ongoing governance processes rather than their limitation to project-based interventions.
The analytical contribution of this study lies in three interrelated insights. First, it demonstrates how formal EDI frameworks may coexist with limited evidence of structural outcomes, highlighting the compliance–implementation gap. Second, it shows how participatory mapping techniques make visible perceived institutional constraints, particularly through the divergence between importance and feasibility. Third, it identifies convergence between staff and student priorities as a potential foundation for coordinated institutional reform.

Together, these findings contribute to feminist institutionalist analyses by linking regulatory frameworks, organisational practices, and participatory processes within a focused institutional case.

6. Conclusion

The novelty of this study lies in empirically linking participatory EDI methodologies with the compliance–implementation gap within a European University Alliance context. Gender equality in European higher education has entered a phase of formal consolidation, as illustrated through the case of UNIOS within the COLOURS European University Alliance. Gender Equality Plans, monitoring frameworks, and regulatory conditionality under Horizon Europe have established an institutional architecture of compliance across universities. However, this study demonstrates that formal alignment does not automatically translate into measurable structural transformation. The available evidence highlights a stronger presence of formal policy frameworks than of clearly demonstrable structural outcomes, thereby substantiating the persistence of a compliance–implementation gap. This distinction between institutional presence and demonstrable impact is analytically central to understanding the limits of current EDI approaches.

By integrating document analysis, Group Concept Mapping with staff, and IDEATE design-thinking workshops with students, the study provides a triangulated account of gender equality as simultaneously structural, organisational, and participatory. The divergence between perceived importance and feasibility in governance-level reforms points to recognised institutional constraints, while the convergence between staff and student priorities establishes a cross-constituency basis for reform. These findings demonstrate that participatory mapping not only captures institutional perceptions but also makes visible the structural and organisational conditions that shape the implementation of equality measures.

Theoretically, the study contributes to feminist institutionalist and socio-legal scholarship by linking regulatory frameworks, institutional practices, and participatory processes within a focused empirical case. It shows that regulatory conditionality establishes necessary preconditions for reform but remains insufficient without mechanisms that support implementation, accountability, and institutional embedding.

The findings further suggest that the effectiveness of EDI frameworks depends not only on their formal adoption but on their integration into everyday institutional practice. While the findings indicate the reflexive and agenda-setting potential of participatory methodologies, they do not provide direct evidence of institutional transformation or long-term structural change. In particular, the analysis highlights the importance of strengthening accountability mechanisms, developing more nuanced data practices, and embedding EDI principles within teaching and learning processes.

Moving beyond compliance therefore requires a shift from formal adoption to cultural and organisational embedding. Participatory methodologies can contribute to this shift when integrated into governance structures rather than remaining project-based or consultative exercises. When embedded as part of institutional practice, participatory EDI processes may enhance institutional reflexivity, support legitimacy-building, and contribute to more substantively gender-inclusive higher education systems.

More broadly, advancing gender equality in higher education requires not only structural and procedural reform, but also greater attention to the epistemic dimensions of institutional life, including whose knowledge is recognised, whose experiences are legitimised, and how participatory processes can contribute to more just and inclusive knowledge practices.

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A scientific paper

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STORYTELLING OF SUCCESSFUL CROATIAN FOOD BRANDS

ABSTRACT

This paper analyses the role and effectiveness of storytelling in the marketing of successful Croatian food brands within the context of a saturated market and evolving consumer expectations. To address this objective, the study examines the extent to which storytelling contributes to capturing consumer attention, eliciting emotions, building trust, and influencing purchase intention and loyalty, as well as the degree to which established theoretical models, narrative processing and the Consumer-Based Brand Performance Model, are supported in the Croatian food market.

The research employs a mixed-methods approach. The qualitative component consists of in-depth interviews with three stakeholders closely associated with the food industry: a successful Croatian food company (Podravka), a restaurant (Dvor), and a food influencer (Marija Mazalin). For the quantitative part of the research, a survey (N=174) examining consumers' self-perceived responses to storytelling in food branding was conducted.

The findings indicate that storytelling is more effective in capturing attention than purely informational advertising. Moreover, a combination of emotional and rational approaches yields the most favorable outcomes, a result that extends prior research in the field. These findings contribute to the discourse on emotional marketing by suggesting a possible saturation effect, whereby consumers increasingly seek factual support alongside emotional narratives. Accordingly, effective storytelling strategies should integrate authentic emotional content with transparent and informative elements. Nostalgia emerges as the central emotion in the storytelling of Croatian food brands; however, quantitative results reveal variability in emotional responses and a preference for information in the early stages of the purchase decision process. Authenticity is confirmed as a prerequisite for trust. Overall, storytelling positively influences purchase intention and loyalty, provided that the product or service fulfills the promise conveyed by the brand narrative.

Key words: *Storytelling, Marketing communication, Authenticity of the story, Food brands.*

1. Introduction

In recent years, storytelling has emerged as a central topic of research in cognitive, social, and personal psychology, as well as neuroscience, confirming its key role in human development and interpersonal relationships (Pereira, 2019), while simultaneously gaining an important position in marketing and communication studies. In contemporary consumer society, characterized by an abundance of products and information consumers seek deeper explanations of brand value through emotional connection, identity, and meaning. Consequently, storytelling has become a central element of marketing strategies (Jaud et al., 2023), leading food brands to increasingly shift their marketing efforts from merely "selling food" toward "selling a story."

Growing investments in digital media further drives the use of video storytelling and social networks as primary communication channels (Teraiya et al., 2023). Rather than factual product information, marketing content increasingly emphasizes inspirational narratives and lifestyle portrayals (Vassallo et al., 2018). Storytelling is also used to enhance the sensory experience of food. A well-crafted product story can positively influence perceptions of taste and quality through narrative transportation; products accompanied by origin stories and coherent packaging tend to receive significantly higher taste ratings, particularly for utilitarian products (Jaud et al., 2023). Storytelling thus represents a sophisticated marketing tool that has emerged in response to contemporary opportunities and challenges in advertising.

Despite its increasing prominence, a clear gap remains in understanding how storytelling is operationalized by food industry actors and to what extent it affects consumer perceptions and brand success. The aim of this study is to examine these dynamics in the Croatian food sector through three case studies: a food producer, a restaurant, and a food influencer, complemented by a survey examining consumers' self-perceived responses to storytelling in food branding.

2. Importance of Storytelling in Marketing

People process information through stories from the beginning of time. Consumers process information more effectively through narratives, particularly when stories reflect real-life situations and clear cause-effect relationships (Escalas, 1998; Woodside et al., 2008).

Green and Brock (2002) define narrative transportation as a state of deep immersion in a story, stimulating imagination and emotional engagement. Emotions play a central role in narrative effectiveness, acting as a mechanism that increases consumer engagement, receptiveness to the message, and persuasion in advertising contexts (Yueh & Zheng, 2019). Story-formatted advertisements evoke stronger emotional responses (Deighton et al., 1989). Furthermore, consumers respond more positively to exciting, warm, and optimistic stories, while dull narratives struggle to retain attention (Escalas et al., 2004). Consequently, storytelling is used as a marketing tactic to enhance consumer engagement and emotional connection with the brand (González Romo et al., 2017). In contrast, factual advertising relies on objective information, promotes analytical thinking, requires higher cognitive involvement, and generates more counterarguments, emphasizing functional attributes and benefits (Júnior et al., 2023). Advertising effectiveness also depends on prior brand familiarity, with emotionally oriented messages producing more favorable impressions for new or unfamiliar brands than informational approaches (Soo Rhee & Jung, 2018).

Pereira (2019) defines storytelling as a three-dimensional process linking brand identity (character), customer experience (plot), and market context (world), arguing that focusing solely on the consumer (Hero's Journey) neglects the brand's narrative role.

Consumer purchase decisions are linked to brand perception (Yueh & Zheng, 2019). The relationship between storytelling, emotions, and brand attitude is reflected in the emotional stage of communication influence, encompassing information-seeking, interest in product attributes, and the formation of favorable brand attitudes (Guiltinan et al., 1997). The Consumer-Based Brand Performance Model (CBBPM) assesses brand success from the consumer perspective across four dimensions: brand value, trust, satisfaction, and loyalty - with perceived brand value positively influencing satisfaction and trust, which in turn enhance loyalty (Molinillo et al., 2018).

Yueh and Zheng (2019) identify four key dimensions of storytelling effectiveness: narrative processing, emotional experience, brand attitude, and purchase intention - which unfold sequentially, with narrative processing influencing emotional experience, which in turn shapes brand attitude and ultimately affects purchase intention.

2.1. Elements of Storytelling

Brands are classified along two axes: accessibility versus aspiration (relatable vs. aspirational brands) and promise of change versus preservation - resulting in four fundamental narrative brand archetypes that guide how brand stories should be adapted (Pereira, 2019). Relatable brands appear approachable, reflecting consumers' current identities and building relationships based on closeness and trust (Pereira, 2019). In contrast, aspirational brands represent ideals consumers strive for, conveying luxury and status while fostering connection through authenticity and vulnerability (Pereira, 2019). At the same time, brands may promise change - highlighting innovation, progress, and personal freedom - or preservation, focusing on safety, reliability, and a sense of care. By combining these two brand types and promises, four brand archetypes emerge (Pereira, 2019): the underdog (relatable, change-oriented; overcoming obstacles), the disruptor (aspirational, change-oriented; challenging norms and promoting innovation), the survivor (relatable, preservation-oriented; emphasizing security and comfort), and the protector (aspirational, preservation-oriented; combining luxury, quality, and vulnerability).

Regardless of the archetype to which a brand belongs, authenticity emerges as a key element of successful storytelling, since unconvincing narratives can undermine brand attitudes (Yin et al., 2023). Consequently, storytelling increasingly serves as a tool to strengthen trust and perceptions of authenticity among consumers (Huang & Guo, 2021). Literature distinguishes between indexical authenticity, indicating a real connection to an original object and greater relevance for higher-priced products, and iconic authenticity, based on symbolic resemblance and more influential in experiential contexts such as hospitality (Yin et al., 2023).

Need for cognition (NFC), a personality trait reflecting how much individuals enjoy mental engagement (Cacioppo & Petty, 1982), moderates perceived brand sincerity, with high-NFC individuals responding more positively to rhetorically rich stories, unlike low-NFC individuals (Huang et al., 2022). Carefully selected rhetorical figures can significantly enhance the effectiveness of marketing messages (Yang et al., 2018; Panigyrakis et al., 2020). Logos, ethos, and pathos constitute the fundamental means of persuasion, each contributing to one of the key

dimensions of perceived consumer value (Huang et al., 2022): functional value, derived from product quality and effectiveness; emotional value, associated with the feelings evoked by the story; and social value, relating to the brand's influence on consumer identity (Sweeney & Soutar, 2001). While pathos fosters emotional connection through emotionally charged language, and ethos contributes to social value by emphasizing brand expertise and credibility (Fiol et al., 2009), logos increases the rational persuasiveness of the story, contributing to the product's functional value (Chu et al., 2014). Consumers perceive brands as sincerer primarily when messages are emotionally appealing and credible, whereas rationality has a weaker effect on perceived authenticity (Huang et al., 2022).

2.2. Storytelling in the Food Industry

Usage of storytelling is not always considered positive. Although storytelling can increase message persuasiveness, it can simultaneously reduce consumers' ability to distinguish strong from weak arguments (Green & Brock, 2000), as it shifts attention away from the product's functional attributes. This raises questions regarding the suitability of storytelling across message types and its applicability to food brands. Storytelling is particularly effective when arguments are not sufficiently strong, whereas in opposite situations its limited use is recommended (Escalas, 2007; Lien & Chen, 2013). But Krause-Galoni and Rucker (2023) demonstrate that even strong arguments can be communicated effectively through storytelling if they are consolidated within the narrative.

Hedonic experiences are oriented toward pleasure, whereas utilitarian ones are driven by practical purpose (Babin et al., 1994). Since utilitarian products are excluded from the analysis, this paper focuses on hedonic food products and the associated experiences. In such experiences, consumer evaluations are primarily emotion-based (Voss et al., 2003). Storytelling, mediated by narrative immersion, may also influence consumers' expectations of product taste (Jaud et al., 2023). Storytelling enables the creation of so-called "prototypes of pleasure" - brands associated with pleasant emotions and positive consumer memories (Yin et al., 2023). Numerous studies emphasize nostalgia as an important emotional aspect of the consumer experience in hospitality. Nostalgia can be triggered by various stimuli such as music, scent, taste, atmosphere, and social interactions (Sedikides et al., 2008), while in hospitality key elements include food, interior design, and staff behavior (Chen et al., 2014). Nostalgia positively influences intentions to revisit luxury restaurants (Hwang & Hyun, 2013), general propensity to dine out (Chen et al., 2014), and emotional attachment to brands and guest loyalty (Li et al., 2019). The emotional aspect of the hospitality experience is directly linked to customers' tendency toward loyalty (Su et al., 2016). According to Jones and Comfort (2019), nearly all the world's largest beverage companies emphasize long-standing tradition, product quality, customer satisfaction, and positive emotions associated with consumption in their corporate communication. Emotional factors exert a stronger influence on consumer decision-making than rational considerations, as evidenced by findings that a substantial share of purchases is driven by emotional branding (Bunga et al., 2024), and that affective concerns, such as perceived health risks, outweigh cognitive motives like environmental awareness in organic product choices (Jose & Kuriakose, 2021).

3. Methodology

3.1. Research Questions and Hypotheses

Based on the literature review, two research questions and hypotheses were formulated:

- Q1: How do successful brands in the Croatian food sector use storytelling to promote food and their brands?
- Q2: How do consumers perceive food brands that use storytelling, and how does such storytelling influence consumers' purchasing behavior?
- H1: Brands that effectively apply storytelling evoke stronger positive emotions among consumers, resulting in more favorable brand attitudes.
- H2: Consumers who identify with a brand's story will exhibit higher levels of trust, emotional connection, and loyalty toward that brand.

To address the research questions and test the hypotheses, both qualitative (three semi-structured interviews) and quantitative research (a survey) were conducted.

3.2. Qualitative Research

In the qualitative part of the research, three semi-structured interviews were conducted with representatives of successful Croatian food brands: a representative of a food company, a restaurant, and a food influencer. The interviewees included the Director of Corporate Marketing at Podravka, a leading CEE food company; the Team Lead Manager of Restaurant Dvor in Split, an award-winning Mediterranean restaurant recognized by major international guides; and food influencer Marija Mazalin, the highest-reach Instagram and TikTok profile in this category in Croatia. All respondents were asked the same questions (Chapter Four).

3.2.1. Sample Selection for the Qualitative Research

The criteria for selecting interview participants were based on brand performance measures used by commercial research agencies. The food company was selected using financial-based brand value measures (the Forbes World's Most Valuable Brands scale) (Badenhausen, 2017). Financial data for restaurants are often of limited relevance, as they may reflect multiple hospitality units. Consequently, an alternative observable criterion, consumer satisfaction interpreted through visitor reviews, was introduced, given that brand satisfaction represents one of the four dimensions of the CBBPM. Financial-based criteria are not applicable to influencers due to the lack of publicly available financial data; therefore, the food influencer was selected based on social media performance.

3.2.2. Selection of a Successful Croatian Food Company

This section outlines the selection of a successful Croatian food company from a sample of four prominent Croatian food companies Podravka, Jamnica, Kraš, and Vindija, based on financial brand value derived from the Forbes model. Podravka is identified as the most financially successful firm.

3.2.3. Selection of a Successful Croatian Restaurant

To evaluate restaurants based on consumer perceptions, Google reviews of 17 Croatian restaurants were analyzed. Only restaurants with more than 600 reviews were included to ensure reliability, while Michelin-starred restaurants were excluded as methodological outliers due to their distinct positioning, international recognition, and potentially inflated review signals, which may reduce comparability.
Two metrics were considered:

- Average user rating (scale 1–5)
- Number of reviews (Google, 22 August 2025)

As ratings alone do not reflect their relative importance without accounting for review volume, a composite indicator was calculated by multiplying the average rating by the number of reviews:
Weighted user satisfaction value = Average rating × Number of reviews
Results were standardized using min–max normalization to calculate a performance index (0–100), where higher values indicate stronger overall consumer perception.

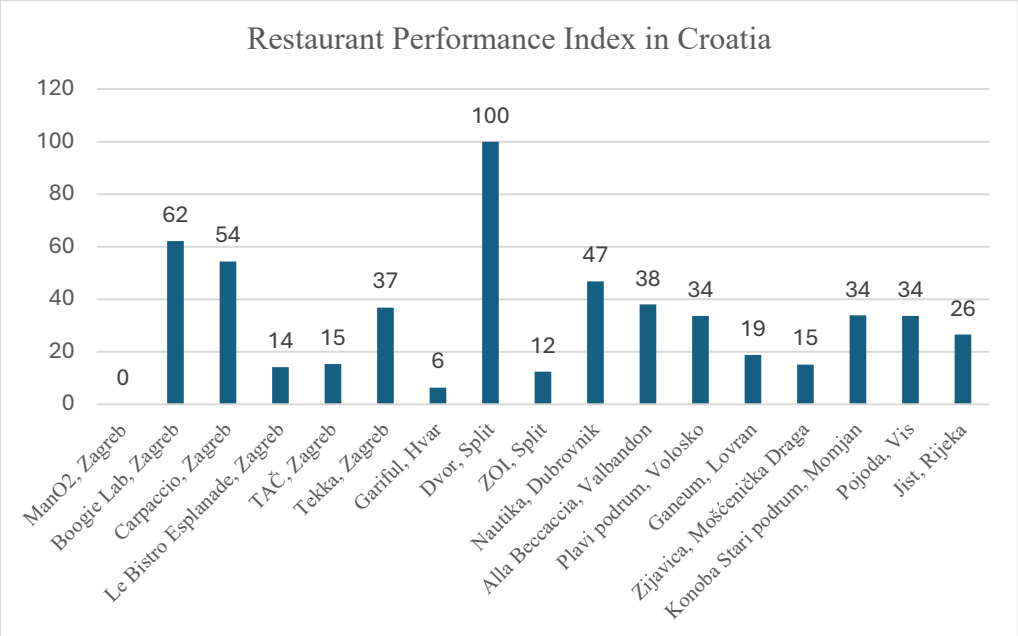
$$Performance\ Index\ = 100\ \times \frac{X - Xmin}{Xmax - Xmin}$$

Where:

- X = weighted user satisfaction value
- $Xmax$ = highest weighted value
- $Xmin$ = lowest weighted value

Based on this index, Restaurant Dvor in Split ranked highest, with a rating of 4.6 and 2,676 reviews (Figure 1).

Figure 1: Selection of a Successful Restaurant in Croatia



Source: Authors

3.2.4. Selection of a Successful Croatian Food Influencer

Influencers with larger audiences are generally perceived as more likeable due to associations with popularity and social endorsement, whereas a low following-to-follower ratio may diminish perceived likeability (De Veirman et al., 2017). The study assumes influencer effectiveness depends on the balance between reach and engagement, as high follower counts without interaction may not translate into actual influence (Djafarova & Trofimenko, 2019). Accordingly, engagement rate was included as a complementary indicator of active follower interaction.
To enable a comparative evaluation of food influencers, a sample of 16 Instagram influencer profiles was analyzed.
Two key metrics were used:

- Number of followers – indicator of reach
- Engagement rate – indicator of interaction.

A combined performance indicator was calculated as the mean of normalized follower count and engagement rate:

$$Pi = 0{,}5 \cdot Fnorm + 0{,}5 \cdot Enorm$$

Where:

- *Pi* = combined influencer performance index
- *Fnorm* = normalized follower count
- *Enorm* = normalized engagement rate.

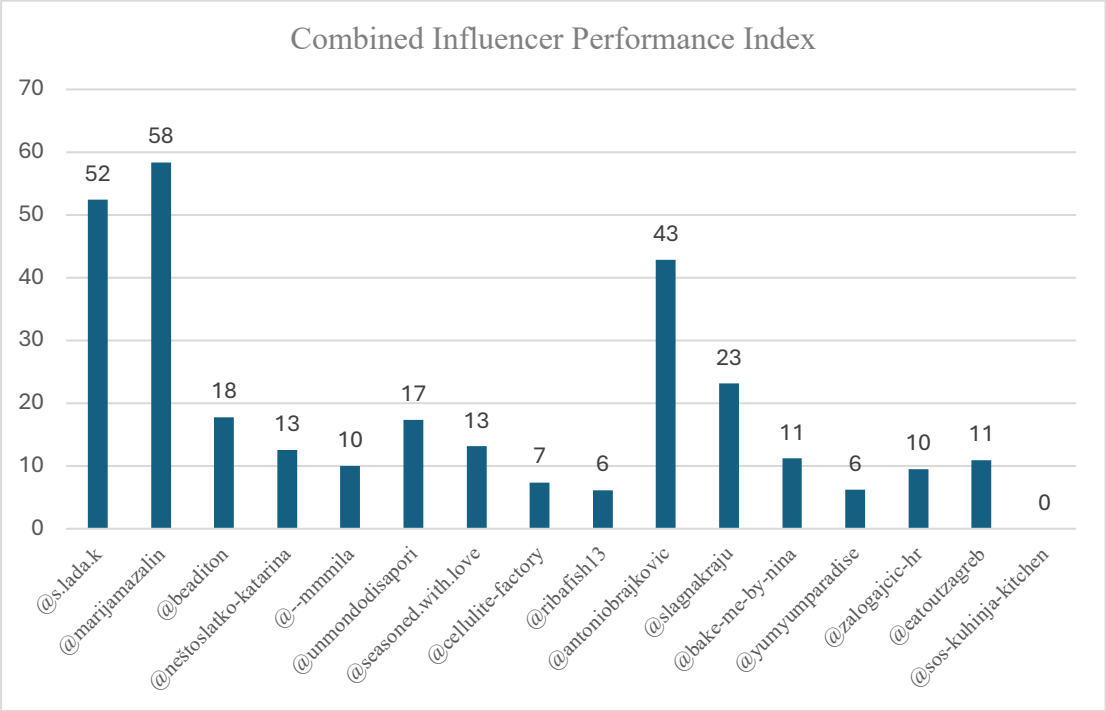
Equal weights (0.5; 0.5) were assigned to ensure balanced consideration of quantitative and qualitative metrics; however, future research should further examine the optimal weighting structure.
To ensure comparability, indicators were standardized to a 0–1 scale:

$$Fnorm = \frac{Fi - Fmin}{Fmax - Fmin}$$

$$Enorm = \frac{Ei - Emin}{Emax - Emin}$$

Where:
Fi = number of followers of an individual influencer
Ei = engagement rate of an individual influencer
Emax = maximum value in the sample
Emin = minimum value in the sample
Accordingly, influencer @marijamazalin ranks as the most successful food influencer (Figure 2).

Figure 2: Selection of a Successful Food Influencer in Croatia



Source: Authors

3.3. Quantitative Research

In the quantitative phase, a survey was conducted via online channels in October 2025, including 174 respondents. The questionnaire consisted primarily of closed-ended questions (Likert-scale and multiple-choice), with one optional open-ended question. The questions cover the following dimensions: perception of storytelling (recognition and experience of brand narratives), the experience of storytelling across different consumption contexts (food products, restaurants, and food influencers), emotional reaction (emotional connection with brands through storytelling), identification with the story, brand trust and perceived brand authenticity), purchase intention and loyalty, audience segmentation questions (assessment of audience interest in the food industry), story-type preferences (emotional vs. informational; short vs. long stories), as well as validation of findings from the interview phase.

4. Research Results

4.1. Results of the Qualitative Research

This section presents the findings of the qualitative research. The results are organized into thematic units, each introduced by the corresponding interview question.

1. How and to what extent is storytelling used in brand or product promotion, and what are its intended communication objectives toward consumers?

Across all three cases, storytelling is used as a strategic communication tool to foster emotional connections with audiences. The company primarily applies storytelling to communicate brand values and identity, the restaurant to convey local tradition and enhance the experiential consumption environment, and the influencer to personalize content and increase audience engagement.

2. Is your storytelling strategically planned or spontaneous, and how are attention-capturing narratives developed?

COMPANY: Storytelling is systematically embedded within strategic brand management and grounded in a clearly defined core brand identity ("brand heart"), which undergoes periodic review and refinement, typically at five-year intervals.
RESTAURANT: A hybrid approach is applied, combining planned and spontaneous storytelling, depending on business seasonality.
INFLUENCER: Storytelling is predominantly developed spontaneously to maintain perceived naturalness in communication. Content is typically produced in a single take, preserving natural pauses and minor speech imperfections associated with informal, interpersonal communication styles.

3. What is the role of authenticity in your brand storytelling, how do you ensure content credibility and authenticity, and how does this affect audience trust?

Authenticity is perceived as a fundamental prerequisite for building trust and maintaining long-term relationships with the audience. The company emphasizes the importance of a deep understanding of core brand values and the consistent communication of narratives that can be credibly substantiated by the brand. The restaurant highlights authenticity as essential for delivering a consistent experiential promise. Similarly, the influencer identifies authenticity as critical for long-term credibility and sustainability on social media.

4. Which rhetorical appeals are used in brand storytelling and what drives their selection?

COMPANY: A combination of emotional, rational, and credibility-based appeals is used, depending on the context and the brand life-cycle stage. For example, emotional appeals are more frequently used in media communication, while rational appeals (e.g., product functionality) are emphasized at the point of sale. In early brand development stages, communication primarily relies on functional arguments, while emotional connection with consumers is developed gradually over time.
RESTAURANT and INFLUENCER: Restaurant and influencer communication relies primarily on emotional appeals. This is particularly evident in the restaurant context, where basic functional needs such as satiety can be satisfied across multiple alternatives, while competitive differentiation is achieved through emotional and experiential value creation. Consequently, rational appeals are positioned as secondary to emotional ones.

5. Do you use universal themes in brand storytelling (e.g., family tradition, local community, success narratives), and if so, which and why?

COMPANY: Universal storytelling themes are used only when they originate from the core brand identity. Podravka is generally positioned as a "caregiver" brand, reflected in communication focused on care, warmth, and family values (e.g., soup campaign "Make soup, create a feeling").
RESTAURANT and INFLUENCER: Restaurant and influencer communication do not systematically rely on universal themes but use them situationally, primarily in the context of tradition. The restaurant uses such narratives during seasonal periods connected to local customs (e.g., Christmas cod preparation tradition), while the influencer integrates traditional themes mainly through family recipes passed down across generations.

6. Is storytelling adapted based on audience segmentation and response patterns?

COMPANY and RESTAURANT: No segmentation based on story type is conducted.
INFLUENCER: Although no formal segmentation is conducted, storytelling is adapted based on practical experience and audience feedback rather than predefined target segments.

7. How is storytelling used to evoke emotional reactions, which emotions are primarily targeted and why?

COMPANY: Emotional identification is fostered through strategically constructed narratives designed to evoke brand-specific emotional associations. In the case of Podravka soup, communication and product design are integrated and aligned to evoke emotions of home, warmth, and togetherness (e.g., heart-shaped pasta in the "Mom's Soup" product).
RESTAURANT: Focus is on emotions related to experiential enjoyment, comfort, and satisfaction.
INFLUENCER: Primary aim is to evoke nostalgia, as such content consistently generates strong audience response and strengthens personal connection between the creator and the audience.

8. How does storytelling shape consumer brand perception and attitudinal responses?

All three respondents perceive storytelling as positively influencing brand perception, audience attitudes, and loyalty. The company emphasizes that positive effects are possible only through authentic and consistent communication. The restaurant highlights storytelling's role in encouraging loyalty by reminding guests of previous positive experiences. The influencer emphasizes that successfully communicated personal experiences create a perception of closeness, which builds trust and subsequently loyalty.

9. Does storytelling influence actual consumer behavior?

COMPANY and INFLUENCER: Storytelling can influence behavior, provided communication remains authentic and consistent.
RESTAURANT: Storytelling functions as a supporting factor in consumer decision-making; however, the quality of the underlying product or service remains the primary determinant of final behavioral outcomes.

10. Can you provide an example of a particularly successful story or campaign?

COMPANY: Emotionally driven campaigns such as "Mom's Soup", as well as socially responsible campaigns such as "Let's Donate for Schools and Beloved Meals", aimed at promoting culinary professions and preserving traditional Croatian cuisine.
RESTAURANT and INFLUENCER: Both the restaurant and the influencer emphasize authentic, often spontaneous storytelling linked to tradition or personal experience. The restaurant reports exceptionally high demand generated through word-of-mouth promotion (e.g., December "Cod Days"), while the influencer highlights high-reach content driven by strong emotional resonance (e.g., a grandmother's strudel recipe video).

4.2. Quantitative Research Results

This chapter presents the results of quantitative research. The findings are organized into thematic sections, each reflecting a specific topic measured through the related survey questions.

4.2.1. Perception of Storytelling and Audience Attention

On average, participants reported that they occasionally notice the use of storytelling in food brand marketing (M = 3.01; SD = 1.12). More than half of respondents (65.5%) perceive the presence of storytelling at least to a moderate extent, while only 9.8% never notice it. This distribution indicates that storytelling is not equally recognizable to all consumers; however, the majority still identify its elements in food brand communication. Participants, on average, agreed with the statement that promotional stories of food brands attract more attention than advertisements presenting only products and factual information (M = 3.64; SD = 1.18). Overall, 84.5% of respondents at least moderately agreed with the statement, while 59.8% expressed a high level of agreement, and only 7.5% completely disagreed. These results imply that most consumers perceive storytelling as a more effective attention-capturing tool compared to purely informational advertising.

4.2.2. Emotional Effects of Storytelling

Participants showed moderate agreement with the statement that brand stories can create an emotional connection with the brand (M = 3.05; SD = 1.26). Distribution data indicate substantial variability in attitudes: although 68.4% rated 3 or higher, a significant share (31.6%) provided lower ratings, while 15.5% completely disagreed. These findings suggest that emotional connection through storytelling exists but is not equally strong across all respondents. Participants also moderately agreed that food brand stories can evoke strong emotions such as nostalgia, joy, or inspiration (M = 3.34; SD = 1.32). Overall, 51.7% gave high agreement ratings, while 27% reported low agreement, and 13.2% completely disagreed.

4.2.3. Authenticity and Trust

Participants agreed that they trust food brands more when they communicate authentic stories rather than only factual information (M = 3.88; SD = 1.19). Overall, 65.5% expressed high agreement (ratings 4 or 5), while 40.8% fully agreed, and only 5.7% completely disagreed. These results indicate that perceived authenticity significantly contributes to trust in food brands. Participants moderately agreed that they had previously recognized an inauthentic brand story that

negatively influenced their brand perception (M = 3.38; SD = 1.30). Overall, 73.6% indicated at least moderate agreement, while 25.3% strongly confirmed such experience. Thus, the lack of authenticity can negatively influence brand perception and consumer attitudes.

4.2.4. Storytelling and Purchase Behavior

Participants agreed that an engaging brand story increases purchase likelihood (M = 3.75; SD = 1.08). Overall, 59.2% expressed high agreement, while only 11.4% expressed disagreement, suggesting that storytelling can significantly increase purchase intention for food products. In the context of repeated behavioral outcomes, participants expressed moderate agreement that brand storytelling had influenced repeated food product purchases (M = 3.10; SD = 1.04). Overall, 51.7% reported repeated purchases attributable to storytelling, 14.4% reported at least one such purchase, while 8% reported no such experience.

4.2.5. Preferences for Rhetorical Style and Narrative Format

Participants demonstrated the strongest preference for communication combining emotional storytelling with rational product information (M = 2.63; SD = 0.61). Overall, 58% preferred this combined approach, while 35.1% preferred purely rational information and only 2.9% preferred purely emotional storytelling. These findings indicate a general preference for balanced communication integrating emotional and rational elements, with a substantial dominance of rational information. Additionally, 87.9% preferred short and simple stories that quickly communicate the message, while only 12.1% preferred longer and more detailed narratives. Therefore, storytelling effectiveness depends on audience preferences, highlighting the importance of adapting narrative formats to target audiences.

4.2.6. Storytelling Across Communication Channels

4.2.6.1. Storytelling in the Company Context

On average, participants demonstrated moderate agreement with the statement that brand stories are considered during purchase decision-making and can influence product choice (M = 3.34; SD = 1.19). The modal response was neutral, with a slight skew toward higher agreement levels, while the standard deviation indicates moderate attitudinal variability. Overall, 44.3% of respondents expressed agreement, whereas 22.9% expressed disagreement or low agreement. These show that storytelling in product communication represents a relevant, yet selectively activated, factor in the consumer decision-making process.

4.2.6.2. Storytelling in the Restaurant Context

On average, participants demonstrated a high level of agreement that they value restaurants characterized by a distinct narrative identity or unique conceptual positioning (M = 4.33; SD = 0.88). Overall, 81.6% of respondents reported high agreement, while only 2.8% expressed disagreement. This indicates that a clearly communicated restaurant narrative identity represents a significant contributor to perceived customer experience and overall satisfaction.

4.2.6.3. Storytelling in the Influencer Context

On average, participants expressed moderate agreement with the statement that influencer storytelling can influence their perception of brands (M = 3.19; SD = 1.31), with the high standard deviation indicating substantial variability in attitudes. Overall, 42.5% of respondents expressed agreement, while 27.6% expressed disagreement. The results suggest that influencer storytelling can influence brand perception, although the strength of this effect varies considerably across consumers.

4.2.7. Respondent Profile and Behavior

4.2.7.1. Trying New Products

On average, participants demonstrated a moderate tendency to try new food products and brands (M = 3.17; SD = 0.80). Overall, 83.9% of respondents reported trying new products at least occasionally.

4.2.7.2. Restaurant Visits

On average, participants reported a moderate frequency of restaurant visits (M = 3.48; SD = 0.95). Most respondents (40.8%) visit restaurants occasionally (approximately once per month), while 28.2% do so more frequently, several times per month. Only 13.2% visit restaurants rarely. This implies that eating out represents a lifestyle component for most respondents.

4.2.7.3. Following Food Influencers

On average, participants reported a moderate level of following food influencers on social media (M = 3.03; SD = 1.20), with moderate variability in attitudes. Although 66.7% of respondents follow such content at least occasionally, 33.3% do not belong to this audience segment. These results suggest that most respondents have occasional exposure to such content, while extremes (very frequent; 13.8%, or never; 12.1%) are less common, with the majority positioned around the midpoint of the distribution.

4.2.8. Qualitative Insights from the Open-Ended Question

The main themes include nostalgia (e.g., products associated with childhood and family tradition), emotional storytelling and authenticity (e.g., brands or individuals emphasizing personal values and authentic narratives), brand archetypes (e.g., brands communicating traditional or ethical values or anti-system positioning), and recommendations from personal networks (word-of-mouth).

5. Discussion

The integration of qualitative and quantitative findings is based on two complementary respondent groups. Participants are professionally active within the examined sectors and therefore possess direct operational insight across all three analyzed dimensions. Respondents represent consumers

relevant to restaurant visitation (86.2%) and openness to trying new food products (83.9%); however, their exposure to influencer storytelling varies across the sample (66.7% at least occasional exposure; 33.3% no exposure). Although exposure to influencer storytelling is present, it is not routine for most respondents, which may partially explain deviations from previous research.

A substantial proportion of consumers recognize storytelling in food brand communication, while producer-side perspectives consistently position it as a central component of contemporary marketing strategy. Qualitative results further suggest that implementation is context-dependent: strategically structured at the corporate level, partially spontaneous within hospitality, and predominantly spontaneous in influencer context. Moderate variability in consumer perception implies that recognition of storytelling is influenced by individual exposure and narrative literacy; however, overall results confirm its significant role from both perspectives. Findings also indicate that storytelling is more effective in capturing attention than purely informational advertising, reflecting evolving expectations for narrative-enriched marketing content. Integrated results support the theoretical propositions of Deighton et al. (1989), suggesting that narrative advertisements generate stronger audience responses. Interviewees use storytelling to capture attention and foster emotional engagement, while consumers confirm its stronger effect compared to rational messaging. The high recognition of narrative elements, combined with the finding that only 4% of consumers have no content-type preference, further supports storytelling as an effective attention mechanism.

The examination of emotional responses and brand connection provides mixed insights. Qualitative findings support theoretical arguments emphasizing emotional storytelling, particularly in hedonic consumption contexts such as gastronomy, where emotional experience becomes part of the product. However, quantitative findings reveal variability, with a subset of consumers reporting no emotional connection despite exposure to storytelling. This only partially supports claims that storytelling consistently elicits stronger emotional responses and more favorable attitudes. Emotional connection is therefore neither automatic nor universal, potentially reflecting differences in emotional sensitivity, narrative identification, or functional decision-making factors such as price or habitual purchasing. Nevertheless, responses to the open-ended survey question indicate that emotional experiences are most frequently recalled, suggesting salience in consumer memory and highlighting limitations of self-reported emotional measures. Further analysis is therefore required to identify divergence between producer and consumer perceptions.

The results also partially deviate from theoretical expectations in the dimension of rhetorical approaches. Although consumers prefer a combination of persuasive elements, there is a visible preference for rational product information over purely emotional storytelling. The restaurant and the influencer predominantly rely on emotional and credibility-based appeals, while the company emphasizes a more integrated approach, highlighting the strategic value of fact-based messaging, particularly during the initial purchase stage. This partially contrasts with Soo Rhee and Jung (2018), who found that emotionally oriented advertisements create more positive impressions for new brands. The company further adapts rhetorical approaches to context, with emotional appeals dominating media communication and rational arguments more prominent at the point of sale. Overall, findings suggest the strongest effects occur when emotional and credibility-based appeals are combined with rational information, as narrative communication alone appears insufficient in

certain contexts. Alignment between consumer and producer perspectives may also suggest emerging emotional marketing saturation.

Nostalgia emerges as the central emotion of successful storytelling. The findings suggest that its role, previously validated in restaurant contexts, may be generalizable to broader food consumption. Within brand archetypes, the most favorable responses are elicited by brands communicating preservation, whether aspirational or accessible (the "Protector" and "Survivor" archetypes), as well as by other archetypes when narratives are consistent and authentic. Podravka aligns with the "Survivor" archetype, communicating preservation and emotional comfort, while Restaurant Dvor reflects the "Protector" archetype through tradition-focused initiatives such as "Cod Days" or "Stuffed Pepper Days." Influencer communication demonstrates weaker reliance on consciously applied archetypes. Quantitative findings similarly suggest that consumers respond most positively to nostalgia- and tradition-based narratives.

Authenticity emerges as a necessary condition for effective storytelling. Brand representatives emphasize that narratives must be rooted in genuine values. Quantitative results reinforce this relationship: 65.5% of respondents report high trust in brands communicating authentic stories, whereas 73.6% recall negative experiences associated with inauthentic storytelling. This highlights the dual role of authenticity: authentic storytelling increases trust and favorable attitudes, whereas inauthentic storytelling leads to negative perceptions, erosion of trust, and potential long-term damage to brand-consumer relationships. Storytelling therefore does not function as a neutral technique; when perceived as authentic, it strengthens reputation, but when perceived as insincere, it can generate adverse outcomes.

The results suggest that Need for Cognition represents a storytelling-related segmentation dimension that Croatian food brands do not fully exploit. Word-of-mouth emerges as an additional theme not explicitly incorporated in the theoretical framework but functioning as a natural extension of storytelling processes. Since word-of-mouth messages are often adapted to enhance relevance, credibility, and engagement (Kozinets, 2010), their objectives converge with those of storytelling. The example of Restaurant Dvor ("Cod Days") shows that successful narratives can spread through guest recommendations, while a subset of consumers reports strongest behavioral influence from peer communication. Given that word-of-mouth effects are more prevalent among nostalgic brands (Gręboszk-Krawczyk, 2020), and nostalgia emerges as a dominant motif, such narratives may exhibit high potential for transition from brand-controlled storytelling to consumer-driven diffusion. Consequently, the role of word-of-mouth in narrative diffusion warrants further examination.

Finally, the study provides insights into storytelling effects on consumer behavior (purchase intention and loyalty). Qualitative findings support its influence on purchase intention, while quantitative results indicate sectoral variation. The effect appears strongest in hospitality, moderate in product-based contexts, and most heterogeneous in influencer-driven environments, possibly reflecting higher engagement with restaurants and new product experiences. Despite these differences, most consumers perceive storytelling as positively influencing purchase intention, although influencer-based storytelling requires further investigation among more engaged audiences. The study also confirms a positive influence on loyalty, though in a nuanced manner. While loyalty in the Molinillo et al. (2018) model results from satisfaction and trust, this research shows storytelling contributes to both through authenticity and emotional experience. Interview

findings emphasize that storytelling may drive initial action, but loyalty depends on fulfillment of the narrative promise through product or service performance. Repeated purchase behavior among more than half of respondents suggests storytelling-driven reinforcement. Overall, storytelling functions as a catalyst of consumer behavior, but its effectiveness depends on authenticity and fulfillment of narrative promises. Hypothesis 2 is thus confirmed, conditional upon fulfillment of the story's promise. Consumers who identify with authentic and consistent brand stories show higher trust, stronger emotional connection, and behaviors beneficial to the brand. Accordingly, both H1 and H2 are generally supported.

6. Conclusion

This study examined the role of storytelling in the communication strategies of successful Croatian food brands by integrating qualitative insights from three semi-structured interviews (a food company, a restaurant, and a food influencer) with quantitative data from a survey of 174 consumers. By linking empirical findings to theoretical frameworks, including the Consumer-Based Brand Performance Model and narrative persuasion models, the study provides an understanding of storytelling's contribution to brand success in the Croatian food market.

Overall, the results confirm that storytelling represents a powerful marketing tool within the food industry. Consumers recognize storytelling techniques and generally respond more positively to narrative-based communication than to purely informative advertising. In line with theory, successful storytelling strengthens purchase intention and contributes to loyalty, if brands consistently fulfill the promise embedded in their narratives. Authenticity emerges as a necessary precondition: while authentic stories function as catalysts of trust, inauthentic narratives risk triggering skepticism and potential long-term reputational damage.

Contrary to prior literature emphasizing emotional primacy, both consumers and the producers demonstrate a strong reliance on logos-based appeals, particularly in the early stages of the purchase decision process. Not all consumers form strong emotional attachment to brand stories, and many prefer factual content over purely emotional appeals. Nostalgia emerges as the central emotion in the storytelling of Croatian food brands; however, variability in emotional responses suggests that effective storytelling requires a balanced integration of rational and emotional cues. Emotional narratives alone may be insufficient in a context of potential "emotional marketing fatigue." The most effective strategies therefore appear to integrate pathos with transparent, factual arguments, simultaneously addressing the affective and cognitive dimensions of consumer decision-making. Furthermore, differences in need for cognition highlight opportunities for more refined audience segmentation.

Future research should incorporate all four dimensions of the CBBPM when selecting brands for analysis. However, as two dimensions are inherently intangible and not directly observable, the present study relied on tangible, measurable criteria. Given the scope of the paper, only basic statistical analysis was conducted. Future studies should examine differences in responses according to socio-demographic characteristics and incorporate more advanced statistical techniques. Moreover, the quantitative findings were based on consumer self-assessment, which may limit the precision of measured emotional and behavioral effects. The qualitative research included three cases that were not treated as a homogeneous group, and each case represented only

one representative of its sector, which constitutes a limitation when interpreting findings at the sector level.

In conclusion, storytelling significantly contributes to positive brand attitudes, trust, and loyalty in the Croatian food market, yet its effects are neither uniform nor unconditional. Optimal storytelling strategies must integrate authenticity, emotional depth, and factual credibility to successfully engage and retain contemporary consumers.

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A scientific paper

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SUSTAINABLE TOURISM LEARNING AND REFLECTIVE PRACTICE AT A CROATIAN UNIVERSITY

ABSTRACT

The application of the sustainability paradigm in education requires the identification of learning methods about sustainable development. Due to the complexity of the topic, there is still insufficient research on the methods and outcomes of sustainable learning. The gap in scientific research (knowledge) about the problem was overcome by analysing grounded theory and conducting a combined survey questionnaire. The goal was to conduct research of the key elements of sustainable learning (SL) and the formation of connections between the learning outcomes of sustainable education and the development of students' knowledge, values and skills (SD), using a combination of qualitative and quantitative methods. A sample of 113 students was selected from undergraduate and graduate students of two different university study programmes over the academic year 2024/2025. Based on the three phases of pedagogical competencies (learning perspective, framework possibilities and reflective analysis), influential factors for the improvement of sustainable education were formed, based on the coding method. The purpose was to assess the key elements important for a sustainable learning perspective. These factors were: improvement of the teaching process, diversification of learning methods and involvement of students in the community. The scientific contribution of this study is to acquaint the academic community with the elements and mechanisms of sustainable education. The benefits of this study are: 1) creating the resilience of educational systems (especially smaller ones) based on pointing out the lack of scientific knowledge about sustainable education in the social sciences, 2) constructing key elements for the elaboration of the mechanism of sustainable learning through three influential factors, 3) a greater participation in the community (application of results through sustainable tourism). These findings are significant for enhancing both student and teacher understanding of the main purpose of sustainable tourism education. Future researchers should strengthen the concept of inclusive tourism and the contributions of "sustainable" teaching to society.

***Key words**: Education, Learning Perspective. Outcomes, Sustainable Teaching, Tourism.*

1. Introduction

The subject of this research is sustainable education. The main objectives are (1) to study factors of education that affect the student knowledge, values and skills at the undergraduate and graduate study levels (qualitative approach), and (2) to assess the potential of sustainable education for teaching development (qualitative and quantitative approaches).
Juraj Dobrila University in Pula is known in its environment for sustainable educational initiatives and its work with small student groups. The teachers' orientation to sustainability education is defined by course names such as "Sustainable tourism", "Corporate social responsibility", and "Environmental economics". The research was conducted over two

semesters (winter and summer) across selected subjects of different academic years in order to examine multiple levels of understanding and adoption of the concept. The main hypotheses were:
H1. Learning about sustainable development is related to the acquisition of sustainable skills.
H2. Sustainability theory promotes active stakeholder collaboration.
H3. Students' perceptions of learning skills influence their own responsible decisions and long-term consequences to the environment.

A qualitative research study was conducted through an attitude survey to determine the awareness of sustainable policies among students, the application of sustainability in learning by teachers, the level of connection between theory and practice, and to indicate opportunities for improvement. The purpose was to determine the level of sustainable education as a university learning framework and perspective through analysis of student perception on sustainable learning (according to Ryegård, Apelgren and Olsson, 2010; Ferguson et al., 2022). This study aimed to answer the following questions: 1. Are the concepts of general and sustainable education different? 2. Is there a connection between learning outcomes and students' acquired knowledge about sustainability? 3. What are the forms of connection between sustainable theory and practice? 4. Are there differences in the social and personal understanding of sustainability?

The sample included students enrolled in subjects that do not have sustainable development/sustainability/ecology in their titles. The aim was to determine the level of holistic approach to sustainable education in the tourism/culture programme, with respect to "A" elements of the destination.

The research contributes to determining the relationship between the attitudes of higher education students and the pedagogical competences of teachers about sustainability and teachers' preparedness for students' interests and, additionally, to achieve the Sustainable Development Goals (SDGs).

The research points to the conclusion that the reform of sustainable education will reduce the gap in the perspective of learning and improve the modalities of connecting science and practice. The study emphasises the possibility of applying additional teaching tools.

2. Literature preview

2.1. Sustainable tourism education (STE)

Sustainable learning in the field of tourism mirrors the complexities and rapid changes of a dynamic environment. According to the Swedish perspective on pedagogical competences (Olsson, Mårtensson, Roxå, 2010), such support should include teaching observation (learning perspective), systematic investigation (framework factors and possibilities), and reflective analysis of student learning (practice and discussion). Teachers are individuals who deliver education for sustainable development (ESD) in the classroom (Ferguson et al., 2022). Education for sustainable development encompasses the knowledge, skills, values, and behaviours with the aim of developing sustainable societies for all (UN, 2015; UNESCO, 2017). The Agenda for Sustainable education is aligned with the *Sustainable Development Goals* (17 Sustainable Development Goals, SDG, UN, 2015), with a fourth goal that is particularly significant - quality education. By 2030, it is expected that inclusive and high-quality education

will be achieved, as well as the promotion of LLO (*lifelong learning opportunities*) and experiential learning methods (Lo, 2022). In the context of tourism, ESD has a focus on the integration of sustainability principles into tourism programmes through the education system (UN, 2012). Research on the connection between SDG and ESD points to the need to connect theorists and practitioners, involve local communities, and be included in every curriculum that will be aimed at developing skills as a fundamental contribution to student knowledge, with the development of environmental awareness and multidisciplinarity in approach (Cihangir, Şeremet, 2021).

Changes in tourism require constant learning about how to articulate sustainable development (Dwyer, 2023). There is a lack of studies promoting sustainability in tourism education at the global level, while the representation of works on sustainable tourism is extensive (Chen et al., 2022). Teachers' commitment to sustainability goals should be reflected through a greater degree of student involvement about roles in society, application of principles and responsibility for the environment and society (Okręglicka, 2018). Research indicates the growth of researchers' interest in sustainable tourism, but from the aspect of different levels of influence (Molina-Azorin & Font, 2015). Primarily, this refers to sustainable development of tourism through three dimensions of influence: economic, social, and ecological (Gregers Eriksen, 2013; Zygmunt, 2016). While tourism management and development can enhance sustainable development, the overall impact of tourism is mixed (London, Alvarez, Posadas, 2023; Matijova et al., 2023). Recent studies indicate the need to connect institutions with tourism and environmental sustainability, especially regulatory quality, government effectiveness, control of corruption and the rule of law (Nguyen, Su, 2021). These findings incorporate three prominent themes: governance, innovation and the SDGs (Garcia-Garcia et al., 2023). The supply chain system has a close relationship with the sustainability of the ecosystem (Ke, Lu, Luo, 2023).

Learning about sustainability is becoming increasingly important in today's dynamic and changing tourism environment, as it involves all stakeholders: local community, DMCs, DMOs, tourists, industry and academic institutions (Usman Khizar et al., 2023). The promotion of the destination through sustainable tourism should be represented through the "A" elements of the destination; *Agencies, Accommodation, Access, Attractions*, and *Actions* through destination management (Amoiradis, Velissariou, Thomas, 2023). *Added values* for the client, which are aimed at protecting nature during a stay and visits to museums, sun-and-sand tourism sites and cultural tourism destinations, are proof of the sustainability tourism value relationship (Kusumaningrum, Wikurendra, Marhadi, 2024). These policies promote responsible management of resources (Jugović et al., 2025). It is important to apply the principles of sustainability and spread them to the population (Šimková, Kořínková, Obršálová, 2024).

2.2. Education for sustainable development (ESD) in Croatian higher education

The share of tourism in the Croatian GDP is the highest among members of the European Union, with almost 26 percent in 2023 (Statista, 2024). This reflects the country's high orientation towards the service industry, as well as the need to protect resources through sustainable paradigms. Previous studies of ESD in small countries highly dependent on tourism, Croatia and Jamaica, point to the mismatch between education and employability in the green economy (Ferguson et al., 2022). Also, the need to offer more content to develop skills and to learn the values of sustainable life in the community (Jeknić, Čop, 2022; Mlađenović, 2023).
In Croatia, education toward sustainability is integrated into the Croatian education system, especially through higher education study courses. In 2009, the State adopted the *Action Plan*

for Education for Sustainable Development as proof of awareness of the growing importance of sustainable policies. Istria County, a highly developed tourist region, illustrates this understanding among stakeholders regarding the importance of sustainable policies and education on sustainable development (tourism). The regional tourist board (*Istrian Tourism Board* - ITB) has initiated the document *Tourism Sustainability in Istria*, which highlights local values and emphasises the benefits from sustainable destination development, nature conservation, development of eco museums, products, e-markets, use of e-bikes, cars, creation of eco-events and eco-certification.

Investigating the impact of sustainability education campaigns and recognition systems on tourists' behaviour is crucial for fostering a more sustainable tourism industry (Fuchs, Konar, 2025). The lack of research on the reflection of pedagogical competencies in student training in Croatia indicates a low level of awareness of the importance of regional sustainable education from the perspective of teachers and students. There is evidence of insufficient professional development of teachers due to inadequate implementation of sustainability education (Anđić, 2020), no reflection of the influence of language on ESD competences (Dobravac, Cvikić, 2020), and a lack of collaboration and involvement of educational and government bodies in ensuring knowledge, skills and values for future generations (Bugarić, 2024). Education on sustainable tourism development can contribute not only to sustainable partnerships between stakeholders in Croatia and its surroundings, but also to students and professors, through the quality of education and life (Gržinić, Kostić Bobanović, Currie, 2019).
In 2019, Juraj Dobrila University of Pula was the first Croatian university to be included in the ranking of 780 participating universities, taking the 390th place among sustainable universities (UI *GreenMetric,* 2024). Sustainable Development Goals in Higher Education are oriented towards university improvement policies regarding various aspects of sustainability, namely: *Setting & Infrastructure, Energy & Climate Change, Waste, Water, Transportation and Education & Research*.

Based on the research conducted on previous theoretical contributions, it can be concluded that the global research focus is on raising awareness about the inclusion of "sustainable topics" in curricula and the development of critical thinking and reflection (Ferguson et al., 2022). The micro-level research of ESD shows a lack of regional sustainable education data, despite the existence of initiatives and work on sustainable tourism development in Croatia.

Although there is comprehensive knowledge on the concept of sustainable learning for the needs of tourism (Fuchs, Konar, 2025), there is no consensus on the definition of sustainable learning from the aspect of coordinating activities with destination stakeholders (local community, companies). Ferguson, Roofe, and Cook (2021) in their research found that, to a lesser extent, teachers associated citizen participation with sustainable development. Mezirow (1991) originally outlined that sustainable learning is searching for new roles or ways of doing and being. Bueddefeld and Duerden (2022) argue that people acquire new skills and knowledge as both a process and a product. Those research has not examined students' attitudes about the reflection of sustainable education in tourism practice and the local community. Furthermore, studies on the sustainable service distribution chain (Kusumaningrum, Wikurendra, Marhadi, 2024), especially in tourism (learning perspective), contribute to the prevention of market disruptions (learning reflection). However, they do not provide answers on how to use sustainable learning to create resilience in the destination (sustainable framework). In particular, the research narrows the knowledge to the given framework (Olsson, Mårtensson, Roxå, 2010) and the economic, ecological and socio-cultural aspects in the field of tourism (Gregers Eriksen, 2013; Zygmunt, 2016). In Croatian tourism, the insufficiency of education in

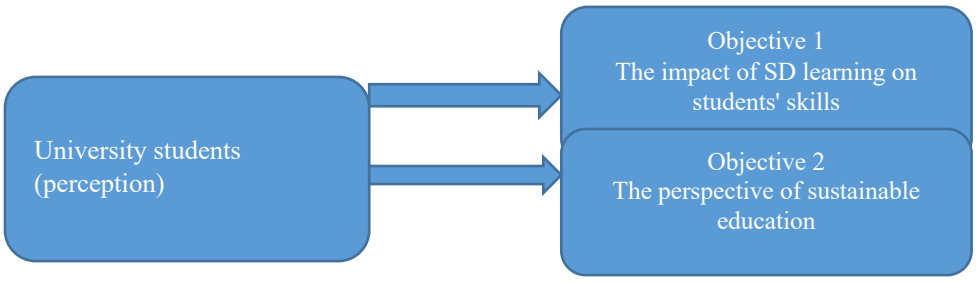
the field of sustainability, cultural competences and the benefits of public-private partnerships has been pointed out (Anđić, 2020; Dobravac, Cvikić, 2020; Bugarić, 2024). The lack of existing research is in the narrow set of teaching topics (Garcia-Garcia et al.). A review of previous theoretical knowledge reveals the following limitation. There is a lack of representation of learning about upgrading teachers' pedagogical competences due to environmental events that directly affect the resilience of destinations (sustainable perspective). With rapid and effective adaptations to sustainable education, and through monitoring and identifying environmental challenges, the capacity of the destination is strengthened from the aspect of sustainable education. In conclusion, this study defines resilience through improvement of the teaching process, diversification of learning methods and involvement of students in the community.

3. Methodology

After a detailed review of the literature on the topic, a research design was formulated (Figure 1). The empirical research was conducted with two study groups, one disciplinary and one interdisciplinary, at the end of the semesters of the academic year 2024/25. Students were informed about the purpose and anonymity of the research during classes. Groups participated by sending their opinions via the MOODLE learning platform. This research technique (online learning platform/community) was used due to the possibility of obtaining quality feedback in a short time. Another reason was to implement a voluntary sampling design in sensitive research (Murairwa, 2015).

The students were sent a link to a survey questionnaire consisting of 6 questions to achieve response quality and to avoid data saturation point. Two of the questions were closed-ended. The questionnaire was developed based on a review of previous studies that investigated sustainable education (Wongsa, 2020; Pongtanee, Choibamroong, 2025; Bezeljak, Scheuch, Torkar, 2020). Open-ended questions served to effectively segment the survey results, given that the validity of the questionnaire was threatened by anonymity (Dumičić, Žmuk, 2009). It was determined whether the basic concepts related to the subject of the research were known: "sustainable education" and "pedagogical competences". These questions were the framework for forming other questions related to the quality of educational processes and the roles of stakeholders.

Figure 1: Conceptual research framework



Source: Author

The study was carried out by four teachers who specialise in both undergraduate and graduate programmes. Three of them volunteered to engage students in research during seminars, explaining the research objectives. One teacher, as the principal investigator, was responsible for collecting feedback in the database, inductive coding, and assessing data about the

development of students' skills and their understanding of sustainability education. Although the courses do not explicitly include sustainability in their titles, they address sustainability issues related to the basics of tourism, tourist attractions and intermediaries, the English language, international tourism, professional practice and tourism transformations. The questions did not specifically refer to a particular course, but rather to attitudes about sustainable tourism/education within the study programme at different stages of study. The aim was to avoid bias in the conclusions with a holistic approach to sustainable learning. The research was conducted in the second and third years of the undergraduate and the first year of graduate programmes in Tourism and Culture and Tourism (interdisciplinary study). The same was carried out with undergraduate/graduate programmes in Tourism (Business Economy/Tourism and Development) at the Juraj Dobrila University in Pula (UNIPU). The recognised pedagogical competences adopted by teachers (examiners) based on university curricula are shown in Table 1.

Table 1: Development perspective in tourism courses

Pedagogical competences	**Description**	**Actions**
Teaching observation	Learning perspective	Sustainable education, Changing society, Lifelong Learning (LLL).
Systematic investigation	Framework factors and possibilities	Student presentations, teamwork, guest speakers, enquiry-based learning, project-based learning, problem-based learning.
Reflective analysis of student learning	Practice and discussion	Discussion about sustainability issues, Tourism attraction planning and cultural competencies, Recognising the importance of tourism documents (action plans), Tourism practice, Presentation of the results in local community, International tourism (case study).

Source: Author's, according to Olsson, Mårtensson, Roxå (2010)

A sample of 113 students was selected, and 71 agreed to participate and returned the questionnaire completely filled. Opinions collected to justify the goal of developing the impact of sustainable development learning on students' knowledge, values and skills were included in a common database, followed by classification, tabulation, and coding.

4. Data collection and analysis

The conditions for selecting respondents were: (1) familiarity with sustainable development terminology, (2) acquired skills in academic writing, interpreting connections between phenomena, and drawing conclusions, (3) familiarity with research terminology; pedagogical competencies and learning outcomes, with the aim of understanding the structure of the semi-structured questionnaire. Classification of respondents was made according to student population, gender, and level of education. The response rate was 62.83%, while 43 candidates in the final sample were women. Of the total number of students, 49 of them studied outside their place of residence. The largest proportion of students surveyed was at the undergraduate level, 43 in total. (Table 2).

Table 2. Selected sample – study groups

Level of education	Sample (study groups)	
	Economy	**Culture and Tourism**
Undergraduate	20	23
Graduate	11	17
Total	31	40

Source: Author

After an in-depth literature review on the research topic, a qualitative analysis was conducted (Table 3). The questions were linked to the research questions and objectives of the research. Operationalisation of variables was carried out by determining the research timeframe, in-depth interpretation (open questions) and quantitative analysis (closed-ended questions). The focus was on three topics: Teaching observation, Sustainability framework possibilities and Reflective analysis. The items of the sustainable tourism education questionnaire were constructed from existing literature. The closed-ended questions in the research were derived from the specific objectives of sustainable learning (Jia, Tan, 2010). The open-ended questions were grounded in a bottom-up approach, drawing on the research subject's knowledge to inform shifts in the direction of inquiry, and facilitated the formation of theoretical assumptions through the integration of concepts (Martin & Turner, 1986).

Table 3: Sampling and data analysis

Undergraduate courses	Postgraduate courses	Sample size	Sampling	Data Analysis	Topics/ Question groups
4	3	71	Purposive sampling Students (UNIPU)	Coding Analysis	General socio-demographic features (1-4) Sustainable education (5) Reflective learning (6-7) Theory and practice (8-9) Recommendations (10)

Source: Author

The questions were designed to offer insight into sustainable education. Transparency and consistency in the evaluation were ensured by questions structured in relation to measurable goals. The questionnaire began with four questions on the sociodemographic characteristics of respondents. The second part of the questionnaire included questions 5 to 10, focused on the research topic of sustainable education, its practices, and benefits. The structure of the questionnaire (open/closed questions) with a rating scale (Yes/ No/ Cannot estimate) is listed below.

1. Why is sustainable education important? (open-ended question/understanding the concept, RQ1)
2. Did you learn about sustainability through your study programme? (Yes/ No/ Cannot estimate; variety of sources during studies, RQ2)
3. How was SD learning implemented in tourism courses? (open-ended question/participation in reflective learning, RQ2)

4. Do teachers present examples of sustainable practice alongside theory? (Yes/ No/ Cannot estimate, RQ3, connecting of theory and practice within the courses)
5. How do you recognise a teacher's task or topic in tourism practice? (open-ended question, RQ3, connecting of theory and practice within the courses)
6. What are the main benefits of improving sustainable education? (open-ended question/ recommendations for curriculum improvement, RQ4)

A qualitative analysis was conducted due to:

- getting deeper introductions due to insufficient research on the topic,
- differences/specificities of opinions of different student groups,
- the specifics of the environment in which it is applied,
- small sample and in-depth understanding of the research problem,
- as a basis for future quantitative research.

Descriptive analysis of specific variables was formed on the principles of logic (from general to specific) and clarity (avoiding ambiguity). The students' responses were transcribed into text materials. The quality of the analysis was ensured through classification into four themes: 1. Holistic approach to sustainable education, 2. Awareness of learning methods (available data/critical thinking), 3. “Good knowledge” and innovations, 4. Importance of sustainable learning (curriculum improvement, justice for future generations). The categorisation of sources ensured the systematic coding process through the conceptualisation of the collected data. The answers were retaining the original meaning, without subjective bias, and by refining the categories (eliminating repetitive concepts).

5. Results

5.1. Closed-ended questions and research concept testing

Closed-ended questions on a small sample helped to validate the hypothesis (checking participants' agreement with the main statement). Furthermore, they made up a smaller portion of this research to avoid the risk of bias of closed-ended questions on a specific sample.
To the question “Did you learn about sustainability during your studies?”, 58 respondents answered affirmatively, while 7 of them answered that they could not estimate. This indicated a high level of specific knowledge by the respondents. The question “Do teachers present examples of sustainable practice alongside theory?” was answered in the affirmative by 63 percent of respondents.

The largest number of affirmative answers related to the third year of undergraduate studies and graduate studies of both study groups, indicating the possibility of further improvement. The same was confirmed by further in-depth analysis in the second part of the questionnaire (open-ended questions).

5.2. Results Of the Coding Analysis

Most students interpreted the goal of sustainable education through environmental conservation, social responsibility, and economic development, which indicates a holistic approach to learning. Table 4 presents an organized overview of the data structured by linking four STL research categories and subcategories to grouped responses (Lengyel et al., 2025; Ferguson et al., 2022).

Table 4: Coding table - categorising and conceptualising of data

Category (SL)	Subcategory (SL outcomes)	Concepts (SL perspectives)
Sustainable education	Transformative competencies, principles of sustainable development.	Holistic approach, determination, sustainability.
Available data/ critical thinking	Energy efficiency, protection of natural resources, waste management.	Students' knowledge, values, skills.
Connecting theory with practice	Project tasks, stakeholders' activity, the local community.	New learning, sustainable, paradigm, tourism practice.
Curriculum improvement	Specific knowledge, sustainable development outcomes.	Tourism sector, Complexity

Source: Author

The results show the four research categories supported by subcategories and concepts. The data were separated into keywords; twelve of them related to the learning perspective and 10 related to learning outcomes. The results indicate the importance of linking learning outcomes with sustainable perspectives in tourism. The focus of sustainable education is on transforming student competencies. A stakeholder's actions enable adaptation to the complex system of tourism through a holistic approach. These conclusions align with the UN Agenda 2030, which promotes inclusive and regenerative tourism systems.

- *Sustainability learning*

Students of business economics, majoring in tourism, expressed views on the superficial treatment of sustainability through courses that do not have it in their titles. The representation of topics in the undergraduate study of economics focused on the balance between economic growth and environmental protection, and the role of local plans, strategies and communities. The responses highlighted undergraduate and graduate courses, Sustainable Development, Sustainable Development of Tourist Destinations, and Tourism and Transformations, as examples of good practice. They made suggestions for courses that could help sustainable education in tourism in the long term. These courses are "Ecological Management", "Sustainable Production", "Environmental Policies" and "Global Change". Also, on the topics of energy transition, development of renewable energy sources, environmental protection, sustainable development of tourism, agriculture and the circular economy.

Students of the graduate study Tourism and Development gained a positive experience with innovative teaching in order to mitigate the negative consequences on society such as mass tourism (overtourism). That approach develops their specialised knowledge and skills. Through lectures and projects, insight was gained into how sustainability can be specifically applied in planning and managing tourism, which they found extremely useful. The role of the European Union and its funds in encouraging green investments in Croatia was particularly emphasised, as was the importance of harmonising national economic policies with sustainable development goals. Through the processes of transformation and regeneration, the graduate study taught how to stop the trend of mass tourism, which is not sustainable in the long term, and about the quality of the tourist experience. Students were introduced to sustainability through brownfield investments, waste management, and green initiatives.

Students of the study of Culture and Tourism mentioned their focus on learning related to impacts through local communities (quality of life) and promotion of destinations. Graduate

students emphasised the importance of recognising the negative externalities of tourism development and fair distribution in society.

The research used a coding method that includes Open Coding (Analysing the options), Axial (Repeated words), and Selective Coding (Integrating data and converting concepts into a theory). An example of students' opinions on sustainable education and the coding analysis are presented in table 5.

In this paper, four key elements of sustainable learning were coded using axial coding. The items were previously validated by the experts of the academic institution with the aim of validity and reliability of data collection.

Axial coding established the logic of connections between the 30 categories identified through open coding. Relationships and evolutionary patterns were then compared and analysed. Axial coding identified six main categories of sustainable learning: local community involvement, socially responsible behaviour, sustainable development, environmental protection and sustainable management. Supporting categories referred to learning for sustainable tourism from an interdisciplinary point of view and were derived through five categories: interdisciplinary influences (1), ethical aspects of tourism (2), transformations (3), tourist destination (4), and engineering (5). Those factors help overcome barriers and include community support networks and skills training (Moyer, Sinclair, Quinn, 2016). The categories were subsequently consolidated, and dominant categories were developed, with the aim of evaluating the emerging theory through selective coding.

Table 5: The results of the coding analysis

Open Coding	**Codes (data decomposition)**	**Axial coding (linking categories)**	**Selective Coding (the conceptual framework)**
"…Students were introduced to terms only as *sustainable development* and *socially responsible behaviour*. It included topics such as environmental protection, management, social justice, economic sustainability, ethics and active citizenship (behaviour). Sustainability was integrated into several aspects of the study, given that it is an interdisciplinary study…"	• sustainable development goals • socially responsible behaviour • environmental protection management • economic sustainability • active behaviour • social justice • integrated aspects	• local community example/values (7 options) • socially responsible behaviour (4 options) • sustainable development (3 options) • environmental solutions/ protection (3 options) • management	Sustainable education is distinguished by its commitment to local community values through more responsible tourism development and responsible

Open Coding	**Codes (data decomposition)**	**Axial coding (linking categories)**	**Selective Coding (the conceptual framework)**
"…Mostly in themes on sustainability such as Sustainable Development of Tourist Destinations, Local Communities, Sustainable Tourism, Tourism and Local Transformations examples, Behaviour in Sustainable Destinations…"	• sustainable development goals • sustainable tourism • local communities • tourism and local transformations examples • sustainability and responsible behaviour • sustainable destinations	(3 options) • sustainable economy (2 options) • interdisciplinarity (2 options) • ethics/social justice (2 options) • sustainable destinations (2 options) • transformations (1 option) • engineering (1 option)	behaviour of all stakeholders. This commitment must be grounded in environmental protection, sustainable management, and sustainable economy. Interdisciplinarity, social justice, and ethics remain dominant influences in studying the sustainability of tourist destinations. It is necessary to work on tourism transformations and the development of an engineering approach.
"…Teachers, in some cases, present concrete examples from the local community, EU projects, or their own professional experience. Examples relate from sustainable development to environmental solutions in tourism, sustainable resource management. I would like to see more local behaviour examples practice and practical (local) examples are present in many ways and that is very important…."	• local community examples • local community values • professional local experience • EU projects (interdisciplinary) • environmental solutions in tourism, • sustainable resource management • sustainable development • local behaviour examples • local case studies		
"…Sustainable learning can be improved in fields such as environmental management, engineering, ethical aspects of business, and sustainable economy. We need to talk not only about	• sustainable development • environmental management • engineering • ethical aspects of business • sustainable economics • sustainable tourism practices		

Open Coding	Codes (data decomposition)	Axial coding (linking categories)	Selective Coding (the conceptual framework)
mass tourism destinations but efforts for new sustainable tourism practices. Also, to promote our local area as hosts. Future trends should be manifest of global change in new sustainable production, management and policies…"	• local area example • tourism destinations		

Source: Author's, according to Wongsa (2020) and Pongtanee, Choibamroong (2025)

Students were generally familiar with the concept of sustainable education, even if it is not explicitly stated in their studies. Instead, they became familiar with concepts such as sustainable development, socially responsible behaviour, innovation and tourism offerings. Many comments emphasised the importance of comprehensive frameworks in sustainable education. Selective coding identified key categories of analysis. It connects categories, examining how they relate to explain a phenomenon. The result of the research is a contribution to the development of a theoretical model (a new SL theory). It was created based on students' knowledge of learning perspectives and outcomes, as well as their opinions on learning through transfer into tourism practice and the benefits for the community. The conceptual framework for the sustainability of education is constructed with the aim of creating resilience in tourism destinations.

- *Available data/critical thinking*

The students of economics recognised from the teacher's syllabus various ways of connecting theoretical knowledge with examples from the global and regional levels. These examples often included successful practices from European and global destinations that have successfully implemented sustainable strategies and, furthermore, situations from a local context, such as those in the Istrian county. There was a high level of positive attitudes about critical thinking development. A smaller part of the responses were prognostically oriented. Students of interdisciplinary study recognised teaching topics and collaborations related to SDGs.
In the context of the analysis, four thematic groups with the highest number of appearances in the responses connected with sustainability were: goals (1), innovations (2), destination (3) and sustainable economy (4). Teachers' lectures consisted of student presentations, teamwork, guest speakers, project and problem-based learning. Student opinions were correlated with the learning outcomes of the courses taken (Appendix 1).

- *Connecting theory with practice*

Both students' study levels indicated that they frequently wrote seminar and project papers on the topic of sustainability in tourism, and they perceived sustainability as an interesting and valuable issue. This approach helped them to better understand the real challenges and possibilities of sustainable development and emphasised the term "brainstorming" after analysing case studies. Among the teaching methods, students most often mentioned guest lectures by experts from practice, workshops, fieldwork and mandatory professional practice.

Participation in international summer schools and the possibility of knowledge exchange through the ERASMUS programme were mentioned by seven graduate students, which may indicate insufficient experience (involvement) in foreign practices at the study level. Additionally, some students noticed the relevance of examples presented because they could observe them, while others considered them significant despite the lack of direct visibility. They recognised the involvement of students in teachers' project activities and a higher level of connecting theory with practice in graduate studies in both majors, although with some shortcomings (challenges):

- "There is no feedback and stronger promotion of student initiatives and projects that promote sustainability within the university and local community."
- "Include more fieldwork and cooperation with real destinations that implement sustainable strategies, so that students can get to know the challenges and practices firsthand."
- "Economics and tourism students could help the management sectors of regional companies with various ideas on how to reduce costs and improve service, and in this way the prices of these services for citizens would be reduced. There are many capable students who have various ideas but lack the space and acquaintances to realise them. With the support of the faculty, and perhaps the initiative of some other competent authorities such as the city of Pula, perhaps some changes could occur in various fields and spheres."
- "Lack of promotional content, especially on social networks, which are today the main source of information for many young people, more content and more motivation."
- "Help students develop their own ideas for sustainable projects, with mentoring support and perhaps connections to the real sector; increase the usefulness of education."
- "Create new courses (practicums) and visiting lectures in which students present their ideas on improving sustainability (provide solutions to existing problems)."
- "Use of artificial intelligence (AI) and digital tools in education."

- *Curriculum improvement*

Part of the answer focused on the importance of environmental protection for future generations through a responsible approach to planning and decision-making. It not only involves acquiring facts but also developing critical thinking and awareness of the importance of preserving natural resources and ethical action for future generations. Students expect an education that prepares individuals to make responsible decisions that take into account the long-term consequences for people and the planet and also to understand the complex challenges of market reality through informed decisions with sustainable education. The key points of *Curriculum improvement* are highlighted below:

- "Improving sustainable education requires instilling critical thinking in the individual. If an individual thinks critically, they can only bring good to society."
- "Sustainable education should be the foundation of every society that wants to progress in the long term and fairly."
- "It is also important that the education system is inclusive, with special measures and access for vulnerable groups, such as people with disabilities or children from disadvantaged backgrounds."
- "My personal suggestion is certain scholarship support for such groups. Equal opportunities do not always mean the same access - some people need additional support to have a real chance to succeed."
- "Integration of sustainability in all study programmes, not only in those directly dealing with the environment or tourism."

- "More interdisciplinary courses and workshops that would connect theory and practice, sustainability with economics, politics, communication and technology, as well as the inclusion of guest experts and study visits to field projects."
- "Interdisciplinary collaborations – connecting tourism, ecology and economics students to work together on sustainable solutions and the introduction of more interdisciplinary projects."
- "Introducing a specialised course or module that focuses exclusively on sustainable development and education in tourism, with an emphasis on an interdisciplinary approach - connecting ecology, culture, economics and ethics."
- "Introduction of mandatory workshops or modules on climate change, circular economy and social responsibility."
- "Offer an elective course focused on sustainability in the context of tourism and culture, with an emphasis on topics such as the circular economy, climate change, social responsibility and sustainable spatial planning."
- "Developing learning as a learning ecosystem through experiential and interdisciplinary learning: Incorporating STEM content (science, technology, engineering, mathematics) through innovative methods such as sports activities, technological innovations and environmental conservation, to make sustainability more accessible and interesting for all ages."
- "Cross-curricular, where sustainability permeates multiple subjects and connects with science, ethics, economics and art."
- "Integrate sustainability principles into the curriculum, to encourage thinking about sustainability as a universal value, not just a specialised topic."
- "Introducing elective courses that delve into specific topics such as the green economy, sustainable policies or ethical consumption."
- "Lifelong learning: organise free workshops and online training on topics such as household energy efficiency and sustainable nutrition."

6. Discussion

The research systematised knowledge about sustainable education for tourism needs. The results of the semi-structured questionnaire were collected and classified into categories. Based on the results of axial coding, the possibility of improving sustainable education framework through the involvement of the local community, socially responsible behaviour, sustainable development, environmental protection and sustainable management was discovered. The support of a functioning system is made by complementary offers: interdisciplinary approach, ethical aspects of tourism, transformation, tourist destination and engineering. After coding, a theoretical model was constructed (selective coding). The contributions are in terms of the influence of the learning perspective and educational outcomes on the resilience of the tourism service distribution chain shown in the subcategories of Table 4. Analytical procedures in the research, through the analysis of concepts and categories, can improve the actions of stakeholders through the indicated coordination of environmental influences (economic, ecological, ethical).

Based on the achieved results, a theoretical STL model was constructed based on the premises of knowledge improvement, teaching methods and integration of destination stakeholders (Table 5, selective coding). The students' proposals on the improvement of sustainable education related to three groups of challenges: a) Improvement of the teaching process (transformative learning), b) diversification of learning methods, c) and c) Involvement of

students and promotion of initiatives in the community. The broader theoretical implications are in strengthening the resilience of tourism to crises through mutual relationships of sustainable learning and sustainable tourism practices.

There were differences in the attitudes of students of economics, culture, and tourism at different levels of study. Undergraduate students of economics expressed a desire to see more local examples in their coursework, as most of the examples currently provided were global in nature. Students of culture and tourism stated that they were introduced to local examples, but only for some topics and by some teachers. Both study fields considered it positive to include teachers' examples related to the topic covered during lectures. Examples were related to sustainable development planning, tourism attractions, implementation of ecological solutions in tourism, sustainable resource management and international tourism. Students were invited to workshops and to visits to domestic and foreign organisations where they could see first-hand the application of the principles of sustainability. EU projects and funds that support sustainable ideas were also mentioned.

Students of culture and tourism studies were more inclined to connect subjects on the topic of sustainability, coordination of performance and local perspective. Business economics students were more focused on intensifying field classes, workshops and guest lecturers in order to more easily connect theory with real life.

Students could not recognise a holistic approach to sustainable education; only "A" elements of the destination. Suggestions for sustainable education should be integrated into the education system, considering a sustainable teaching framework, a local perspective, and feedback analysis.

The study attempted to eliminate the gap in research into the key elements and mechanisms of sustainable tourism learning. It encourages the development of the future educational perspective needed as a basis (research scenarios) for future educational values through the design of related questionnaires. Furthermore, it can help to optimise processes in the tourism sector. The results (concepts in the coding process) are a landmark for managers in tourism as a detailed incentive for better crisis management (resilience of the economy through knowledge).

7. Conclusion

The importance of ESD intensifies throughout the academic years for both professors and students. The critical opinions observed in undergraduate studies and the reflection, along with the reflections of what is learned in graduate studies, indicate the university's efforts to foster awareness of sustainable themes.

The hypotheses were confirmed. The goal was to assess students' understanding and engagement with sustainable education throughout their studies and to identify differences in perception based on their level of education and comprehension of key concepts related to SD and ESD at a Croatian university.

The findings suggest a need for a broader approach to sustainability in terms of both course content and interdisciplinary teaching. It is necessary to more clearly indicate the importance of sustainable education. Furthermore, students should be more integrated into sustainable

projects with local communities that will bring them long-term benefits and the prospect of personal development (transformation through sustainable practices). Thirdly, in addition to the economic, ecological, and socio-cultural impact, students should also be educated about the technological, political, ethical, and legislative impacts of sustainable tourism and destination development. The limitations of this study are: (1) The lack of use of descriptive statistics and structural equation modelling. At the same time, analysing at the beginning of the semester, to compare the results before/after the application of the concept, (2) The data may be partially related to the tourism industry due to the complexity of the sector and the dependence on other elements of the destination, (3) A small sample may limit the generalisation of the results.
Sustainable development as a learning outcome was examined within six tourism courses. The research results indicated that the perspective of learning should be more focused on the mentoring, enquiry-based learning internship, interconnections between disciplines about ESD and its benefits to society. The results of both programmes indicated that student knowledge about education for sustainable goals is linked to the academic framework (sustainable curriculum). The second result was that student improvement is most connected with individual and group projects and discussions, workshops, and instruction in cultural competencies. The research results can help teachers in modifying their teaching approaches, developing new content, adapting the curriculum, and transforming towards the community in which they teach. Future research on this issue should include surveys of the opinions of STEM/LLL university students in order to determine the possibilities of joint projects. Also, longitudinal studies should be conducted to monitor changes in ESD at the university level. From the perspective of business entities in tourism, the results may offer a knowledge in terms of operationalisation and formation of new ecosystems in destinations.

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Appendix

Table 1: Overview of teacher methods and students' opinions (learning outcomes)

Course title	Teaching activities	Recognised learning outcomes
Tourism in spatial planning and management in culture and tourism	Seminar papers on the topic of sustainability, cooperation with local entrepreneurs and associations, examples of good practice, socially responsible investment and real situations: urban garden projects and energy self-sustaining settlements. Group discussions on current problems and solutions in festival or heritage management.	Analyse company operations. Assess stakeholder roles. Solve sustainability issues. Create responses to environmental challenges.
Sustainable development of tourist destinations *Sustainable development in tourism* *Special forms of tourism*	Involvement in the work of the local community, destinations that implement sustainable development strategies, analysis of projects related to renewable energy sources, recycling or socially responsible business, environmental initiatives in schools, green cities, slow and rural tourism, eco-villages, national parks.	Identify the roles of stakeholders. Analyse current projects and initiatives such as the EU Sustainable Tourism Programme. Evaluate regional strategies for preserving destination identity.
International tourism	Projects related to global sustainability, regional strategies to preserve the identity of destinations. Reports and analyses (UNWTO, OECD), video presentations, with concrete examples of hotels, tour operators and destinations that implement ethical and sustainable business strategies.	Recognise global trends and internationalisation of business. Analyse and evaluate impacts (political, economic, ethical, ecological, sociocultural, legislative). Create solutions to remove international barriers (sustainable development policy).
Tourism and transformations	Case studies of sustainable practices of cities or regions, analysis of development plans, EU funds and concrete measures of spatial planning and environmental management. Examples of companies (sustainability strategies), critical thinking.	Define the term transformation in tourism. Distinguish the changing roles of tourism market stakeholders. Analyse regenerations. Identify leaders of change. Create transformative (sustainable) solutions.
Tour operators and travel agencies (DMCs)	Models of work of tour operators that apply sustainable business practices, guest lectures (incoming tour operators) of agencies that use green technologies or promote responsible tourism, comparison of Croatian practices in mediation with foreign countries.	Understand the impacts of trends on tourism specialisation. Assess the impact of tourism specialisation, certification and integration at the international level.
Croatian economy	Local initiatives such as waste management systems in cities, implementation of solar panels on public buildings, international examples of sustainable agriculture and eco-tourism. Field visits and workshops with companies and organisations involved in sustainable projects, classes on family farms.	Analyse sustainable agriculture and eco-tourism initiatives. Recognise the importance of the circular economy. Understand the challenges of sustainable policies in tourism.
Introduction to tourism	Analysis of the development of the cities and discussions on overtourism, examples of eco-certificates, guest lectures (DMOs), case studies: the island of Krk, Plitvice Lakes, Amsterdam, etc.	Analyse indicators of the volume, dynamics and structure of tourist traffic. Assess the importance of tourism policy and planning in tourism.
Management of attractions in tourism	Analysis of the balance between economic growth and environmental protection, the	Identify the characteristics of the resource base.

Course title	Teaching activities	Recognised learning outcomes
	role of the local community and strategies, specific situations of attraction management, examples of good practice and global examples of environmental impacts.	Analyse the development of tourist attractions in the destination system. Critically evaluate the management of tourist attractions. Create development attraction models in a dynamic environment.
Cultural heritage management	The real challenges of preserving cultural heritage in urban areas, the impact of tourism on local communities and ways to involve the local population in the development of tourism.	Critically examine the impacts of tourism on tourist (cultural) resources. Create preconditions for local community involvement.
Tourism policy and development, Digital tourism	Example of successful implementation of green business, domestic hotel companies and orientation towards ecology, waste separation and disposal, energy efficiency. Visit to destinations that integrate the local community. Practices of eco-certified hotels, local initiatives for the development of tourism that respects the environment and community. Examples of the use of social networks in tourism (DMO initiatives).	Identify the company's orientation towards ecology. Analyse the benefits of standardisation and certification of hoteliers. Identify local communities in tourism and levels of partnerships. Realise the importance of ICT and new technologies in tourism (technology and sustainable paradigms).
English language	Language skills combined with cultural competences (verbal/non-verbal skills) with practical examples from around the world. Memorising language topics through examples, city tour of Pula (interpretation of monuments in a foreign language).	Language skills and teamwork. Communication and organisational skills. Knowing the destination and heritage interpretation.
Practicum	Mandatory professional practice, work in real business environments and application of acquired knowledge, tasks that simulate real situations, involvement in projects.	Analysis of destinations and current environmental events. Creating skills for responsible behaviour in society/tourism practice. Evaluation of ethical aspects of tourism.

Source: Author's, according to university course syllabi and research results

A professional paper

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CYBERSECURITY AS A KEY STAKEHOLDER IN THE FISCALIZATION PROCESS

ABSTRACT

The aim of this paper is to explore cybersecurity as a fundamental pillar of contemporary business operations, emphasizing its strategic importance for small and medium-sized enterprises (SMEs) in the digital economy. The study focuses on the preparedness of Croatian SMEs for the upcoming mandatory implementation of electronic invoicing (e-invoicing) as part of the fiscalization process. It examines how cybersecurity awareness, practices, and investments influence their readiness for mentioned "government guided" digital transformation. The paper seeks to identify the main vulnerabilities and barriers that hinder the development of robust cyber resilience within the SME sector.
The research methodology is based on quantitative survey data of respondents' perceptions. The survey results reveal that cybersecurity remains a significantly underdeveloped area among Croatian SMEs. Nearly half of the surveyed firms rely solely on basic antivirus protection, while only a minority implement advanced safeguards such as multi-factor authentication or professional monitoring services. The findings also indicate that many SMEs underestimate cyber threats associated with e-invoicing, particularly the risks of data theft, phishing, and unauthorized access, highlighting an urgent need for education and capacity building.
The results underscore the necessity of shifting from a reactive to a strategic approach to cybersecurity. Strengthening cyber resilience through employee training, policy support, and collaboration with technology providers can enhance trust and efficiency in digital business ecosystems. The paper concludes that cybersecurity should no longer be viewed as a technical expense but as an integral component of sustainable and competitive business strategy in the era of digital fiscalization.

Key words: *Cybersecurity, Cyber Resilience, SMEs, Digital Transformation, E-Invoicing, Digital Maturity.*

1. Introduction

The contemporary business environment is fundamentally focused on digital transformation processes, which had a disruptive impact on how organizations communicate, manage resources, and fulfill their legal obligations. It is clear that in such a case, considering security is a key skill that must be considered, regardless of employee position or business field of work. Current practices indicate that cybersecurity in the SME sector is often treated reactively only after an incident occurs (European Union Agency for Cybersecurity, 2021). However, the

introduction of mandatory e-invoicing requires a proactive approach, as compromising a fiscalization system does not only mean data loss but also directly jeopardizes the legal status and financial stability of the enterprise. The strategic integration of security protocols into daily business operations is becoming a prerequisite for sustainable digital transformation.
In the year 2026, there was a paradigm shift in Croatia's economic landscape with the full-scale implementation of the Fiscalization 2.0 initiative (Porezna uprava Republike Hrvatske, 2025). Effective January 1, 2026, the Croatian Ministry of Finance has mandated comprehensive electronic invoicing (e-invoicing) and real-time e-reporting for all Value Added Tax (VAT)-registered businesses. This regulatory guideline extends the 2019 B2G e-invoicing framework mostly into the B2C sector, aiming to achieve near real-time visibility of all financial transactions within the national tax infrastructure (EdiCom, 2025).

This transition to a fully digitized fiscal environment significantly expands the attack surface for malicious actors, as the volume of sensitive financial data transmitted between enterprises and the national platform reaches unprecedented levels. In such a centralized system, the integrity of an e-invoice is no longer limited to internal accounting processes. Instead, it represents a critical component of national fiscal security, directly influencing the reliability, transparency, and resilience of the overall financial infrastructure (Seyfor, Minimax, 2025). In order to minimize security risks, Fiscalization 2.0 introduced information intermediaries (service providers) that are responsible for the continuity of the fiscalization chain (Porezna uprava, 2026). Providers are verified to determine if they possess and comply with the stringent ISO/IEC 27001 standard to ensure their information security and stability.
Cybersecurity has almost overnight become a crucial part of businesses in Croatia. The successful establishment of a stable, scalable, and secure financial data platform relies on a synchronized tripartite ecosystem: the government, which oversees the fiscal system and centralized data processing, information intermediaries, who facilitate the seamless flow of data, and the enterprises, which are responsible for the accurate preparation and transmission of critical financial information.

To assess the actual level of preparedness within the newly established fiscal framework, the authors conducted a survey among small and medium-sized enterprises (SMEs) in Croatia. The main focus was set on cybersecurity and its influence on fiscalization readiness in the analyzed enterprises. By researching current security practices, the survey sought to identify whether SMEs perceive e-invoicing as a potential vector for cyber threats or merely as an administrative obligation. The collected data provide critical insight into the existing security gap between the stringent requirements imposed by the Fiscalization 2.0 initiative and the operational realities of small and medium-sized enterprises. This reflection on cybersecurity is crucial, as it highlights the vulnerabilities that could lead to systemic failures in the national fiscal chain. The survey results will be used as a foundation for recommending strategic interventions that align business security practices with the evolving demands of Croatia's digital fiscal policy.

2. Literature Overview

Cybersecurity is finally no longer seen merely as a technical subset of Information Technology (IT), but as a multidimensional strategic imperative that encompasses technology, processes, and people. The literature increasingly conceptualizes this view as cyber resilience, defined as an organization’s capacity to anticipate, withstand, recover from, and adapt to adverse conditions or cyberattacks affecting its systems (Björck et al., 2015). According to authors (Schatz, Bashroush, & Wall, 2017), cybersecurity involves the protection of information assets

by addressing threats to information processed, stored, and transported by internetworked information systems. This definition is particularly relevant in the era of digital fiscalization, where the "asset" is no longer just internal company data, but sensitive financial information shared with state authorities.

In scholarly debate, small and medium-sized enterprises are frequently characterized by "resource poverty", a condition where the lack of financial, human, and technological capital directly dictates their (cyber)security posture (Lee, 2018). While large corporations can implement complex Defense-in-Depth (DiD) strategies, SMEs often view cybersecurity as a luxury rather than a necessity. The aforementioned "poverty" can be noted in irregular email checking or lack of skills in recognizing scams or fraud in messages (Irish SME Association, 2024). Research indicates that this sector tends to treat cyber defense reactively, investing in safeguards only after a security breach has already occurred (Alahmari & Duncan, 2020). This reactive nature is particularly evident in the reliance on basic antivirus tools, which literature suggests are insufficient against modern, multi-stage attacks like ransomware or advanced phishing (OGHENETEGA AVWOKWURUAYE, 2025). Strategic cybersecurity requires a shift toward proactive risk management, where security is integrated into every business process from the design phase, which is a concept known as Security by Design (Bygrave, 2022). It is essential to acknowledge that micro and small enterprises constitute approximately 99% of all businesses in the European Union, thereby highlighting the increasing relevance of digital challenges, particularly given the structural and resource-related limitations these enterprises face in the adoption and implementation of digital technologies (Eurostat, 2024). Similarly, in Croatia, there are 99.7% of SMEs among all businesses (CEPOR – Centar za politiku razvoja malih i srednjih poduzeća i poduzetništva, 2024).

Despite all the mentioned situations, for Croatian SMEs, the transition to Fiscalization 2.0 represents a critical point where technical limitations must be overcome to protect the legal and financial integrity of the enterprise. Croatia's move towards mandatory e-invoicing is not a local idea or a test event but part of a broader European initiative known as VAT in the Digital Age (ViDA) (European Commission, 2025). The European Commission seeks to modernize the value-added tax (VAT) system through the implementation of real-time reporting based on e-invoicing. Pursuant to Directive 2014/55/EU, electronic invoicing was initially mandated for business-to-government (B2G) transactions with the objective of ensuring interoperability, standardization, and cross-border compatibility within the European Union (European Commission, 2025).

No matter which security system is suggested or implemented, the "human factor" remains the most significant vulnerability in any digital ecosystem (Saeed, Altamimi, A., Alshehri, & Alabbad, 2023). Digital skills, on the other hand, can play a significant role in a digitalized world where each piece of data can be crucial for business existence and competitiveness. Such skills are and can be measured mostly with self-assessments, which can have questionable outcomes and provide a perception gap (ICDL Global, 2025). This gap is dangerous especially in the context of e-invoicing, because it leads to a false sense of security. Training and continuous capacity building must be the focus as the only effective methods to bridge this gap, shifting the organizational culture from mere compliance to active cyber resilience (OffSec, 2025). The human factor in combination with the perception gap and fatigue in questionnaire-based research (Ghafourifard, 2024) poses a challenge for SMEs in determining the current cybersecurity level. The explained points are the basis for a situation in which the Croatian government is implementing a digitalized approach for businesses that may not be aware of all security obstacles that can arise during that process.

The convergence of mandatory fiscal requirements, such as Fiscalization 2.0, and the inherent resource limitations of SMEs, create a unique environment of systemic risk. While the literature emphasizes the necessity of "Security by Design" and professional monitoring, the operational reality of Croatian enterprises often dictates a more fragmented approach. To understand this discrepancy, it is insufficient to merely acknowledge the existence of a "perception gap". Moreover, it is necessary to quantify how this gap occurs in daily business operations, especially in terms of investments in security and the recognition of e-invoicing as a threat vector. Consequently, the empirical component of this study aims to test these theoretical assumptions by systematically assessing the cybersecurity posture of Croatian small and medium-sized enterprises. This empirical approach facilitates a critical evaluation of the extent to which European digital mandates are accompanied by sufficient levels of cyber resilience at the local level.

3. Methodology and Research

The objective of this empirical research is to evaluate the level of cybersecurity readiness among Croatian SMEs in the context of the mandatory transition to Fiscalization 2.0. While the theoretical framework suggests that resource limitations and a "reactive" security mindset are prevalent in the SME sector, this study seeks to quantify these variables within the specific regulatory environment of the 2026 e-invoicing mandate. To guide the investigation and analyze the data effectively, the following research questions were formulated:
RQ1: To what extent does the size of a Croatian SME is in connection with its reliance on reactive versus proactive cybersecurity measures in the context of mandatory e-invoicing?
RQ2: Is there a "perception gap" between the self-assessed digital competence of SME employees and the actual implementation of advanced security protocols?
By addressing these questions, the study aims to identify whether the technical requirements of the new fiscal policy are matched by the operational security capacities of the enterprises involved.

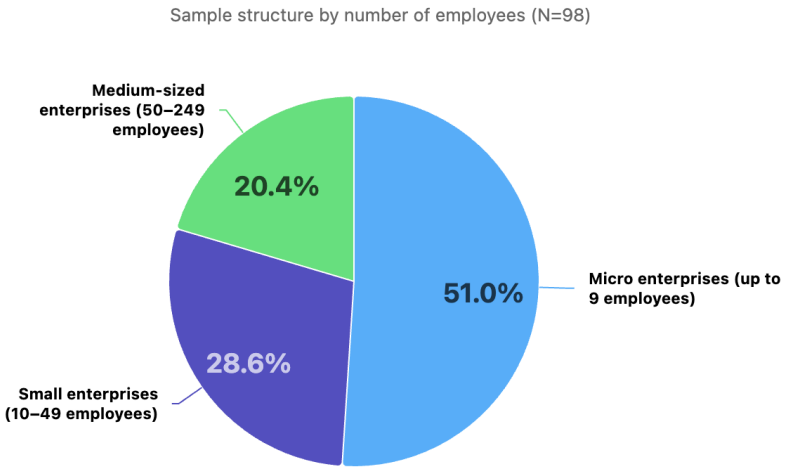
The research sample consists of a total of 98 respondents, with data collected during the period from August 25 to September 15, 2025. A total of 6,927 micro, small, and medium-sized enterprises (SMEs) were contacted, which were identified through publicly available data from the Croatian Court Register (Ministry of Justice, Public Administration and Digital Transformation, 2025). The survey was conducted using digital tools (Brevo and Google Forms[1]), with full anonymity of the respondents assured. Despite the large number of invited respondents, a total of 98 responses were collected, corresponding to a response rate of less than 2%. The reasons for such a low response rate can be attributed to the phenomenon of "survey fatigue" and the operational overcapacity prevalent among small and medium-sized enterprises. Additional challenges included limited digital infrastructure within smaller enterprises and the inconsistent monitoring of official email communications. Although the overall response rate is modest, the sample size allows for a meaningful identification of cybersecurity challenges across diverse industries, effectively establishing this work as a pilot study for future large-scale assessments of SME resilience.

The research instrument is a structured questionnaire consisting of 21 predominantly closed-ended questions, incorporating single-choice, multiple-choice, and 5-point Likert scales for psychological and technical self-assessment. The demographic section categorizes respondents

[1] https://docs.google.com/forms/d/e/1FAIpQLSfN2WetO3XkH4RenxCrV3Sk1ytmPoRZGa-mbUONM-FaXV_-ow/closedform, accessed on September 15, 2025.

by company size, industrial sector, and geographic location to ensure a representative sample of Croatian SMEs. A core component of the survey evaluates cybersecurity readiness, utilizing multiple-choice items to identify perceived digital threats such as phishing and ransomware. Furthermore, ordinal Likert scales are employed to quantify the current level of investment in security protocols and the employees' adherence to digital safety standards. The instrument also includes a specific section for measuring the perceived complexity of e-invoice implementation through interval scaling. While the majority of the data collection is quantitative, the survey concludes with an open-ended question (qualitative) for additional remarks and contact information. This methodological framework allows for a comprehensive analysis of both the organizational profile and the digital resilience of the participants.

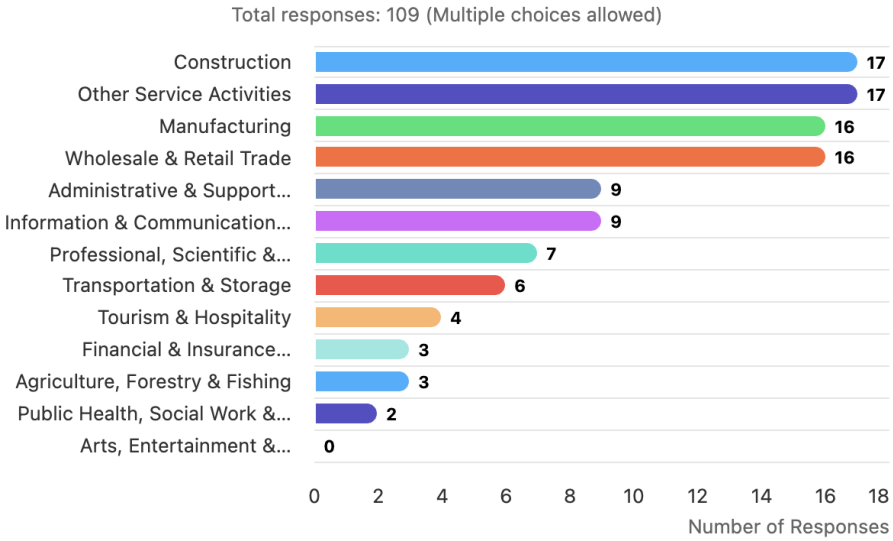
Figure 1: Distribution of enterprises by size



Source: Authors' own work

The distribution of respondents by the size of the enterprise, as presented in Figure 1, indicates a strong predominance of micro-enterprises, while small and medium-sized enterprises are represented in approximately equal proportions, which is consistent with the overall structure of the SME sector in Croatia. The most prominent group in the sample consists of micro-enterprises with up to nine employees. A total of 50 micro-enterprises participated in the study, accounting for 51.0% of the total responses. This group is followed by small enterprises (10–49 employees), represented by 28 respondents, or 28.6% of the sample. The least represented category is medium-sized enterprises (50–249 employees), which comprise 20.4% of the sample, with 20 participating enterprises. This distribution reflects the Croatian economy, where micro-businesses make up the majority of enterprises.

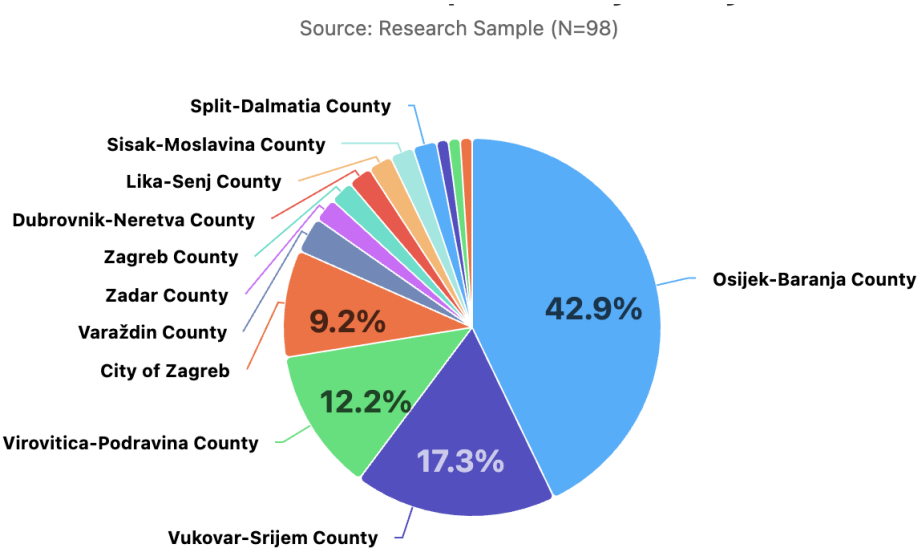
Figure 2: Distribution of respondents by business sector



Source: Authors' own work

Respondents were allowed to select multiple sectors, resulting in a total of 109 recorded responses. As illustrated in Figure 2, the highest number of responses originated from the construction sector and other service activities, with 17 responses (15.6%) reported for each sector. These are followed by wholesale and retail trade, motor vehicle repair, and the manufacturing industry, each with 16 responses (14.7%). The information and communication sector (ICT) and administrative services each accounted for nine responses (8.3%). Professional, scientific, and technical activities included seven participants (6.4%). Finally, the transportation and storage sector was represented by six responses (5.5%), while tourism and hospitality included four respondents (3.7%). The financial and insurance activities sector, as well as agriculture, forestry, and fishing, were represented by three responses (2.8%) each. The lowest number of responses, a total of two (1.8%), was recorded in the public health, social care, and education sector. No respondents were recorded in the arts, entertainment, and recreation sector.

Figure 3: Distribution of respondents by county

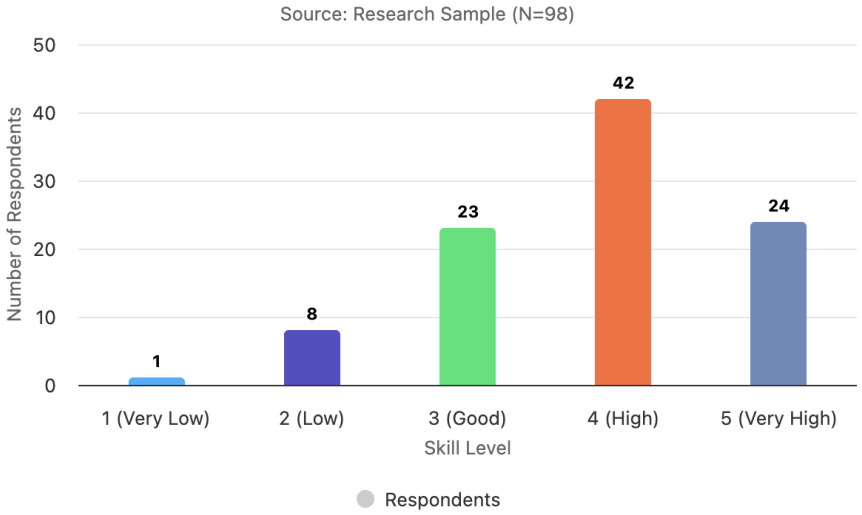


Source: Authors' own work

Figure 3 represents the geographical distribution of respondents by county. A total of 42 respondents (42.9%) were from Osijek-Baranja County, followed by Vukovar-Srijem County with 17 respondents (17.3%). Virovitica-Podravina County accounted for 12 respondents (12.2%), while the City of Zagreb was represented by nine respondents (9.2%). Varaždin County contributed three respondents (3.1%).

Furthermore, two respondents (2.0%) were recorded in each of the following counties: Zadar County, Zagreb County, Dubrovnik-Neretva County, Lika-Senj County, Sisak-Moslavina County, and Split-Dalmatia County, while one respondent (1.0%) originated from each of the following counties: Šibenik-Knin County, Istria County, and Karlovac County.

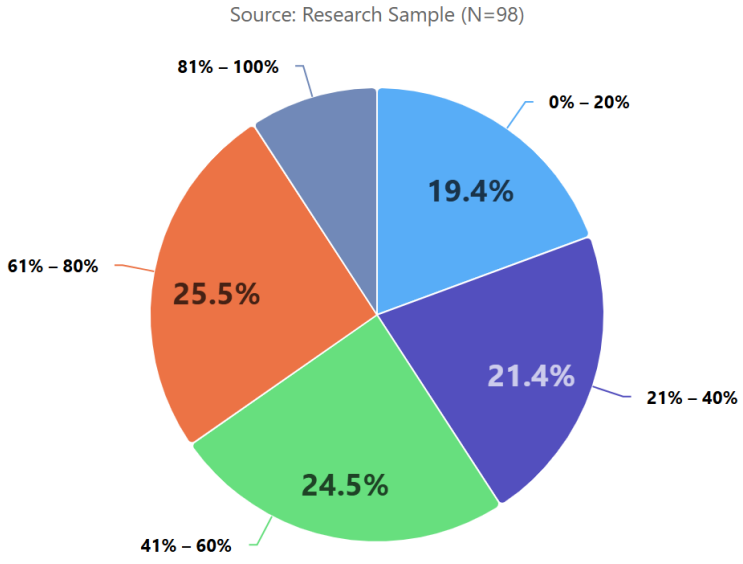
Figure 4: Self-assessment of digital skills levels



Source: Authors' own work

Figure 4 illustrates the respondents' self-assessment of their digital skills levels. Only one respondent (1.0%) rated their skills as 1 (very low), while eight respondents (8.2%) gave a rating of 2 (low). A rating of 3 (good) was reported by 23 respondents (23.5%), while 42 respondents (42.9%) opted for a rating of 4 (high). Finally, 24 enterprises, representing 24.5% of the sample, assessed their skills with a rating of 5 (very high).

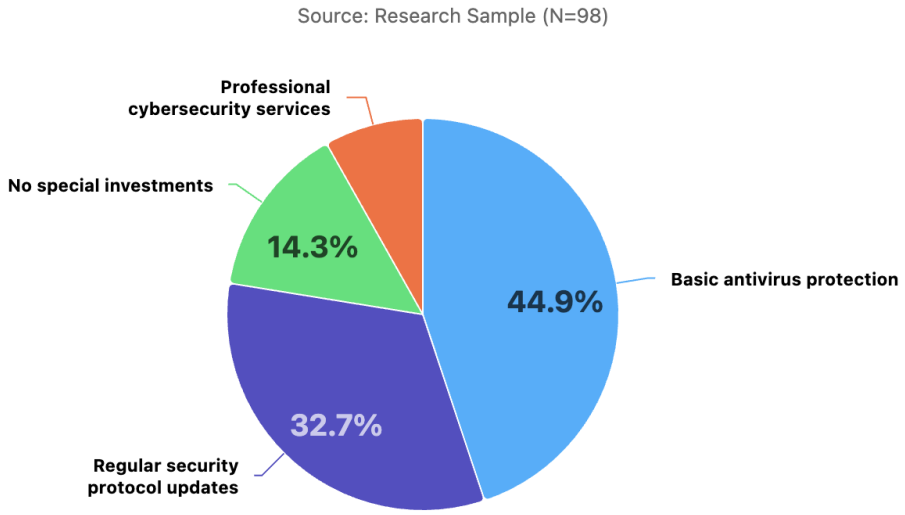
Figure 5: Estimated share of digitalized processes



Source: Authors' own work

The next question and its corresponding answers are shown in Figure 5. It shows the respondents' estimate of the share of digitalized processes within their enterprises. A share of 0%–20% was reported by 19 respondents (19.4%), while 21%–40% was indicated by 21 respondents (21.4%). Furthermore, 24 respondents (24.5%) estimated their digitalized processes at 41%–60%, and 25 respondents (25.5%) reported a share of 61%–80%. Finally, a high level of digitalization, between 81% and 100%, was reported by nine respondents (9.2%).

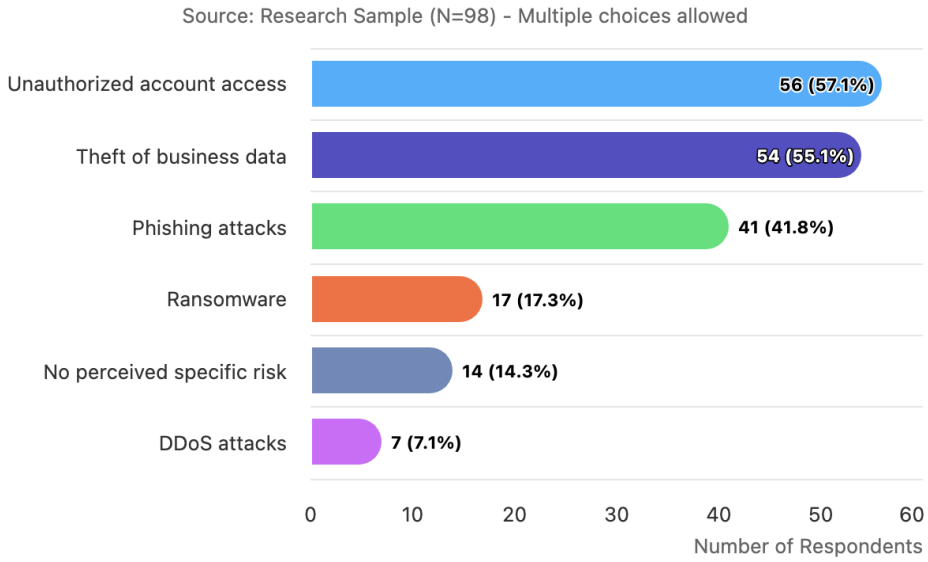
Figure 6: Assessment of current investments in cybersecurity measures



Source: Authors' own work

The current situation in cybersecurity measures investments is shown in Figure 6. Basic antivirus protection is used by 44 respondents (44.9%), while 32 respondents (32.7%) report regularly updating security protocols. Furthermore, 14 respondents (14.3%) state they make no special investments in cybersecurity, whereas only eight respondents (8.2%) utilize professional cybersecurity services.

Figure 7: Perceived cybersecurity risks in e-invoice implementation

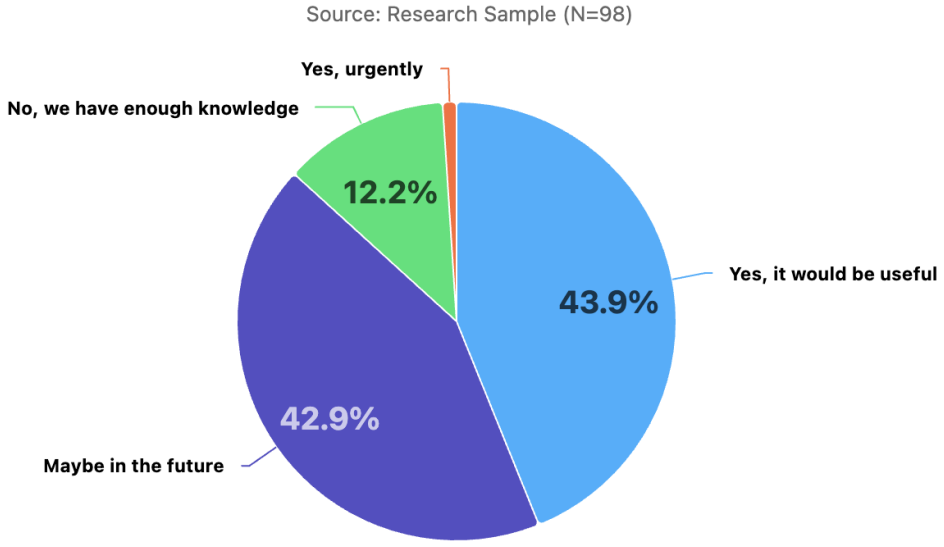


Source: Authors' own work

Figure 7 presents the security threats that respondents identify as the highest risks during the implementation of e-invoicing, with multiple choices allowed. Unauthorized account access was noted by 56 respondents (57.1%), followed by the theft of business data, mentioned by 54 respondents (55.1%). Phishing attacks were identified by 41 respondents (41.8%), while 17 respondents (17.3%) reported ransomware attacks as a threat. Additionally, 14 respondents

(14.3%) stated they do not perceive any specific risk, and seven respondents (7.1%) identified DDoS attacks as a threat.

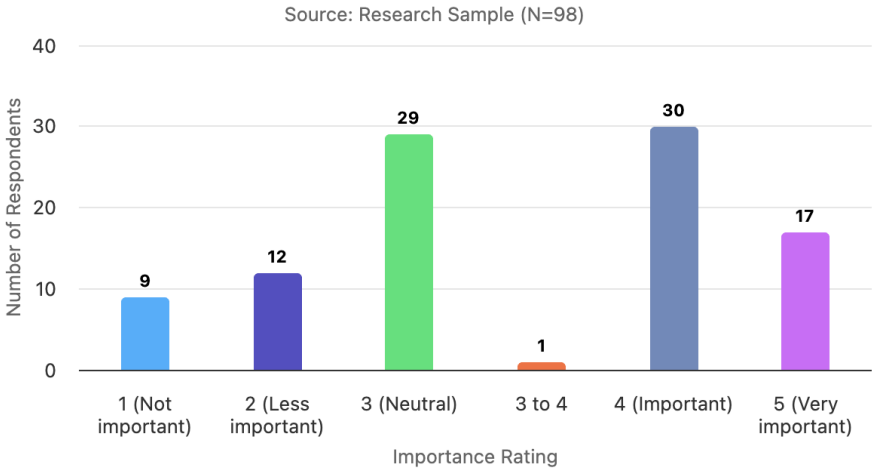
Figure 8: Need for additional information on cybersecurity



Source: Authors' own work

The attitudes of respondents regarding the need for additional information on cybersecurity are illustrated in Figure 8. The response "Yes, it would be useful" was provided by 43 respondents (43.9%), while "Maybe in the future" was indicated by 42 respondents (42.9%). Furthermore, 12 respondents (12.2%) stated that they already possess sufficient knowledge, whereas only one respondent (1.0%) described the need for cybersecurity support as urgent.

Figure 9: Importance of cybersecurity risks

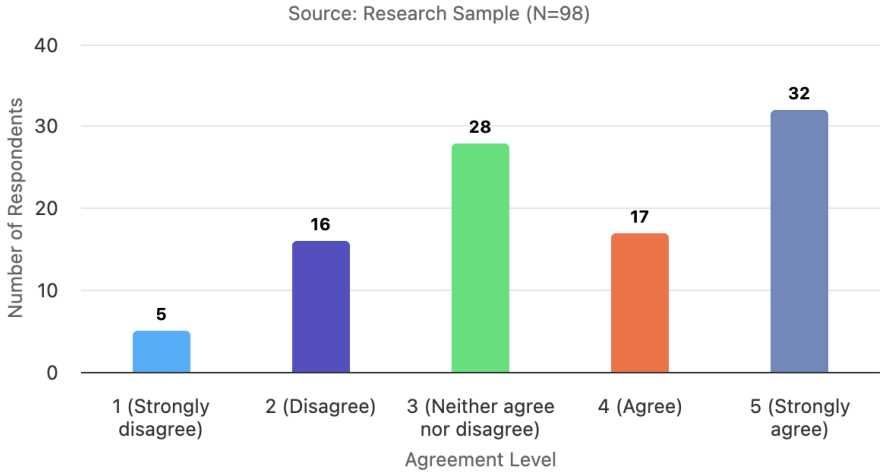


Source: Authors' own work

The importance of cybersecurity risks as a barrier to e-invoice implementation is evaluated in Figure 9, where a rating of 1 represents "not important" and a rating of 5 represents "very important". According to the data, nine respondents (9.2%) assigned a rating of 1, while 12 respondents (12.2%) gave a rating of 2. A neutral stance (rating 3) was assumed by 29 respondents (29.6%), and one respondent (1.0%) provided a rating between 3 and 4. Higher importance was reported by 30 respondents (30.6%) who gave a rating of 4, while 17

respondents (17.3%) considered these risks very important, assigning them the maximum rating of 5.

Figure 10: Adherence to digital security recommendations



Source: authors' own work

Figure 10 presents the extent to which employees operate in accordance with digital security recommendations, such as using strong passwords and identifying suspicious emails. In this context, a rating of 1 represents "strongly disagree", while a rating of 5 indicates "strongly agree". The data shows that five respondents (5.1%) provided a rating of 1, and 16 respondents (16.3%) gave a rating of 2. A neutral position was maintained by 28 respondents (28.6%), while 17 respondents (17.3%) stated that they agree (rating 4) with the claim. Finally, the largest group, 32 respondents (32.7%), reported full compliance with security recommendations, assigning themselves a rating of 5.

4. Results and Discussion

Survey results provide a quality insight into digital readiness and cybersecurity perception among micro, small, and medium-sized enterprises in the Republic of Croatia in terms of mandatory e-Invoicing implementation starting from January 1, 2026. Even though the response rate was low (less than 2%), the gathered sample of 98 respondents provides an opportunity to identify patterns and relationships that are crucial for understanding the current situation and challenges in the digitalization process in Croatian SMEs.

The sample structure indicates a dominance of micro-enterprises, which account for more than half of all respondents. This distribution aligns with the general economic structure of the Republic of Croatia, where micro-enterprises represent the largest share of business entities. The roughly equal representation of small and medium-sized enterprises further enables a comparison of behavioral patterns and perceptions with respect to the size of the organization. The sectoral overview of the sample reveals a predominance of traditional industries, such as construction, retail, and manufacturing. Meanwhile, the share of the ICT enterprises remains relatively smaller, yet significant in the context of digital transformation. The regional concentration of responses, particularly from the Osijek-Baranja County, indicates a spatial imbalance in the sample that could not be mitigated during the data collection process.

Employees' self-assessment of their digital skills reveals a positive pattern. More than two-thirds of respondents rate their digital skills with 4 or 5, while low ratings occur rarely. Such distribution points to respondents having a relatively highly valued perception of their own digital capacities, regardless of the size of the enterprise or the business sector. Since this is a case of self-assessment, results should be taken with caution, especially regarding employees' familiarity with security recommendations. The discrepancy between the perceived level of competence and the actual implementation of security practices suggests a potential gap between knowledge and behavior.

The estimated share of digitalized processes illustrates the heterogeneity of the respondents' digital maturity. The majority of responses are concentrated in the middle categories (41–60% and 61–80%), suggesting that most enterprises are in a transitional phase of digitalization. At the same time, the substantial proportion of respondents in the lowest (0–20%) and highest (81–100%) categories points to pronounced disparities among respondents. These extremes are particularly evident among micro-enterprises, confirming that the enterprise size alone does not determine the level of digitalization. Generally, it is shaped by the sector of activity and the specific characteristics of business processes.

Investments in cybersecurity measures point out that the majority of respondents rely on basic forms of IT protection. Almost half of them state basic antivirus protection, while one-third apply regular safety maintenance and updates. Only a small fraction of respondents use professional cybersecurity services. At the same time, a significant share of respondents' report that they make no dedicated investments in cybersecurity. This distribution suggests a predominantly minimalist approach to security, where advanced measures are implemented selectively.

Unauthorized IT account access and the theft of business data were identified as the primary risks, with phishing attacks ranking among the most prominent threats. Ransomware and DDoS attacks were perceived as less frequent, yet still present risks. Together with that, some respondents reported no perceived threat, indicating heterogeneous risk perceptions. All reported facts suggest that, although the overall cybersecurity awareness is relatively high, it is not uniform across all respondents.

A clear majority of respondents express a need for additional knowledge regarding cybersecurity threats, whether immediately or in the future, while only a small proportion considers their current level of knowledge to be sufficient. This distribution of responses indicates a broadly recognized need for education and support, irrespective of their current level of digital competence. Respondents who rate their skills highly likewise express an interest in further information, which may suggest that they perceive cybersecurity as a complex and evolving field subject to continuous change.

The perception of cybersecurity risk as a barrier to e-invoice implementation shows significant dispersion. While a portion of respondents considers this obstacle minor or irrelevant, a large share of respondents assigns it high importance. The most frequent ratings are 3 and 4, with nearly a fifth of respondents viewing these risks as a critical barrier. This distribution suggests that for a substantial segment of the sample, cybersecurity represents a serious factor in the e-invoice implementation process, though it is not a universal barrier.

The findings concerning employees' compliance with security recommendations further underscore the complexity of the relationship between knowledge, perception, and practice.

Although the largest single proportion of respondents fully agree that employees follow the recommended guidelines, a substantial share expresses neutral or negative views. This polarization points to uneven levels of security within organizations. Lower ratings appear alongside high self-assessments of digital competence, suggesting that formal or technical skills do not necessarily ensure the consistent implementation of security practices.

Considering the survey in its entirety, several key patterns emerge that directly address the core research questions. First, regarding research question 2, there is a relatively high level of perceived digital competence among employees; however, this "perceived maturity" is not consistently matched by a similarly high level of digitalization or robust security practices, confirming a significant perception-behavior gap. Secondly, in response to research question 1, the data identifies a clear "security stratification", where cybersecurity is perceived as a significant barrier primarily by larger SMEs with more complex processes, while micro-enterprises maintain a more reactive, minimalist approach due to resource poverty. Thirdly, the need for additional information and training is expressed by most respondents, irrespective of the enterprise size, sector, or region. Taken together, these findings suggest that the successful implementation of e-invoicing will require more than just technical solutions. It demands systematic education to bridge the identified perception gap, the strengthening of a proactive security culture, and tailored approaches that account for the resource constraints of different SME groups. Strengthening cybersecurity resilience is thus a crucial dimension of overall readiness for Fiscalization 2.0 and an essential component of Croatia's broader digital transformation strategy.

5. Conclusion

The implementation of the Fiscalization 2.0 initiative in 2026 represents a transformative milestone for the Croatian economy, positioning cybersecurity as an indispensable pillar of modern fiscal policy. This research has demonstrated that while the transition to mandatory e-invoicing offers significant administrative benefits, it simultaneously introduces complex digital vulnerabilities for the SME sector. The survey findings reveal a concerning security gap, where nearly half of the analyzed Croatian SMEs still rely exclusively on basic antivirus software for their digital protection. Such a reactive approach is inconsistent with the sophisticated nature of modern cyber threats, especially within a centralized and real-time financial reporting system. With less than ten percent of enterprises utilizing professional cybersecurity services, it is evident that the sector currently lacks the technical infrastructure required for high-level cyber resilience. The admission that a significant portion of firms invest only minimally in security highlights a systemic underestimation of digital risks within the national economy.

Although firms frequently identify unauthorized access and phishing as primary concerns, they generally lack the strategic tools and internal protocols to effectively mitigate these threats. A particularly critical point of concern is the perception gap among enterprises that perceive no specific risk associated with e-invoicing, which indicates a pressing need for institutional awareness-raising initiatives. As fiscalization processes become fully digitized, the integrity of financial data becomes a shared responsibility that must be synchronized between the state, information intermediaries, and private enterprises. The reliance on structured XML platforms and constant interaction with external service providers necessitates advanced measures like multi-factor authentication and incident response planning. Current data indicate that advanced measures remain underutilized, as preparedness for the 2026 mandate is often mistakenly

viewed as a purely administrative task rather than a strategic security upgrade. The majority of respondents expressed a potential or definite need for additional education, confirming that SMEs are seeking professional guidance during this transition. This situation creates a vital opportunity for policymakers, chambers of commerce, and ERP providers to develop tailored training programs and accessible security resources. Without such targeted interventions, SMEs face increased exposure to ransomware and data breaches that could jeopardize their legal compliance and long-term financial stability. Consequently, this study concludes that cybersecurity must be treated as a primary stakeholder in the fiscalization process rather than a peripheral IT expense.

The research concludes that a "one-size-fits-all" approach to digital fiscalization fails to address the structural vulnerabilities inherent in micro-enterprises. To address research question 1, it is evident that as the fiscal chain becomes more centralized, the "reactive" posture observed in 51% of the market creates a systemic risk. Policy interventions must specifically target micro-SMEs to move them beyond basic antivirus protection, as their current reliance on minimal tools is insufficient for the high-intensity, real-time data exchange requirements of 2026. Regarding research question 2, the study identifies that high self-perceived digital competence is a poor indicator of actual cyber resilience. The transition to Fiscalization 2.0 must therefore prioritize "behavioral security" over mere "technical access".

The findings of this study need to be interpreted within certain methodological limitations. The low response rate of under 2% and the regional concentration in Osijek-Baranja County suggest that the results, while indicative of significant trends, should not be generalized to the entire national economy without further validation. Future research should employ longitudinal studies to track how these perceptions evolve after the mandatory implementation of Fiscalization 2.0 in 2026, potentially utilizing cross-sectoral correlations to identify specific vulnerabilities in non-ICT industries.

This research serves as a call to action for all stakeholders to recognize that digital fiscalization and cybersecurity are two sides of the same coin. Only through a collaborative and well-funded approach can Croatian SMEs navigate the complexities of the digital economy without compromising their integrity. By closing the existing knowledge and technology gaps, Croatia can set a regional example for secure and efficient digital tax administration.

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A scientific paper

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AUDITORS' PERCEPTION OF ARTIFICIAL INTELLIGENCE ADOPTION IN FINANCIAL STATEMENT AUDITS – CASE FROM CROATIA

ABSTRACT

A financial statement audit is an important corporate governance mechanism that ensures the transparency, fairness, and objectivity of financial statements and reduces the information gap between management and the company's stakeholders. Increasingly complex, dynamic, and changing business conditions require more time for auditing and more human, financial, and technological resources. The rapid development of technology in recent years, especially in artificial intelligence (AI), provides a strong platform for significantly improving efficiency and productivity across all professions, including the auditing profession. Along with the advantages of this technology, there are numerous application risks and specific concerns about the consequences of future AI development. The significance of AI in the auditing profession is evident, as all major auditing firms have integrated the technology into their operations. Despite this, the question arises as to the extent of its actual application and how useful auditors consider it in their activities. Therefore, the objective of this research is to analyse auditors' attitudes and behavioural intentions regarding the use of AI in their regular audit engagement activities in Croatia. For research purposes, we surveyed 52 statutory auditors in Croatia. We based the questionnaire on the Technology Acceptance Model (TAM). Our results indicate that, although both perceived ease of use and perceived usefulness have a statistically significant effect on AI technology acceptance among statutory auditors in Croatia, usefulness is more important to them, with performance and efficiency increases being the most important determinants. Finally, we concluded that statutory auditors who consider AI technology useful will use it if given the opportunity.

Key words: *artificial intelligence (AI), financial statement audit, statutory auditors, audit methodology, technology acceptance model (TAM).*

1. Introduction

Financial statement audit is a profession whose purpose is to enhance user confidence in the client's financial statements by expressing the auditor's opinion on whether they give a true and fair view of the company's financial position, changes in financial position, and financial performance. Auditors provide an opinion on whether companies have prepared their financial statements in accordance with the applicable financial reporting framework. They base their opinion on the assessed risk of material misstatement, the materiality level, and the sufficient and appropriate audit evidence collected. By obtaining sufficient and appropriate audit

evidence, the auditor gains reasonable assurance, thereby reducing audit risk to an acceptable low level that allows him to draw reasonable conclusions on which to base the auditor's opinion (ISA 200, paragraph 17). In this regard, the appropriateness of audit evidence denotes a measure of its quality, i.e. relevance (logical connection) and reliability, and sufficiency is a measure of the quantity of audit evidence.

Essentially, the purpose and objectives of the audit do not change with technological development and the digitalisation of business; however, technological advances have a radical impact on the methodological aspects of all phases of the financial statement audits. Thus, the audit procedures auditors use to gather audit evidence are transforming from traditional manual procedures into technology-based ones through digitalisation, automation, and artificial intelligence.

The audit profession, which until recently relied on sampling, is now focused on population analysis using advanced techniques of descriptive, diagnostic, predictive, and prescriptive data analytics and visualisation. The development of technology in Industry 4.0 enables the introduction of continuous auditing, characterised by automation, data analytics, and real-time auditing across complete data sets.

The fundamental technologies that drive the fourth-generation industrial revolution in terms of the readiness of Croatian companies to strengthen their technological and innovative potential include (Hrbić & Grebenar, 2021): artificial intelligence, big data, robots, simulations, horizontal and vertical system integration, the Internet of Things, cybersecurity, cloud computing, 3D printers, and augmented reality. Fundamental attributes characterising Industry 4.0 are system interoperability (e.g., connectivity via the Internet of Things), virtualisation, decentralised decision-making, real-time capacity, service orientation, and modularity (Ibarra et al., 2018). Although Industry 4.0 offers numerous advantages, it also has disadvantages, such as high implementation costs, a lack of competencies, data protection challenges, and emerging risks.

Industry 5.0 introduces a completely new dimension of sustainable, human-oriented technology, where audit procedures are no longer viewed solely through the prism of automating routine, repetitive activities. Instead, the emphasis is on ethical, synergistic cooperation between man and machine, whereby technology serves the auditor (human-centric) rather than the other way around. The transparency of algorithms is especially important, namely that the auditor understands the models used (explainable AI), thereby avoiding the problem of the "black box" in the audit. Industry 5.0 thus emphasises the responsible, transparent and purposeful use of technology in the auditing process. The European Union's policy strongly supports such changes. Namely, three key goals are simultaneously supported: "accelerate the green and digital transition of key EU industrial ecosystems, and following the Industry 5.0 policy approach to foster human-centricity, resilience and sustainability in industry" (Industrial Technologies Roadmap on Human-Centric Research and Innovation for the Manufacturing Sector ERA Research and Innovation, 2024)

In the context of Industry 5.0, four main thematic units, or clusters, have been identified that represent key research directions within the field. The first cluster encompasses the fundamental concepts of Industry 5.0, such as personalisation, digital transformation, the vision of society 5.0, and sustainability. Furthermore, the second cluster focuses on the future work environment, which aggregates the shared future workplace for humans and machines. Then, the third cluster emphasises the importance of digital twins, especially for simulating, optimising, and predicting

the behaviour of physical objects. Finally, the fourth and largest cluster represents key technologies such as blockchain, the Internet of Things, augmented reality, and 5G and 6G networks (Barata & Kayser, 2023).

However, the main role today, but in the coming period, is played by artificial intelligence. The concept of artificial intelligence raises numerous questions, such as: What is intelligence? How can we measure intelligence? How does the brain work? These questions are important for a deeper understanding of artificial intelligence itself. However, the central question concerns the behaviour of a smart machine: how it can act like a human and exhibit different forms of intelligence (Ertel, 2025).

It is well known that there is no generally accepted definition of artificial intelligence. As a result, the term artificial intelligence is often used in different senses, both within and outside the field. Namely, when defining the term intelligence, the concept is often violated, since people do not consider everything intelligent. For example, most people do not consider a conventional computer program that calculates the arithmetic mean to be smart if it performs certain "smart" actions. For this reason, intelligence should not be defined through terms such as "intelligence", "thinking", "cognition", "wisdom", "consciousness", etc., without first defining them (Wang, 2019).

However, certain definitions in the literature offer different views of artificial intelligence. One of the most famous definitions came from John McCarthy, one of the pioneers of the field, who defined artificial intelligence as: „the science and engineering of making intelligent machines, especially intelligent computer programs" (McCarthy et al., 2006). Wang (2019) points out that artificial intelligence is "Intelligence is the capacity of an information-processing system to adapt to its environment while operating with insufficient knowledge and resources" (Wang, 2019).

Some of the key advantages of artificial intelligence include improved accuracy and reliability, increased productivity and efficiency, better cost control, more reliable fraud detection, improved risk management, the use of predictive analytics for business decision-making, and the ability to process very large amounts of data. However, in terms of artificial intelligence, there is a whole series of shortcomings and challenges, among others, the high cost of implementation, impacts on employment opportunities, social consequences, data security and privacy issues, ethical and legal issues, transparency and bias of algorithms, lack of human judgment and context, reliability and errors (Altawalbeh et al., 2025). The lack of standardisation and regulation is also a challenge, given that the technology is still in its early stages of development. Accordingly, both standards and legal frameworks are still in the process of being formed (Tantawi et al., 2025).

Tools based on unsupervised machine learning and deep neural networks enable auditors to detect patterns, anomalies, and outliers that traditional approaches would miss, thereby significantly facilitating the identification of errors and/or fraud. In such an environment, the auditor of the future moves away from technically demanding and routine tasks and focuses on risk assessments, the interpretation of data analysis results, and the communication of results, while applying professional judgment and maintaining professional scepticism. In this sense, the question arises of how certified auditors perceive modern technologies, especially artificial intelligence, and how they assess their usefulness, intended use and actual application in audit practice.

2. Literature Review

Existing literature has examined AI acceptance among external auditors; however, the scope of this research is relatively limited compared to other areas of AI application. Only a small proportion of these studies utilise the Technology Acceptance Model (TAM) framework (Abdullah & Almaqtari, 2024; Al-Marzouki et al., 2025; Cuc et al., 2025; Lam Nguyen & Huy Pham, 2025; Syahnal et al., 2025). It is noteworthy that several studies investigate differences between local and international audit firms (Al-Marzouki et al., 2025; Hayek et al., 2022; Noordin et al., 2022). In this context, Noordin et al. (2022), who studied AI acceptance among local and international audit firms, found no statistically significant differences in perceptions of AI's impact. Similarly, Hayek et al. (2022) also found no statistically significant differences in perceived ease of use between these groups. In contrast, Al-Marzouki et al. (2025) concluded that local auditors found machine learning more user-friendly and rated its usefulness higher than their international counterparts. These findings challenge the notion of significant disagreement between local and international audit offices regarding the ease of using machine learning (Al-Marzouki et al., 2025). Previous studies support the TAM's concept that perceived ease of use and perceived usefulness are key determinants of technology acceptance. In most studies, they are found to have a positive influence on auditors' readiness to adopt AI-based technology in financial statement audits (Abdullah & Almaqtari, 2024; Cuc et al., 2025; Hayek et al., 2022; Lam Nguyen & Huy Pham, 2025; Syahnal et al., 2025).
Hayek et al. (2022) focused their research on the acceptance of machine learning among external auditors in the UAE. Their findings indicate limited knowledge of this technology among auditors; however, local auditors found it slightly easier to use and more useful than international auditors (Hayek et al., 2022). The research by Al-Marzouki et al. (2025), which also examined the benefits and applicability of machine learning in financial statement audits, was conducted on a sample of 100 external auditors from the Arab Republic of Egypt (ARE) and is consistent with previous conclusions. They found differences in the acceptance of this technology between local and international external auditors. Al-Marzouki et al. (2025) also concluded that auditors are still not fully familiar with machine learning.

Most studies based on TAM concepts investigated, among other things, the perceived ease of use and perceived usefulness of AI-based technology in financial statement audits. Prior research largely confirms basic concepts of TAM. Lam Nguyen & Huy Pham (2025) integrated the Technology Acceptance Model (TAM) and the Theory of Planned Behaviour (TPB) to examine which determinants are relevant for auditors' intention to use AI in financial statement audits. By analysing data from 139 Vietnamese external auditors, the authors found that a positive attitude towards technology is a crucial factor in behavioural intention to adopt it. Consistent with the theoretical concept, they found that perceived usefulness (PU) and perceived ease of use (PEU) positively influence AI adoption. Finally, the authors concluded that there are significant differences in motivation and competencies to adopt AI across different auditor groups (Lam Nguyen & Huy Pham, 2025). Syahnal et al. (2025) results are consistent with the previous study. They defined AI as a latent construct defined by big data analytics capabilities, deep learning applications, and cloud computing integration. Next to factors indicating technology acceptance, their model included numerous other effects as mediating variables. However, regarding TAM findings, they concluded that those factors (e.g. internal factors, national culture) increase auditors' intention to use the technology and perceived benefits, which significantly and positively influence intention to use, supporting TAM's assumption of perceived usefulness. Cuc et al. (2025) also used TAM to examine professionals' readiness to accept AI in accounting and auditing among 558 examinees. To analyse data, they used confirmatory factor analysis, Pearson's correlation, and network analyses. As in previous

studies, the authors concluded that perceived usefulness (PU) moderately and perceived ease of use (PEOU) highly positively influence the intention to use AI among accounting and auditing professionals. Additionally, they found that those factors interact with emerging factors, such as AI knowledge and subjective norms. Abdullah & Almaqtari (2024) also investigated accounting and auditing professionals. Although they did not base their research on the original TAM, they investigated the effects of multiple technological advances, including AI, big data analytics, cloud computing, and deep learning, as well as TAM factors, on various aspects of the accounting and auditing professions (e.g. education, audit planning, costing) among 228 examinees. Regarding TAM factors, the authors found a positive relationship between AI and perceived usefulness. Additionally, results indicated that perceived ease of use positively influences intention to adopt AI in accounting and auditing. In this regard, the authors concluded that a user-friendly solution motivates users and enhances efficiency (Abdullah & Almaqtari, 2024). Unlike other authors, Al-Mawali et al. (2025) used the AI Device Use Acceptance (AIDUA) model, an extended TAM model developed to examine the acceptance of AI-based technologies, among 153 certified auditors in Jordan. Their model included factors such as social influence, hedonic motivation, and anthropomorphism. Authors emphasise the need to understand specific AI factors influencing adoption in auditing. Thus, they concluded that greater technology readiness positively impacts emotions and AI acceptance (Al-Mawali et al., 2025). Noordin et al. (2022) focused their research on audit quality rather than the audit profession as a whole. They analysed auditors' perceptions of how AI technology affects audio quality in the United Arab Emirates (UAE). As in the cases of Hayek et al. (2022) and Al-Marzouki et al. (2025), Noordin et al. (2022) also analysed 63 auditors at the local and international levels. The authors concluded that AI can significantly improve the identification of potential threats and fraud, thereby significantly enhancing audit quality.

3. Methodology and Data Sample

3.1. Methodology

The auditing profession is facing increasing challenges, both in terms of greater information requirements and the growing volume of data they must process to collect sufficient and appropriate audit evidence, as a cornerstone of high-quality audits, to form an opinion on the fair and objective representation of financial statements. Accordingly, new technologies, such as artificial intelligence, increase external auditors' productivity and the efficiency of the entire audit process. This research **aims to examine both the perception of acceptance and the actual use of AI-based technologies in the audit process by statutory auditors in the Republic of Croatia**.

People's perceptions of ease of use, usefulness, intention to use, and actual use of technology are usually measured using the well-established Technology Acceptance Model (TAM). The results of this model have great predictive value for future actual acceptance of certain technologies. They can help developers direct their features towards users' preferences to make them more attractive. The model was developed in the mid-80s by Davis (1985). His premise was to develop a model that would anticipate users' acceptance of contemporary technology during the early phase of development, capturing relevant information when it has the greatest value (Davis, 1985). For purposes of this research, we used the original TAM model, which comprises five composite constructs: perceived usefulness (PU), perceived ease of use (PEU), attitude towards use (ATU), behavioural intention to use (BIU), and actual use (ACU) of AI-

based technology (Table 1). Furthermore, all constructs in this study are reflective and consistent with the original TAM concept (Davis, 1985).

Table 1: Statements used in Technology Acceptance Model (TAM)

Construct	Code	Statement	Reference
Perceived Usefulness (PU)	PU1	Using artificial intelligence technologies increases the efficiency of the audit process.	Lam Nguyen & Huy Pham (2025) Abdullah & Almaqtari (2024) Damerji & Salimi (2021) Venkatesh et al. (2003) Venkatesh & Davis (2000) Davis (1993) Davis et al. (1989)
	PU2	Artificial intelligence contributes to an improved methodology for performing audit engagements.	
	PU3	The application of artificial intelligence shortens the time required to carry out audit procedures.	
Perceived Ease of Use (PEU)	PEU1	I find AI-supported tools easy to use in the audit process.	Hayek et al. (2022) Lam Nguyen & Huy Pham (2025) Abdullah & Almaqtari (2024) Damerji & Salimi (2021) Venkatesh et al. (2003) Venkatesh & Davis (2000) Davis (1993) Davis et al. (1989)
	PEU2	Using artificial intelligence in my everyday audit work would not represent a burden.	
	PEU3	I believe it is easy to learn how to apply artificial intelligence tools in audit work	
Attitude Towards Using (ATU)	ATU1	Using artificial intelligence in auditing is a positive change.	Lam Nguyen & Huy Pham (2025) Salloum et al. (2019) Davis et al. (1989)
	ATU2	Artificial intelligence should be an integral part of my audit work.	
	ATU3	Introducing artificial intelligence into the audit process is necessary.	
Behavioural Intention to Use (BIU)	BIU1	I intend to use artificial intelligence tools in future audit engagements.	Abdullah & Almaqtari (2024) Salloum et al. (2019) Venkatesh & Davis (2000)
	BIU2	I believe that the use of artificial intelligence will become an integral part of my everyday audit work.	
	BIU3	I intend to expand my professional knowledge so that I can effectively use artificial intelligence in audit work.	
Actual Use (ACU)	ACU 1	So far, I have used some form of artificial intelligence in auditing.	Damerji & Salimi (2021) Davis et al. (1989)
	ACU 2	I have participated in audit projects or tasks where artificial intelligence was used.	

Construct	Code	Statement	Reference
	ACU 3	I use AI-based tools in my everyday audit work.	

Source: Authors

Two key indicators of developing attitude towards using intention and actual use of technology are perceived ease of use and perceived usefulness. Besides, ease of use is a strong predictor of perceived usefulness (Tbaishat et al., 2026; Venkatesh & Davis, 2000). Ease of use is a measure of technology complexity, i.e., it represents the degree of perception of technology usage complexity (Salloum et al., 2019). Furthermore, it represents an understanding of the effort required to engage with a technology effectively (Davis, 1985; Lam Nguyen & Huy Pham, 2025; Tbaishat et al., 2026; Venkatesh & Davis, 2000). For statutory auditors, a high level of integration with the IT system and an intuitive, user-friendly interface, without the need for advanced programming skills, positively affect auditors' perception of ease of use of AI-based technology in complex, demanding, and time-pressured tasks of financial statement audits. When auditors perceive the benefits of technology, they are more likely to intend to use it (Syahnal et al., 2025). Thus, another key factor in technology acceptance is perceived usefulness, which is the perceived degree of job performance improvement from technology use (Davis, 1985; Salloum et al., 2019; Tbaishat et al., 2026; Venkatesh & Davis, 2000). Given that statutory auditors usually operate in a dynamic, often stochastic environment and need to deliver results quickly, the tools they use must be effective and enhance their performance. They are audit evidence-, risk- and effectiveness-focused. Thus, if AI reduces error risks, increases audit evidence quality and reliability, and accelerates the conduct of procedures, auditors will consider it useful and be more prone to use it. Thus, previous research found positive relationships between perceived ease of use and perceived usefulness on attitude towards using (Damerji & Salimi, 2021; Davis, 1985; Lam Nguyen & Huy Pham, 2025; Salloum et al., 2019; Tbaishat et al., 2026; Venkatesh & Davis, 2000). Authors usually define attitude towards using as a positive or negative estimate of the external and internal environment, ideals, activities, events, or feelings about performing in a certain way (Lam Nguyen & Huy Pham, 2025; Li, 2023; Tbaishat et al., 2026). We can conclude that perceived ease of use and usefulness have a synergistic effect on attitude toward using the technology. Furthermore, the core predictor of actual usage in TAM is behavioural intention to use technology (Syahnal et al., 2025). Behavioural intention to use refers to the intention to employ technology in everyday activities (Salloum et al., 2019).

Attitude towards using is a predictor of behavioural intention to use, along with the direct effect of perceived usefulness. According to TRA, a person's behavioural intention depends on their attitude and subjective norms. Mathematically, behavioural intention expresses the sum of attitude and subjective norms (Sharma & Mishra, 2014). However, in emerging economies, despite high intentions to use technology, technological readiness can be associated with limited actual use of technology (Syahnal et al., 2025). Regarding audit technology, Syahnal et al. (2025) note potential uncertainties in the transition from behavioural intention to actual AI adoption in auditing. Nevertheless, previous studies reveal positive effects of attitude towards using on behavioural intention to use and on the relationship between intention and actual usage of technology (Davis, 1993; Lam Nguyen & Huy Pham, 2025; Salloum et al., 2019; Tbaishat et al., 2026; Venkatesh & Davis, 2000). Considering relationships from the original TAM and the results of previous studies, we developed five research hypotheses to study **the perception of acceptance and the actual use of AI-based technologies in the audit process by statutory auditors in the Republic of Croatia** (Li, 2023; Ngomane, 2024; Tbaishat et al., 2026; Venkatesh et al., 2003):

- H1: Perceived Ease of Use (PEU) positively influences Perceived Usefulness (PU).

- H2: Perceived Ease of Use (PEU) positively influences Attitude Toward Use (ATU).
- H3: Perceived Usefulness (PU) positively influences Attitude Toward Use (ATU).
- H4: Perceived Usefulness (PU) positively influences Behavioural Intention to Use (BIU).
- H5: Attitude Toward Use (ATU) positively influences Behavioural Intention to Use (BIU).
- H6: Behavioural Intention to Use (BIU) positively influences Actual Use (AU).

To gather data necessary for the research we prepared questionnaire divided into three parts: (1) general information on examinees, (2) auditors' perceptions on intention to use and usage of AI technology in financial statement audits, (3) auditors' opinions on needed competencies, ethical risks, and general role of AI technology in auditing profession in the Republic of Croatia. The central part of the questionnaire is the section on technology acceptance statements, which underlies this research. There were a total of 15 statements that examinees evaluated on a 7-point Likert scale, with grade 1 representing *Completely Disagree* and grade 7 representing *Completely Agree*.

3.2. Data Sample

The survey participants were auditors registered in the Croatian Register of Certified Auditors of the Ministry of Finance. Although there is an official database of statutory auditors in the Republic of Croatia, e-mail addresses are not available, which made data collection difficult. The survey questionnaire was anonymous and conducted in July 2025 via an online form (Google Forms) sent to participants by e-mail. During this period, we collected 52 responses. The authors conducted the research primarily to write a master's thesis entitled "*The Application and Impact of Artificial Intelligence on the Financial Statement Audits in the Republic of Croatia*" (Gregurec, 2025). Thus, the data collection period was short, resulting in a smaller sample, which is a limitation of this research. The thesis included descriptive statistics of the gathered data and relevant conclusions regarding the current state of AI-based technology adoption among auditors in Croatia. This research extends those results by designing a TAM and drawing statistically significant conclusions about auditors' perceptions and acceptance of AI technologies in financial statement audits.

3.3. Data Analysis

Technology acceptance models (TAM) are usually analysed using so-called second-generation techniques, namely structural equation modelling (SEM), where two popular methods are covariance-based SEM (CB-SEM) and partial least squares SEM (PLS-SEM) (Hair et al., 2021). "Structural theory shows hot the latent variables are related to one another (i.e., it shows the constructs and their path relationships in the structural model)." (Hair et al., 2021, p. 8) The main difference between the two methods is the direction of measurement. While CB-SEM starts from latent factors that manifest in their indicators, PLS-SEM starts from indicators, which are combined to form composite constructs (Hair et al., 2021). Thus, CB-SEM is predominantly used to test established theory and relies on stricter statistical assumptions. In contrast, PLS-SEM is typically used for prediction-oriented models and is more flexible regarding statistical assumptions. Thus, PLS-SEM is efficient with smaller samples, does not require normally distributed data, can easily handle reflective and formative measurement models, and yields greater statistical power (Hair et al., 2021). Therefore, given that our model has predictive properties, we analyse the data using PLS-SEM. Although this approach handles smaller samples well, Hair et al. (2021) suggested a minimum sample size relative to the minimum path coefficients, which are model results. In our model, the smallest path coefficient is $\beta = 0.27$, and at the 5% significance level, the required sample size to achieve 80% statistical

power would be approximately 69 examinees. However, our sample size is 52 statutory auditors, which means the model's statistical power would fall short of the recommended level. Therefore, when relationships are statistically significant, results are considered robust and relevant; however, when relationships are statistically insignificant, researchers should interpret results with caution. The results of our model will show that all relationships are statistically significant. Regarding data distribution, the Kolmogorov–Smirnov and Shapiro–Wilk tests indicate a clear deviation from normality, with p-values of 0.000 for almost all indicators. A few indicators show slightly higher p-values, but still below the 0.050 threshold, confirming the non-normal distribution of research data. Given that PLS-SEM is robust to violations of normality assumptions, this method is a good fit for our data. Finally, to obtain descriptive statistics and the results of the chosen tests (e.g., tests of normality), we used SPSS, and to calculate results for the PLS-SEM method, we used SmartPLS.

4. Results and Discussion

4.1. Evaluation of the Measurement Model

Assessing the validity of reflective measurement models usually includes assessment of internal consistency reliability, convergent validity, and discriminant validity According to literature, the best tests of **Internal consistency reliability** are Cronbach's alpha and composite reliability, **convergent validity** by outer loadings and average variance extracted (AVE), and of **discriminant validity** cross-loadings, the Fornell-Larcker criterion, and by heterotrait-monotrait ratio (HTMT) (Hair et al., 2017).

Table 2: Results of measurement model

Construct	Indicator	AVG	SD	SFL	CA	CR	AVE
Perceived Usefulness (PU)	PU1	5.519	1.291	0.920	0.872	0.921	0.796
	PU2	5.327	1.279	0.873			
	PU3	5.423	1.526	0.883			
Perceived Ease of Use (PEU)	PEU1	4.673	1.309	0.822	0.809	0.887	0.724
	PEU2	5.173	1.264	0.838			
	PEU3	4.750	1.341	0.891			
Attitude Towards Using (ATU)	ATU1	5.481	1.350	0.874	0.896	0.935	0.828
	ATU2	5.135	1.609	**0.954**			
	ATU3	5.077	1.655	0.900			
Behavioural Intention to Use (BIU)	BIU1	5.750	1.312	**0.957**	0.907	0.941	0.843
	BIU2	5.519	1.435	0.932			
	BIU3	5.981	1.163	0.864			
Actual Use (ACU)	ACU1	4.058	1.765	0.853	0.872	0.921	0.797
	ACU2	3.750	1.856	0.896			
	ACU3	3.923	1.595	0.927			

Legend: AVG – mean; SD – standard deviation; SFL – Standardized Factor Loadings (outer loadings); CA – Cronbach's alpha; CR – Composite Reliability; AVE – Average Variance Extracted

Source: Authors

Table 2 includes results relevant to internal consistency reliability and convergent validity testing. Researchers should be cautious when interpreting the obtained results. Although each

indicator has a preferred threshold, they should consider the context when making the final decision on validity. "When analysing and assessing the measures' internal consistency reliability, the true reliability usually lies between Cronbach's alpha (representing the lower bound) and the composite reliability (representing the upper bound)." (Hair et al., 2017) Indicators of internal consistency reliability, Cronbach's alpha and composite reliability show excellent results. If the value of Cronbach's alpha is above 0.70, the result is acceptable, and if it is over 0.90, the result is excellent. In our research, Cronbach's alphas are over 0.80, indicating favourable internal consistency.

Table 3: Discriminant validity and the correlations of variables (Fornell-Larcker criterion)

	ACU	ATU	BIU	PEU	PU
ACU	**0.892**				
ATU	0.638	**0.910**			
BIU	0.584	0.798	**0.918**		
PEU	0.665	0.665	0.691	**0.851**	
PU	0.470	0.839	0.786	0.581	**0.892**

Source: Authors

The results of composite reliability (CR) confirm this conclusion, with values ranging from 0.887 to 0.941, which is considered ideal. We tested convergent validity by calculating outer loadings and average variance extracted (AVE). Outer loadings should range from 0.70 to 0.95 to indicate appropriate convergent validity (Hair et al., 2017). In our case, all indicators (items) have outer loadings over 0.80, which is excellent; two of them (ATU2 and BIU1) are marginal at 0.95. Nevertheless, the average variance extracted (AVE), which should be over 0.50, confirms the convergent validity of the composite constructs. Their values range from 0.724 to 0.843.

Researchers typically use three tests to assess **discriminant validity** in reflective PLS-SEM models. In this context, it is important to test whether the observed composite constructs differ sufficiently and whether each composite construct measures a specific, distinct concept, e.g., perceived usefulness or actual use. We used the Fornell-Larcker criterion to test this fact. Diagonal entries in Table 3 represent the square root of the average variance extracted (AVE), and their values must be higher than the off-diagonal correlations between constructs. Our results are consistent with this criterion: for every composite construct on the diagonal, the value is higher than the off-diagonal correlations.

Table 4: Results of the heterotrait-monotrait ratio (HTMT) discriminant validity

	ACU	ATU	BIU	PEU	PU
ACU	-				
ATU	0.723				
BIU	0.649	0.876			
PEU	0.793	0.777	0.802		
PU	0.538	0.948	0.881	0.688	-

Source: Authors

One of the latest tests of discriminant validity is the heterotrait-monotrait ratio (HTMT). This ratio also tests whether two constructs are sufficiently similar to measure the same thing or

sufficiently different to be considered distinct latent variables. It is a much stricter test compared to the Fornell-Larcker criterion. Upper testing threshold is 0.90; values up to 0.95 are considered acceptable (Hair et al., 2017). Results indicate that HTMT for all constructs is below 0.90, except for the relation between perceived usefulness (PU) and attitude towards using (ATU), which is very close to 0.95, at 0.948 (Table 4). This result could indicate that statutory auditors have similar perceptions of perceived usefulness (PU) and attitude towards using (ATU). Additionally, it is necessary to emphasise that PU and ATU are usually highly related in the TAM-based model; this result does not represent a decisive factor.

Table 5: Results of cross-loadings

	ACU	ATU	BIU	PEU	PU
ACU1	**0.853**	0.563	0.496	0.556	0.405
ACU2	**0.896**	0.597	0.513	0.617	0.454
ACU3	**0.927**	0.551	0.553	0.607	0.402
ATU1	0.516	**0.874**	0.662	0.714	0.771
ATU2	0.638	**0.954**	0.766	0.633	0.768
ATU3	0.586	**0.900**	0.750	0.468	0.752
BIU1	0.583	0.782	**0.956**	0.604	0.764
BIU2	0.585	0.797	**0.934**	0.685	0.725
BIU3	0.422	0.597	**0.863**	0.614	0.673
PEU1	0.577	0.493	0.513	**0.820**	0.462
PEU2	0.566	0.596	0.635	**0.841**	0.508
PEU3	0.558	0.600	0.606	**0.890**	0.509
PU1	0.401	0.773	0.744	0.558	**0.920**
PU2	0.346	0.690	0.656	0.480	**0.872**
PU3	0.505	0.778	0.699	0.513	**0.884**

Source: Authors

The final and crucial test of discriminant validity is the results of cross-loadings between composite constructs and indicators (items). Cross-loadings represent correlations between each composite construct and each indicator (item). The idea is that correlations are the highest between a composite construct composed of sourcing indicators, etc. ACU to ACU1, ACU 2, and AVU 3 and so on. Our results confirm these conditions because loadings of each indicator (item) are the highest for the associated construct (Table 5).

Based on model testing results, we concluded that the model is valid, stable, and theoretically consistent. Composite constructs are reliable and adequately operationalised in the context of statutory external auditors' perception of acceptance and use of AI technologies in financial statement audits.

4.2. Evaluation of the Structural Model

First, regarding the obtained results, we concluded that all anticipated relations are statistically significant and that all research hypotheses are accepted. The results are consistent with TAM theory. First, there is no multicollinearity problem, as all values are well below the 10 thresholds. The VIF indicator ranges from 1.0 to 3.4 (Table 6).

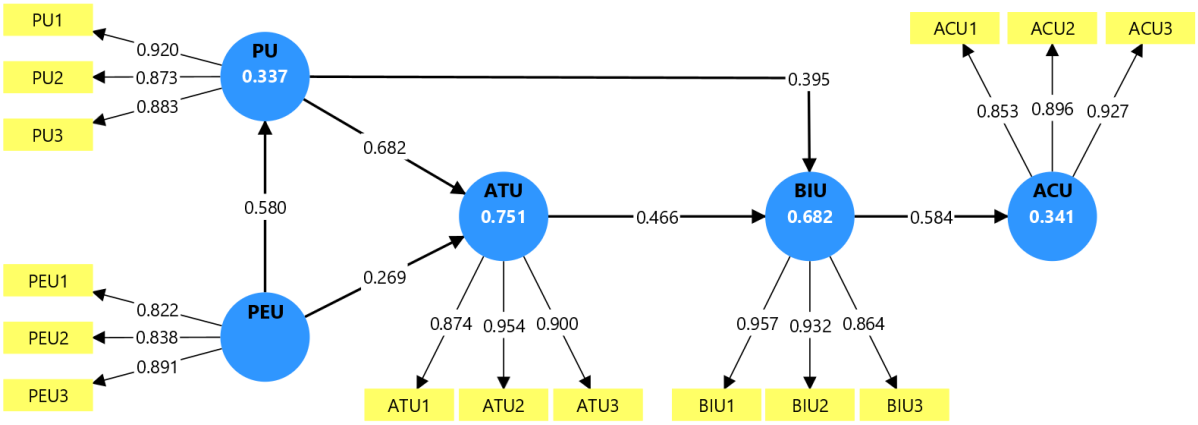
Table 6: Results of structural model and path coefficients

Criterium	Predictor	H	R^2	Path coefficients	t value	p value	VIF	Result
PU	PEU	H1	0.337	0.580	4.273	0.000	1.000	Supported
ATU	PU	H2	0.751	0.682	7.580	0.000	1.508	Supported
ATU	PEU	H3	0.751	0.269	2.475	0.013	1.508	Supported
BIU	PU	H4	0.682	0.395	1.995	0.046	3.369	Supported
BIU	ATU	H5	0.682	0.466	2.599	0.009	3.369	Supported
ACU	BIU	H6	0.341	0.584	5.711	0.000	1.000	Supported

Source: Authors

Results of R^2 indicate that attitudes towards using (75.1%) and behavioural intention to use (68.2%) AI technology in financial statement audits are well explained. Lower actual use results for R^2, by which the model explains 34.1% of the variance, are also expected, as other factors affect the opportunity and likelihood of technology use, e.g., the competences of statutory auditors, ethical considerations, or the availability of AI technology. Furthermore, the attributed t- and p-values for each relation confirm its significance. Research results indicate the strongest relationship between perceived usefulness (PU) and attitude towards using (ATU) AI-technology in financial statement audits, suggesting that statutory auditors who consider AI-technology useful develop a positive attitude towards its use. It is important to emphasise that perceived ease of use strongly affects perceived usefulness, boosting it relative to the attitude towards using. Considering these results, although ease of use is not a key factor in using AI technology, it strongly affects usefulness, which has the greatest effect on attitude towards using. Additionally, perceived usefulness has a medium direct effect on behavioural intention to use (BIU) AI technology among statutory auditors. The second-strongest relationship in the model, after the one between PU and ATU, is between behavioural intention to use (BIU) and actual technology use (ACU), indicating that statutory auditors who consider AI technology useful will actually use it if given the opportunity.

Figure 1: Results of PLS-SEM from SmartPLS



Source: Authors

The results confirm the mutual significance of the individual composite variables for the actual use of AI in the audit of financial statements (Figure 1). Unlike other user groups, such as students, for whom ease of use is a crucial factor, certified auditors prioritise the usefulness of technology. Considering the specifics, complexity, and regulation of the auditing profession, it

is not surprising that the ease of technology application is not a key characteristic for statutory auditors. Of course, it is not unimportant and has a significant impact on the perception of usefulness. The auditing profession, which characterises the need to quickly process large amounts of data to provide reasonable assurance about the fair and truthful presentation of financial statements, considers the perception of usefulness a fundamental characteristic. In this sense, we can conclude that statutory auditors are pragmatic, i.e. if AI technology will improve the productivity of statutory auditors by increasing the audit quality, enabling the analysis of large amounts of data and accelerating the process of reaching results and reducing audit risk, they will consider it useful and this will define a positive attitude towards this technology, but also positively influence the intention to use it, which almost completely spills over into the actual use of AI technology in the audit process. Accordingly, statutory auditors accept AI technology primarily through the prism of its usefulness. Ease of use plays a significant but secondary role in the acceptance of AI technology, which primarily affects perceived usefulness.

5. Conclusions

The objective of this research is to analyse auditors' attitudes and behavioural intentions regarding the use of artificial intelligence (AI) in their regular audit engagement activities in Croatia. For the study, we surveyed 52 statutory auditors, using a questionnaire based on the Technology Acceptance Model (TAM). According to the results of the conducted research, the most significant factor in the acceptance of AI, i.e., the behavioural intention to use and the actual use of AI, in financial statement audits in the Republic of Croatia, is perceived usefulness. However, it is important to emphasise that the results indicate the statistical significance of all constructs included in the TAM. Accordingly, in addition to perceived usefulness, perceived ease of use also has a significant impact on technology acceptance; however, usefulness is more significant. Such a result is not unusual, given the specificity of the audit profession in terms of regulation, ethical requirements, professional judgment, and professional scepticism of statutory auditors. Often under time pressure in short intervals, they are obliged to fulfil a whole series of requirements and collect sufficient and appropriate audit evidence. In this sense, it is not unusual that improving productivity, effectiveness and efficiency is crucial for them in the context of emerging technologies. Accordingly, if AI technology improves the quality of audit evidence and the audit process, speeds up data analysis, and reduces audit risk, auditors will consider it useful and be willing to use it in their daily activities. Finally, the research results imply that those auditors who have a behavioural intention to use will actually use AI in the audit process.

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A scientific paper

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UNIT AMBIDEXTERITY AND PERFORMANCE: THE MEDIATING ROLE OF CROSS-TRAINING

ABSTRACT

Modern organizations increasingly seek to achieve both innovation and efficiency objectives, which requires balancing dual strategies. Although we have insights into organizational-level ambidexterity, how this phenomenon is operationalized at the unit level to boost performance remains underexplored. Managers face challenges deciding how to implement the ambidexterity agenda within their organizations: whether to focus on explorative adaptability, exploitative alignment, or both (unit ambidexterity). Therefore, we need empirical evidence on whether and how ambidextrous, exploratory, and exploitative units perform. As recent research has highlighted the importance of human resource (HR) practices for ambidexterity, we introduce and test cross-training (i.e., training employees to perform multiple jobs within a unit) as a potential mediator.

This unit-level study employs a time-lagged, multisource research design. We collected survey data from top- and middle-level managers and included 253 organizational units from 67 industry-wide Croatian organizations. Mediation analyses were conducted using the PROCESS macro for SPSS.

Findings indicate that unit ambidexterity improves unit performance without requiring cross-training. The same pattern was observed for the unit alignment–performance relationship. However, our evidence shows that cross-training is an HR mechanism that further enhances the performance of exploitative units. This research helps organizational leaders decide when cross-training is advantageous and when it may not add value, especially for units that rely on stability and routines.

Key words: *Unit Ambidexterity, Cross-Training, Unit Performance*, Mediation Analysis.

1. Introduction

To remain competitive in increasingly complex, uncertain, and dynamic environments, modern-day organizations face greater pressure than ever to innovate while remaining efficient (e.g., Nigg-Stock et al., 2023; Papachroni et al., 2016). According to paradox theorists (e.g., Berti & Cuhna, 2023; Smith & Lewis, 2011), organizations must develop ambidextrous capabilities (e.g., O'Reilly & Tushman, 2008; Zhang et al., 2022) not only to survive but also to outperform. An ambidextrous organization refers to one that is carrying out its ongoing operational activities

(exploitation strategy) while simultaneously seeking to develop new, innovative solutions (exploration strategy) (Andriopoulos & Lewis, 2009; Raisch & Birkinshaw, 2008).

Although ambidexterity is a well-established umbrella term for desirable organizational designs, it has many facets and operates at different analytical levels. It is typically studied at the organizational level (e.g., Junni et al., 2013) and through contextual (Gibson & Birkinshaw, 2004) or strategic (Tushman & O'Reilly, 1996) lenses. Growing evidence suggests that performance outcomes are primarily driven by day-to-day team roles and employees' behaviours. Building on this micro-level perspective (Pertusa-Ortega et al., 2021), ambidexterity also emerges at the unit level through the collaborative management of alignment- and adaptation-oriented tasks within teams (Gibson & Birkinshaw, 2004). As such, teams translate strategic objectives into operational action, serving as critical carriers of both stability and change. Therefore, the ongoing scholarly discussion concerns which designs (e.g., human resource [HR] practices) organizations should adopt to foster unit ambidexterity (Jørgensen & Becker, 2017).

Recent bibliometric reviews (e.g., Melkić, 2025) have indicated a scarcity of unit-level evidence on ambidexterity. Specifically, we lack studies on how unit ambidexterity influences unit performance (Jansen et al., 2012). Pioneering evidence predominantly documents a positive relationship between unit ambidexterity and unit performance (e.g., Jansen et al., 2012). However, a very few units within organizations are ambidextrous. For the majority of exploitative and exploratory units, we still do not understand whether their unit strategy translates into higher unit performance. Although HR practices have recently been extensively studied within the context of ambidexterity (e.g., Pak et al., 2023; Varandas et al., 2024), we lack a focused understanding of their role as antecedents, moderators, or mediators.

Given that ambidexterity requires teammates to handle a variety of tasks (Ceptureanu et al., 2024), cross-training is an essential aspect of the workplace. It enhances a range of skills and expertise (Asif & de Vries, 2015) as team members learn each other's tasks, responsibilities, and roles. This suggests it could be an important mechanism for fostering unit adaptability or aligning unit performance. However, empirical research on the impact of cross-training on performance remains limited (Hernaus et al., 2021), both as a boundary condition (Kostopoulos et al., 2015; Melkić et al., 2026) and as a mediator.

However, it remains unclear whether cross-training as an HR practice benefits all types of teams equally. Highly aligned organizational units may already possess strong routines and shared structure, reducing the marginal value of cross-training. Conversely, highly adaptive organizational units may rely more on flexible role switching and collaborative learning, making cross-training a more central practice to their effectiveness. Despite theoretical or intuitive expectations, empirical evidence that clearly distinguishes between these pathways is scarce. To address this research gap, our study disentangles the effects of unit adaptability and unit alignment on unit performance through cross-training. Using two separate mediation models, we hypothesized that cross-training positively mediates the relationship between each polarity (unit adaptability and unit alignment) and unit performance.

The findings suggest that cross-training serves as a mediator only for unit adaptability, which, in turn, enhances unit performance. This means that unit managers need not invest in cross-training when managing ambidextrous or exploratory units, only exploitative ones. Thus, our evidence shows that cross-training, despite its benefits, cannot be universally applied. The research helps unit managers see that this HR practice acts as an innovation catalyst and adds

value only within specific contexts. This study contributes to the understanding that HR tools generally vary in their ability to support unit ambidexterity (Marchington & Grugulis, 2011).

2. Theoretical Framework

Ambidextrous units are formal work groups that concurrently and collectively handle both exploratory (innovation) and exploitative (operationalization) tasks to improve unit and organizational performance and increase competitiveness in dynamic settings. Exploration characterizes adaptive teams that identify new opportunities, drive innovation, and create new knowledge or products. In contrast, exploitation involves aligned teams that focus on enhancing efficiency, leveraging existing resources and skills, and refining current knowledge (e.g., Li et al., 2024; Zhang, 2020). Adaptive work teams engage in tasks that shape future operational activities, while aligned teams perform tasks that embody the outcomes of prior innovation efforts (Sikavica & Hernaus, 2011). Grounded in the collective cognitive and behavioural characteristics of team members, unit ambidexterity may be actively enabled by HR practices such as cross-training.

Drawing on the concepts of paradox and ambidexterity, organizational units must simultaneously ensure both adaptability and alignment. Instead of choosing one over the other, they should adopt a both-and approach (Fairhurst & Putnam, 2024; Smith & Lewis, 2022). This balance helps clarify how such duality is reflected in employees' daily tasks. Unit adaptability refers to the ability to respond swiftly to changing demands by adjusting processes, roles, tasks, and resource allocation. This capacity supports quick reactions to uncertainty, promotes rapid problem-solving, and enhances operational flexibility—key elements for staying effective in dynamic environments. By reconfiguring work arrangements and mobilizing resources as needed, adaptable units operate effectively amid change and ambiguity. However, focusing solely on adaptability can lead to risks such as coordination failures, role confusion, and overload among team members, as frequent shifts and fluid roles can reduce clarity and focus. These challenges show that adaptability alone might not sustain performance and highlight the importance of mechanisms that balance flexibility with order.

Conversely, unit alignment refers to how well team members share a common understanding of goals and work together through coordinated routines, processes, and clearly defined roles. It boosts performance by improving efficiency, minimizing errors, and making task execution more predictable and reliable. Through standardized practices and shared expectations, aligned units can coordinate more effectively and produce consistent results. However, unit alignment has potential downsides. If it becomes too strict, it can limit responsiveness, hinder experimentation, and reduce a unit's capacity to adapt to changing conditions. Over-standardization and tightly linked routines may block adaptation and innovation, especially in fast-changing environments. This highlights that, while alignment improves performance, it should be balanced with mechanisms that maintain flexibility while ensuring coordination. Although unit adaptability and alignment are complementary, they can also be contradictory. Organizational units need to be flexible while maintaining coordination and stability and remaining responsive. This raises the key question: which HR mechanism can enable achieving both at the same time?

As discussed earlier, cross-training acts as a key integrative tool within successful organizations, encouraging units to exceed formal expectations (Hernaus et al., 2021). Also known as cross-functional or cross-domain training, it is a human resource management

practice involving on-the-job learning and the development of diverse skills, knowledge, capabilities, and expertise. Team members participate in various activities outside their primary roles, facilitating a horizontal knowledge transfer where they learn about their colleagues' responsibilities (Slomp & Molleman, 2002; Volpe et al., 1996). Cross-training promotes team development by enabling proficiency in multiple roles and broadening understanding of work processes, which enhances effectiveness and success at the team level. As a form of intellectual capital less affected by departmental silos and rigid divisions, it can improve unit ambidexterity by removing structural barriers to balancing innovation and resource alignment (Asif & de Vries, 2015). In highly adaptable contexts, cross-training allows quick task reallocation and reduces operational delays. In aligned environments, it maintains flexibility without disrupting coordination by helping team members understand the wider system, not just their specific roles. Thus, cross-training does not replace but enables unit adaptability and alignment to be realized more effectively. Consequently, units with cross-trained members benefit from greater flexibility, fewer disruptions, faster and more effective task execution, and increased resilience. Due to task expansion and skill diversification, it also boosts team productivity and is regarded as a crucial high-performing practice that improves overall unit performance (Hernaus et al., 2021).

Thus, unit (or team) performance refers to the extent to which an organizational unit effectively and efficiently completes tasks and sets goals that contribute to overall organizational outcomes (Pennings & Steers, 1977). It includes both short-term operational (exploitative) tasks and long-term strategic (exploratory) goals (Junni et al., 2013). The variable also includes intangible assets, such as the quality of team collaboration through knowledge sharing, adaptability to change, and collective decision-making ability (Salas-Vallina et al., 2023). Rooted in a both-and approach to balancing competing demands (Fairhurst & Putnam, 2024), it highlights that adaptive and aligned teams achieve their greatest success when in equilibrium. The same principle applies to a team balancing innovation with operational activities.

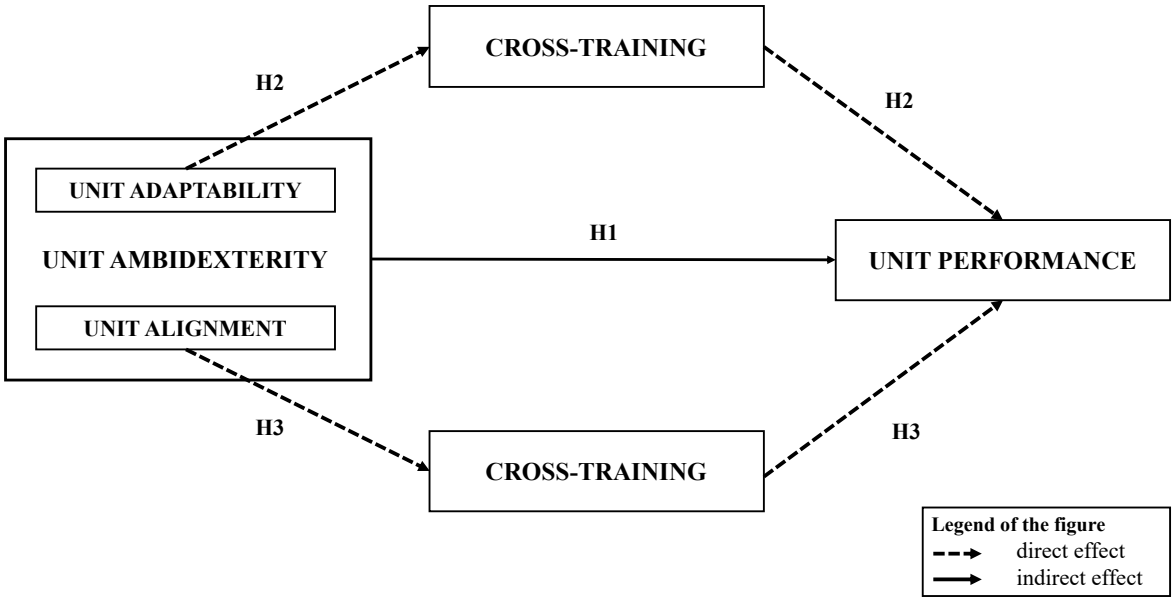
As illustrated in the conceptual research model (Figure 1), this study aims to examine the relationships among unit adaptability and unit alignment (independent variables) and unit performance (dependent variable), with cross-training (mediating variable) serving as the mediating variable within two parallel mediation models. As shown, cross-training serves as a mechanism that enables, amplifies, and operationalizes the performance effects of unit adaptability and unit alignment. Accordingly, the following hypotheses are addressed:

H1: *Unit ambidexterity is positively related to unit performance.*

H2: *Cross-training mediates the positive relationship between unit adaptability and performance*.

H3: *Cross-training mediates the positive relationship between unit alignment and performance.*

Figure 1: Conceptual Research Model



Source: Authors

3. Methodology

3.1. Procedure and Sample

Drawing on paradox theory, which underscores how organizational units operate within complex organizational structures that affect unit-level outcomes (e.g., Kostopoulos et al., 2015), this study examines the interplay among the paradoxical dimensions of unit ambidexterity (unit adaptability and alignment) and their individual effects on unit performance, with and without cross-training as a mediator. A single-method research design was employed to examine the one-way connectedness of each model and to compare the two models. Therefore, the study was administered at the L2 (organizational) and L1 (unit) levels, and time-lagged multisource managerial data were collected from top- and middle-level managers. An initial list of eligible organizations meeting the criterion of active legal status was created using the InfoBiz service of the Financial Agency (FINA). We collected data from 253 organizational units, mainly mid- to large-sized (85.1%) and privately owned. Overall, 67 top and 261 unit managers participated in our research. The modal and median numbers of units per organization were 3.

Initial contact was established with top managers or organizational representatives, who participated in the study themselves and facilitated additional participant recruitment via a snowball sampling strategy. The chosen respondents were unit managers, specifically strategy or organizational design professionals with a comprehensive overview of unit-level processes (Kwak et al., 2020). Accordingly, the sampling strategy targeted up to five units (unit managers) per organization. To participate in the study, each organization was required to provide at least 2 complete and valid responses (Jansen et al., 2016). Data were collected via an online survey (precisely, via the SurveyMonkey platform) using questionnaires administered in Croatian. All measures were developed following a translation-back-translation procedure to ensure

conceptual equivalence, accuracy, and clarity. The survey questionnaires were distributed via email, providing a simple, efficient way to reach participants. Participation in the research was entirely voluntary, with the confidentiality and anonymity of all participants guaranteed. No ethical concerns were anticipated during the survey process.

The research was conducted at two measurement points (T1 and T2) to reduce common-method bias. This temporal separation between the measurements of key variables enables more reliable conclusions and minimizes the risk of subjective response distortion (Podsakoff et al., 2003). At the first measurement point (T1), data collection began for unit managers who completed the managerial questionnaire. The respondents retrospectively self-assessed unit ambidexterity (unit adaptability and unit alignment) and cross-training within their organizational units. Three months later (Miller et al., 1997), at the second measurement point (T2), top managers or organizational representatives completed the organizational questionnaire. The respondents assessed in real time the performance of each organizational unit that also participated in the study. Perceptual measures in both surveys employed five-point Likert-type (dis)agreement scales, anchored from 1 ("strongly disagree") to 5 ("strongly agree").

3.2. Measures

Measures for all key constructs (unit ambidexterity – unit adaptability vs. unit alignment, cross-training, and unit performance) were drawn from previously validated instruments.

Unit ambidexterity is conceptualized as a higher-order construct comprising *unit adaptability* and *unit alignment* and is evaluated using a six-item scale across these two dimensions adopted from Gibson & Birkinshaw (2004). Following unit-level CFA, one ordinal manifest item ("Management systems in this organization encourage employees in our organizational unit to spend resources on unproductive activities") was excluded from the three-item unit alignment scale due to an insufficient factor loading, yielding a two-item latent construct. Accordingly, unit managers self-assessed unit adaptability and unit alignment as distinct, non-substitutable attributes rather than as opposing ends of a single continuum. Therefore, unit adaptability was measured with a three-item scale (e.g., "Management systems in this organization encourage employees in our organizational unit to question traditions, outdated practices, and sacred cows"), while unit alignment was measured with a 3-item scale (e.g., "Organization's management systems consistently support the overall goals of our organizational unit").

Cross-training was measured using a three-item scale adapted from Cua et al. (2021) and assessed via respondents' self-reports. The scale was adapted to the unit level with minor wording adjustments. Based on unit-level CFA results, one ordinal manifest item with an insufficient factor loading ("In your organizational unit, employees only learn how to do their part of the job/tasks (R)") was removed from the original four-item scale, resulting in a three-item first-order latent construct ("Employees in your organizational unit have undergone training to perform various tasks", "Employees in your organizational unit learn to perform different tasks/jobs", and "Your employees are cross-trained to substitute for each other when needed").

Unit performance is the outcome variable, a subjective unit-level performance measure developed by Gibson & Birkinshaw (2004). This four-item scale differs in timing from the measurement of previous variables. Respondents provided performance evaluations for multiple organizational units nested within their own organizations. The ordinal-scale manifest items were as follows: "This organizational unit is reaching its full potential", "Top managers

are satisfied with the performance level of this organizational unit", "This organizational unit does a good job of satisfying its [internal and/or external] customers", and "This organizational unit provides top managers the opportunity and encouragement to do their best managerial work".

3.3. Data Analysis

This study employs a single analytical approach, which tests the mediation effects of each model: Model 2 (unit adaptability–cross-training–unit performance) and Model 3 (unit alignment–cross-training–unit performance). Specifically, we use simple mediation analysis to examine the direct and indirect effects between predictor and outcome variables, to test whether each model has significant (partial) mediation, and whether it has no mediation. Firstly, survey data were prepared using MS Excel. To test the proposed mediation models, we conducted a prior regression analysis to verify the basic relationships on which the mediation analysis is based. Both mediation analyses were performed using the PROCESS macro for SPSS (Hayes, 2018), which applies OLS regression and automates the entire mediation model, including the estimation of the indirect (a x b) effects and their bias-corrected bootstrapped confidence intervals, providing greater statistical power and robustness.

4. Results

Table 1 presents the means, standard deviations, and Pearson's correlations among the four key variables in this study, based on a sample of 247 organizational units. All variables show positive and significant relationships, which is the central assumption for mediation analysis. Unit ambidexterity is positively associated with unit performance ($r = 0.439$, $p < 0.01$), indicating a moderate, statistically significant direct relationship. In addition, unit ambidexterity is positively related to cross-training ($r = 0.443$, $p < 0.01$), and cross-training is positively associated with unit performance ($r = 0.289$, $p < 0.01$). While the relationship between unit adaptability and cross-training ($r = 0.227$, $p < 0.0003$), and unit adaptability and unit performance ($r= 0.347$, $p < 0.0002$), is of weak to moderate strength, the positive and significant relationship between unit alignment and cross-training ($r = 0.522$, $p < 0.01$) is notably strong. Both unit adaptability and unit alignment are linked with cross-training, which supports testing its mediating role. All correlations are < .70, and all variance inflation factors are below the conservative threshold of 3 ($VIF_{unitamb} = 1.24$, $VIF_{adapt} = 1.05$, $VIF_{align} = 1.38$), thereby ruling out multicollinearity.

Table 1: Means (M), standard deviations (SD), and correlations

Variable	*M*	*SD*	1	2	3	4	5
1. Unit ambidexterity	14.35	4.50	-				
2. Unit adaptability	3.82	0.72	.818**	-			
3. Unit alignment	3.71	0.76	.830**	0.390**	-		
4. Cross-training	4.03	0.66	.443**	0.216**	0.510**	-	
5. Unit performance	4.02	0.62	.439**	0.347**	0.387**	0.289**	-

Notes: N = 253, M = Mean, SD = Standard deviation; ** $p < 0.01$. All correlations are two-tailed.

Source: Authors

While bivariate correlations provide preliminary support for the hypothesized relationship, Table 2 reports the results of regression analysis testing the conditional paths of the mediation models. To test the hypotheses, three separate yet simple regression analyses were performed.

Regression analyses indicate that unit ambidexterity significantly predicts cross-training (β = 0.07, SE = 0.01, p < .001), explaining a substantial proportion of variance in cross-training (R^2 = 0.2173). However, when both unit ambidexterity and cross-training are included in the model predicting unit performance, cross-training does not significantly predict unit performance (β = 0.11, SE = 0.06, p ≥ .05). Contrary, the direct effect of unit ambidexterity on unit performance remains statistically significant (β = 0.05, SE = 0.01, p < .001), indicating the absence of a mediation effect in Model 1. When predicting unit performance, Model 1 explains 21.73% of the variance, suggesting meaningful explanatory power. Therefore, although unit ambidexterity is positively related to cross-training, cross-training does not account for the relationship between unit ambidexterity and unit performance. Regression analyses indicate that unit adaptability significantly predicts cross-training (β = 0.21, SE = 0.06, p < .001), which in turn predicts unit performance when both variables are included in the model (β = 0.25, SE = 0.07, p < .001). The direct effect of unit adaptability on unit performance remains significant (β = 0.25, SE = 0.07, p < .001), suggesting a partial mediation pattern. On the other hand, although unit alignment is strongly related to cross-training (β = 0.46, SE = 0.05, p < .001), cross-training does not significantly predict unit performance once alignment is accounted for (β = 0.10, SE = 0.08, p ≥ 0.05). Across Model 2, unit adaptability explains a modest share of variance in cross-training (R^2 = 0.0513), whereas across Model 3, unit alignment explains a substantially larger share of variance (R^2 = 0.02728). When predicting unit performance, the models explain a moderate proportion of variance (R^2 is between 0.1224 and 0.1534), indicating meaningful but not exhaustive explanatory power. Notably, unit alignment shows a substantially stronger association with cross-training than unit adaptability does. In contrast, only unit adaptability shows a pattern in which cross-training is significantly related to unit performance.

Table 2: Regression results for mediation path analysis

	predictor → outcome variable	**path**	***β***	***S.E.***	***t***	***R^2***
Model 1	Unit ambidexterity → Cross-training	a	0.0690	0.0087	7.97***	0.2173
	Cross-training → Unit performance	b	0.1107	0.0621	1.78	0.2173
	Unit ambidexterity → Unit performance	c'	0.0533	0.0093	5.75***	
Model 2	Unit adaptability → Cross-training	a	0.2096	0.0576	3.64***	0.0513
	Cross-training → Unit performance	b	0.2467	0.0711	3.47***	0.1224
	Unit adaptability → Unit performance	c'	0.2486	0.0658	3.78***	
Model 3	Unit alignment → Cross-training	a	0.4554	0.0475	9.59***	0.2728
	Cross-training → Unit performance	b	0.1047	0.0797	1.31	0.1534
	Unit alignment → Unit performance	c'	0.3387	0.0695	4.87***	

Notes: *= p < .05; **= p < .01; ***= p < .001; β – unstandardized regression coefficients; S.E – standard error; t-test statistic

Source: Authors

Because the sampling distribution of indirect effects is rarely normal, mediation was tested using bootstrapped confidence intervals, which provide more accurate inference. Bootstrapped mediation analyses (5,000 samples) provide non-significant evidence for the mediating role of cross-training in the relationship between unit ambidexterity and performance (indirect effect = 0.0076, 95% CI [-0.001, 0.016]). However, we found a significant indirect effect of unit adaptability on unit performance via cross-training (indirect effect = 0.052, 95% CI [0.016, 0.098]). Because the confidence interval does not include zero, cross-training partially mediates

the relationship between unit adaptability and performance. Finally, the indirect effect of unit alignment on performance via cross-training is not statistically significant (indirect effect = 0.048, 95% CI [–0.025, 0.119]), suggesting no mediation.

Table 3: Indirect (bootstrapped) effects of unit adaptability and unit alignment on unit performance via cross-training (5,000 samples)

	Indirect effect	Boot SE	95% Boot CI	Mediation type
Model 1	0.0076	0.0044	[-0.0009, 0.0164]	not significant (no mediation)
Model 2	0.0517	0.0213	[0.0159, 0.0981]	significant (partial mediation)
Model 3	0.0477	0.0363	[-0.0249, 0.1185]	not significant (no mediation)

Notes: Indirect effects (a x b) are based on 5,000 bootstrap samples. Confidence intervals (CI) that do not include zero indicate significant mediation. N = 247.

Source: Authors

The results show that unit adaptability and unit alignment differ in their relationships with cross-training and unit performance, with only unit adaptability exhibiting a performance-relevant pathway via cross-training.

5. Discussion

The current single-level (multisource, two-wave) field research study found that cross-training partially affects the connection between unit adaptability and unit performance; however, it does not mediate the relationship between unit alignment and unit performance. Such a finding indicates that unit adaptability improves unit performance, both directly and indirectly through increased cross-training (Zhang et al., 2022). Conversely, unit alignment enhances unit performance only directly; cross-training does not mediate this relationship. These findings, which challenge conventional expectations, are further examined from both theoretical and practical perspectives.

5.1. Theoretical Implications

The findings indicate that both polarities of unit ambidexterity (unit adaptability and unit alignment) rely on distinct underlying mechanisms to improve unit performance. While unit adaptability operates through cross-training, unit alignment operates through independent alternative pathways. Organizational units that explore new ideas contextually, temporarily, or structurally (Enang & Rudd, 2025; Lavie et al., 2010) need to exhibit greater cognitive openness and behavioural flexibility among teammates. To foster innovativeness, teams need to continuously develop new skills and actively engage in collaborative work within their own or other organizational units. Contextually ambidextrous organizations (Fourne et al., 2019; Gibson & Birkinshaw, 2004) encourage unit managers to create collaborative learning environments that foster innovative behaviours among teammates, helping them achieve superior outcomes. Therefore, cross-training serves as a meaningful HR practice by shaping employees' cognitive frames, signalling that learning from one another's tasks and responsibilities broadens their perspective and facilitates the recognition of ideas and opportunities (Hopp & van Oyen, 2004). Consequently, cross-training serves as a bridge that translates abstract ideas into actionable plans and day-to-day operational practices. This does

not suggest that innovative teams cannot build a foundation for success without HR interventions; however, when present, such practices act as a social "torpedo" that propels teams toward more effective action.

On the other hand, teams that exploit existing competencies benefit less from cross-training and more from well-defined roles and aligned procedures. Aligned teams do not need additional education, as their roles focus on routine, coordination, optimisation, and productivity. Cross-training does not add value, since their tasks are already standardized and there is a clear division of labour within teams and formal structures across organizational units. Since unit alignment already has its incremental effect due to settled organizational strategic objectives and performance targets, cross-training is just a disruptive force. In this case, excessive information provision—a proxy for cross-training—can overload team members' cognitive capacities (Yun et al., 2024; Melkić et al., 2026) and trigger a "too-much-of-a-good-thing effect" (Pierce & Aguinis, 2013) which ultimately may impair their ability to effectively manage diverse tasks and undermine unit performance.

Contrary to widespread organizational beliefs, the study shows that cross-training is not universally beneficial but rather context-dependent, in our case, an innovation driver. Although unit alignment directly contributes to higher unit performance, unit adaptability can achieve comparable levels when organizations contextually support cross-training practices. Therefore, as a social amplifier, cross-training cannot serve as a "one-size-fits-all" applicable solution. Accordingly, this study does not privilege unit adaptability or unit alignment, nor does it frame cross-training as inherently beneficial or harmful. Rather, it rejects the notion of a single best solution and adopts a both-and approach central to organizational ambidexterity (Fairhurst & Putnam, 2024; Smith & Lewis, 2022).

5.2. Practical Implications

From a practical perspective, our research suggests that cross-training practice should be applied selectively rather than uniformly (Marchington & Grugulis, 2011). Top and unit managers should not automatically create or implement cross-training programs in both adaptive and aligned teams. In fact, they need to understand how organizational units and team roles are designed—whether they emphasize unit adaptability or alignment—and how these designs align with organizational goals and structures. Therefore, a differentiation strategy is a key to organizational success, as different unit ambidexterity demands require distinct HR architectures. Equally important, aligning the development of such HR practice with diverse teams may improve returns on investment, since cross-training is a well-established but time-, effort-, and resource-intensive practice (Ebeling & Lee, 1994). In simple terms, organizations should optimize cross-training investments based on which team type can create the most value. This study neglects a widely accepted managerial overgeneralisation that "everyone should be able to do everything".

5.3. Research Limitations and Future Research

Several limitations should be acknowledged. From a research design perspective, the chosen mediation models were grounded in causal logic (Nguyen et al., 2021) and used a two-wave, retrospective dataset, aligning with prior ambidexterity research (e.g., Gibson & Birkinshaw, 2004; Jansen, 2006). This approach reduces the risk of common-method bias and enhances empirical robustness. However, this design does not reach the gold standard of experimental (psychological) data and interventions that provide stronger causal evidence (Schmidt &

Pohler, 2018). Although retrospective or self-assessments are sometimes questioned for common-method bias, they remain accepted in organizational research (Huber & Power, 1985). Therefore, the study encourages future research to adopt longitudinal or experimental approaches to confirm our preliminary findings.

Moreover, although our study meets the minimum sample size requirement (Park & Yu, 2018), it is not ideal yet. We achieved the initial goal of including at least two unit managers from the same organization to ensure reliable, stable results. However, for a more comprehensive and robust sample, future research could replicate the study with all available unit managers within each organization. Since our empirical study involved large Croatian private organizations across various industries, the results may have limited generalizability. Nevertheless, no differences were found across industry types, regardless of the unit ambidexterity polarity (unit adaptability vs. unit alignment) considered. Due to the diverse nature of organizational unit structures, comparing the same business functions or divisions across organizations was not feasible. Future research should consider expanding the sample to include a broader range of organizational sizes, ownership types, more uniform organizational unit designs, and different institutional, economic, or cultural contexts (Carter, 2015).

Building on current limitations, future research should aim to improve the measurement of variables to enhance objectivity, even though perfect measurement cannot be achieved (Rucker et al., 2011). Instead of relying solely on limited monitoring of top managers to assess unit performance, it is better to use a multimethod research design or objective performance metrics, such as KPIs, for a more complete picture. Additionally, rather than measuring unit ambidexterity and cross-training through self-reports using validated scales, future studies could incorporate behavioural indicators to provide a more accurate assessment. Although SPSS showed no statistically significant differences across industries, future studies should include additional theoretically meaningful control variables (Bernerth & Aguinis, 2016), such as organizational unit status characteristics (e.g., unit status, unit type, unit position within the hierarchy).

From a conceptual perspective, future studies should assess whether conclusions differ when unit adaptability and unit alignment are modelled independently versus jointly, with unit ambidexterity as an interaction with unit performance. Given that ambidexterity is a multilevel phenomenon in real organizational settings, future studies should broaden the research model to include the organizational or individual level (two-level design) or both (three-level design) to capture both the contextual and behavioural processes underlying cross-training's impact. In that way, scholars may examine whether the moderating role of cross-training is consistent across levels or context-specific. Additionally, the cross-training construct can be further developed by accounting for temporal sequencing, contextual embeddedness, and structural design. Moreover, the studies could not only explore cross-training as a mediator, but also whether it serves as a boundary condition. We confirmed that cross-training partially mediates the relationship between unit adaptability and unit performance, suggesting that other unexplored mechanisms or boundary conditions may also drive the causal relationship (Rucker et al., 2011). Novel research should consider additional job design practices or characteristics (e.g., human capital paradox – specialist vs. generalist) that could shape this relationship.

6. Conclusion

This study enhances understanding of unit ambidexterity by demonstrating how its dimensions

(unit adaptability and unit alignment) influence unit performance through cross-training. We found that cross-training mainly boosts unit adaptability rather than establishing unit alignment, indicating it is not a universal solution, as many organizations intuitively believe. Instead, it serves as a context-dependent HR practice that drives innovation. While cross-training enhances the performance of adaptive units, it does not improve the effectiveness of aligned units. The research helps organizational managers decide when cross-training is advantageous and when it may not add value, especially for units that rely on stability and routines.

Conflict of interest statement: The authors have no conflict of interest to declare.

Data availability statement: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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A scientific paper

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REAL OPTIONS AND ESG: A BIBLIOMETRIC ANALYSIS OF AN EMERGING RESEARCH FIELD

ABSTRACT

The growing importance of Environmental, Social, and Governance (ESG) considerations has reshaped corporate investment and strategic decision-making under uncertainty. While real options theory offers a well-established framework for valuing managerial flexibility, its connection to ESG-related research remains dispersed. The aim of this paper is to map the academic literature at the intersection of real options and ESG and to identify its main research directions and intellectual structure.
The study applies a bibliometric analysis based on a systematic literature review following PRISMA guidelines. Peer-reviewed English-language journal articles were retrieved from the Scopus database using predefined keyword combinations related to real options, strategic flexibility, and ESG. After screening and eligibility assessment, 116 articles were included in the final sample. Performance analysis, citation analysis, and keyword co-occurrence network analysis were conducted using VOSviewer to identify thematic clusters and research trends.
The results indicate a clear increase in academic interest in ESG-related real options research, particularly after 2015. Three dominant thematic clusters emerge: sustainability and corporate social responsibility, strategic investments and corporate governance, and environmental risk and uncertainty management. Governance mechanisms and strategic flexibility appear as key linking elements between real options theory and ESG applications. The findings reveal a fragmented but rapidly developing research field with significant opportunities for further conceptual integration and empirical investigation.

Key words: *Real Options, ESG, Bibliometric Analysis, Uncertainty, Managerial Flexibility.*

1. Introduction

In recent years, environmental, social, and governance (ESG) considerations have become core elements of corporate strategy and investment decision-making. While corporate sustainability once occupied a peripheral position, ESG issues are now firmly embedded in strategic agendas across industries (Surroca et al., 2010). This shift is driven by intensifying regulatory pressures (Chen et al., 2024; Shui et al., 2025), growing societal awareness of environmental and social challenges (Calculli et al., 2021; Agrawal et al., 2023), and heightened stakeholder expectations regarding corporate responsibility (Mella & Gazzola, 2018; Salman et al., 2024).

At the same time, ESG-oriented investments are characterized by substantial uncertainty. Regulatory frameworks related to environmental protection, social standards, and governance practices continue to evolve, while technological innovation and changing stakeholder preferences introduce additional unpredictability (Bin-Feng et al., 2024; Chibane & Joubrel, 2024). These uncertainties complicate traditional investment appraisal methods, which typically rely on static forecasts and assume irreversible commitment. Consequently, firms face the challenge of balancing sustainability objectives with financial performance under conditions of heightened uncertainty.

In this context, real options theory has gained prominence as a framework for managing uncertainty in strategic investment decisions (Dixit & Pindyck, 1994; Trigeorgis, 1996). By conceptualizing investments as options rather than irreversible commitments, real options analysis explicitly values managerial flexibility, such as the ability to defer, expand, contract, or abandon projects as new information becomes available (Trigeorgis & Reuer, 2017). The potential complementarity between ESG considerations and real options thinking has only recently begun to attract systematic scholarly attention.

This study addresses this gap by providing a bibliometric analysis of the literature at the intersection of real options theory and ESG. By mapping the structure, dominant themes, and emerging research directions of this interdisciplinary field, the study seeks to clarify how real options thinking is being applied to sustainability-related investment challenges and to identify opportunities for future research. In doing so, this study contributes to the literature in three ways. First, it systematizes the emerging intersection between real options theory and ESG-related research, a nexus that remains fragmented across finance, strategy, and sustainability studies. Second, by applying bibliometric methods and VOSviewer-based mapping, the paper provides a structured overview of the intellectual and thematic evolution of this research field. Third, it identifies key publication trends, influential contributors, and underexplored research directions, thereby offering a basis for future conceptual and empirical work.

Beyond their immediate financial implications, ESG considerations increasingly shape firms' strategic positioning under uncertainty. ESG-related decisions often involve irreversible commitments, long investment horizons, and path-dependent outcomes, making early strategic choices particularly consequential (Busch et al., 2015; Kräussl et al., 2023). As a result, firms must not only assess whether to invest in sustainability initiatives, but also determine the appropriate timing, scale, and sequencing of such investments.

Traditional capital budgeting tools are not suitable to address these challenges, as they typically abstract from uncertainty resolution and adaptive decision-making. This critique is consistent with earlier valuation research, which emphasizes that conventional DCF-based approaches, although still highly influential in practice, may fail to capture the strategic value of managerial flexibility and therefore motivate the use of real options logic in more uncertain decision environments (Ulbert et al., 2017). This limitation is especially pronounced in ESG contexts, where regulatory intervention, technological disruption, and stakeholder reactions can substantially alter project payoffs over time (Kapil & Rawal, 2023; Ma, 2023). Consequently, there is growing interest in decision frameworks that explicitly recognize uncertainty as a source of strategic value rather than merely as a risk to be minimized.

Real options theory offers such a perspective by framing ESG investments as strategic positions that generate future choice rather than fixed outcomes. By embedding flexibility into

sustainability-oriented decision-making, firms can reconcile long-term ESG objectives with short-term performance pressures. This conceptual alignment suggests that ESG and real options are not merely compatible, but potentially mutually reinforcing components of strategic investment analysis.

2. Literature review

2.1. The ascendancy of ESG

The growing prominence of ESG reflects a broader recognition that corporate performance cannot be assessed solely through short-term financial metrics (Epstein & Roy, 2005; Mihalcová et al., 2017). Investors, regulators, and other stakeholders increasingly evaluate firms based on their environmental impact, social responsibility, and quality of governance (Gaa, 2009; Eccles et al., 2014). The environmental dimension typically includes emissions reduction and resource efficiency (Kocmanová & Simberová, 2014; Senadheera et al., 2021), the social dimension encompasses labor practices and community engagement, while governance focuses on transparency, accountability, and risk management (Campanella et al., 2021; Brogi & Lagasio, 2025).

A growing body of empirical research suggests that ESG performance can be linked to financial outcomes such as firm value, profitability, and cost of capital (Friede et al., 2015; Hartzmark & Sussman, 2019; Aydogmus et al., 2022). Intangible benefits - including enhanced reputation, stronger stakeholder relationships, and improved regulatory standing - may translate into long-term competitive advantages (Steyn, 2014). At the same time, ESG factors are increasingly recognized as material risks, as failure to comply with environmental regulations or adapt to social expectations can undermine future profitability (Busch et al., 2015).

Despite its growing relevance, ESG-driven investment remains highly uncertain. Sustainability initiatives typically involve long time horizons and evolving external conditions, including regulatory change and technological disruption (Kapil & Rawal, 2023; Ma, 2023). Technological advancements in renewable energy and clean technologies create both opportunities and risks, reshaping business models and investment strategies (Xinyu et al., 2024; Moghadam & Karami, 2024). These characteristics underscore the need for decision-making frameworks that explicitly account for uncertainty and flexibility.

From a strategic management perspective, ESG considerations increasingly influence firms' access to capital, cost structures, and growth opportunities. Empirical evidence suggests that firms with strong ESG performance may benefit from lower financing costs and enhanced investor demand, particularly from institutional investors integrating sustainability criteria into portfolio allocation decisions (Halbritter & Dorfleitner, 2015; Lee et al., 2021). These financial effects reinforce the strategic relevance of ESG by linking sustainability performance to firms' competitive positioning in capital markets.

At the same time, the relationship between ESG and financial performance is neither linear nor uniform across firms and industries. While moderate ESG engagement may enhance firm value and reduce downside risk, excessive or poorly aligned ESG investment can generate diminishing returns or managerial inefficiencies (de la Fuente et al., 2022). This heterogeneity highlights the importance of strategic discretion in ESG decision-making, as firms must

calibrate sustainability investments to their specific risk profiles, resource constraints, and institutional environments.

ESG initiatives often generate option-like strategic assets—such as reputational capital, regulatory goodwill, or technological capabilities—that may not yield immediate financial returns but enhance firms' ability to respond effectively to future environmental or social shocks. In this sense, sustainability-oriented investments can be interpreted as strategic positions that create future flexibility rather than short-term payoffs (Orsato, 2006; Steyn, 2014). These features underscore the limitations of static valuation approaches and highlight the need for frameworks capable of capturing contingent and forward-looking benefits.

2.2. Real Options Theory: Addressing Uncertainty and Flexibility

Real options theory provides a framework for evaluating investment decisions under uncertainty by treating strategic investments as analogous to financial options (Dixit & Pindyck, 1994; Trigeorgis, 1996). Unlike traditional net present value approaches, which require "now-or-never" decisions based on static forecasts, real options analysis recognizes the value of managerial flexibility, allowing firms to adapt investment decisions over time (Smit & Trigeorgis, 2004).

By explicitly valuing the option to wait and respond to new information, real options analysis can reveal strategic value that conventional valuation methods tend to overlook. Projects that appear unattractive under high uncertainty using NPV may become viable once flexibility is incorporated (Morreale et al., 2020). This perspective has proven particularly useful in industries characterized by irreversible investments and volatile environments, such as natural resources, infrastructure, R&D, and renewable energy (Martínez Ceseña et al., 2013).
Real options theory should not be understood solely as a valuation technique, but also as a strategic way of thinking about investment decisions under uncertainty. As emphasized by Triantis and Borison (2005), the core contribution of real options lies in its ability to structure managerial decision-making by explicitly accounting for flexibility, learning, and the sequential nature of strategic choices. Rather than focusing exclusively on numerical valuation outcomes, the real options perspective encourages managers to frame investments as adaptive processes, where decisions evolve over time in response to new information and changing environmental conditions. This interpretation is particularly relevant in ESG-related contexts, where long-term uncertainty, irreversibility, and institutional dynamics often limit the applicability of static evaluation methods and require a more flexible, forward-looking strategic mindset.

2.2.1. Synergies Between ESG and Real Options

The uncertain and long-term nature of many ESG initiatives makes them particularly well suited to real options analysis. ESG-related investments can be interpreted as contexts in which strategic value depends not only on the magnitude of uncertainty, but also on whether firms possess the flexibility required to respond to changing regulatory, technological, or market conditions (Csapi, 2013). ESG investments often involve staged commitments and contingent payoffs, enabling firms to manage downside risks while preserving upside potential (Agaton, 2022). Real options logic allows firms to treat sustainability initiatives not merely as compliance costs, but as strategic investments that create future growth opportunities.

Moreover, real options theory can capture the value of intangible benefits associated with ESG initiatives, such as reputation, stakeholder trust, and license to operate, which are difficult to monetize using traditional valuation methods (Schwartz & Trigeorgis, 2001; Steyn, 2014). Proactive environmental strategies may generate future competitive advantages once regulatory standards or societal expectations shift, consistent with the notion of a "sustainability premium" (Orsato, 2006).

In practical terms, the real options perspective encourages firms to adopt staged and adaptive approaches to ESG investment. Rather than committing to large-scale sustainability projects upfront, firms may initiate pilot programs, modular investments, or reversible initiatives that preserve future flexibility (Agaton, 2022). Such approaches are particularly relevant in regulatory environments characterized by policy uncertainty, where premature commitment may expose firms to adverse regulatory shifts.

The value of flexibility is also evident in geographic and technological dimensions of ESG investments. Firms operating across multiple jurisdictions may face heterogeneous ESG regulations and enforcement regimes, making location-specific real options—such as the option to expand, contract, or relocate sustainable operations—especially valuable (Smit & Trigeorgis, 2004). Similarly, investments in emerging clean technologies can be structured to allow future scaling or abandonment as technological trajectories and cost curves become clearer.

By framing ESG initiatives as portfolios of real options, managers can explicitly incorporate learning effects, uncertainty resolution, and strategic adaptation into investment appraisal. This perspective shifts the evaluation of ESG projects away from static cost–benefit analysis toward a dynamic assessment of strategic pathways. As a result, real options analysis not only complements ESG decision-making, but also provides a coherent logic for integrating sustainability objectives into broader corporate strategy under uncertainty.

2.2.2. Emerging Integration of Real Options into ESG Decision-Making

Recent studies have begun to explicitly integrate real options frameworks with ESG-oriented decision-making. Formal real options models show how ESG-related risks can shape investment choices under uncertainty. Nishihara (2023) models sustainable and unsustainable investment opportunities with ESG risk represented as the random termination of cash flows, demonstrating how higher ESG risk, volatility, and certain economic parameters influence the timing and selection of sustainable investments in a real options context. Other contributions conceptualize ESG initiatives as portfolios of options, including the option to initiate, scale, or abandon sustainability efforts depending on external conditions (Borges et al., 2023).

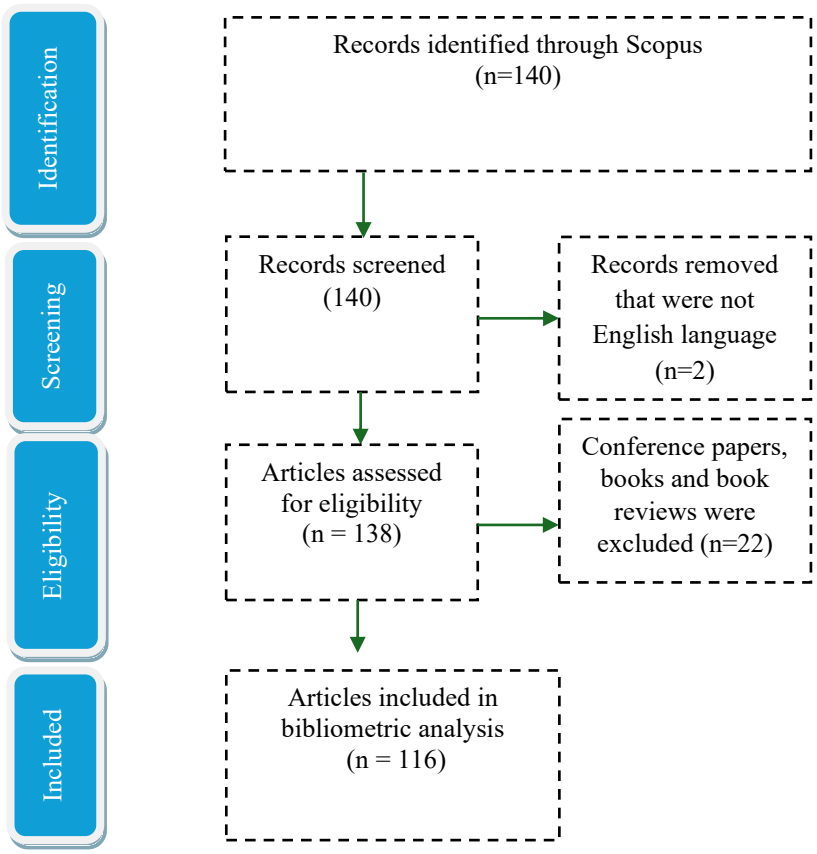
Additional research expands valuation perspectives by introducing the concept of sustainability or societal real options, emphasizing that ESG investments may generate value beyond the firm by reducing systemic risks such as climate change (Smit, 2025). Empirical evidence further suggests a nuanced relationship between ESG engagement and firm value, indicating that moderate ESG investment may enhance growth options, while excessive investment can yield diminishing returns (de la Fuente et al., 2022).

These emerging conceptual integrations are reflected in the thematic clusters identified in the bibliometric analysis, particularly those related to governance, uncertainty, and strategic investment decisions.

3. Methodology

To synthesize the literature, this study employs a bibliometric analysis based on peer-reviewed articles indexed in the Scopus database. Following PRISMA guidelines (Moher et al., 2009) a structured search strategy was used to identify publications addressing real options, managerial flexibility, and strategic investment under uncertainty in relation to ESG-related concepts ("real option*" OR "managerial flexibilit*" OR "strategic flexibilit*" OR "strategic investment*" OR "irreversible investment*" OR "investment under uncertainty") AND ("ESG" OR " environ*social*govern* " OR "ESG criteria" OR "ESG factors" OR "corporate governance" OR "social responsibilit*" OR "environmental risk"). After screening and refinement, 116 English-language journal articles were included in the final sample (Figure 1).

Figure 1: PRISMA diagram



Source: Authors

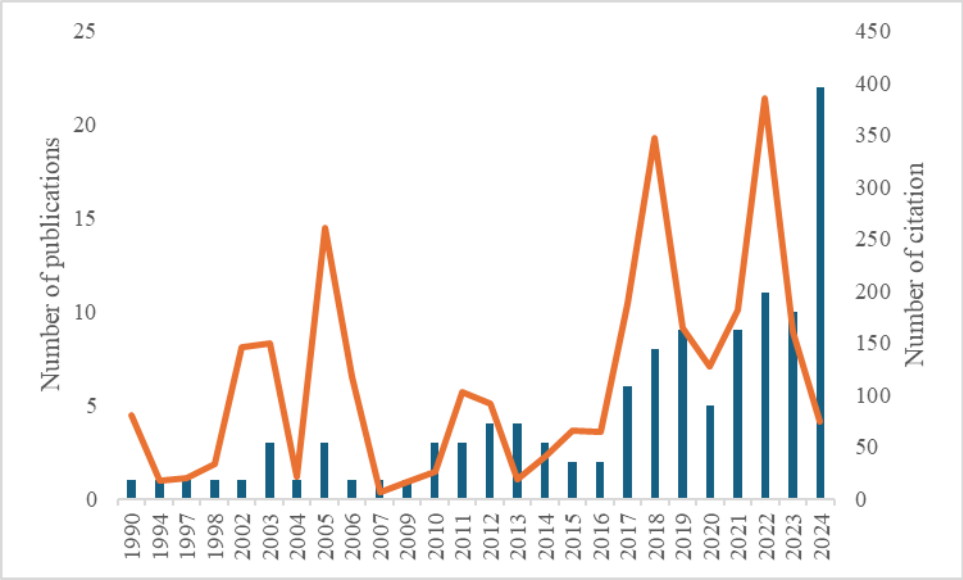
The analysis combines performance indicators with network-based techniques, including co-citation analysis and keyword co-occurrence mapping, using VOSviewer for visualization (Van Eck & Waltman, 2010). This approach enables systematic identification of dominant themes, collaboration patterns, and emerging research clusters.

3.1. Citation Analysis

Firstly, for the selected studies, we conducted performance, keyword co-occurrence, and author network analyses, using VOSviewer (Van Eck & Waltman, 2010) for visualization. *The performance analysis* included: (1) total publications per year; (2) citation metrics (e.g., average citations per article, h-index distributions); and (3) rankings of the most influential

authors, institutions, and journals. Figure 2 provides a comprehensive visual representation of the bibliometric trends related to the relationship between real options and ESG, based on data extracted from the Scopus database from 1990 to 2024. During the early 1990s and early 2000s, the number of publications on the topic was minimal, reflecting limited scholarly interest. The years following 2006 show a gradual increase in publication counts, suggesting a growing awareness of the intersection between real options and sustainability dimensions. This increase aligns with the global rise of ESG discussions, particularly following the 2008 financial crisis, which emphasized corporate governance and risk management. A significant increase in publications is observed post-2015, peaking around 2021. This period coincides with heightened global attention to climate change (e.g., the Paris Agreement in 2015) and corporate sustainability initiatives. The surge in research output during this time indicates a convergence of ESG principles with real options applications in investment decision-making.

Figure 2: Article published between 1990 and 2024



Source: Authors

In the citation analysis, influential research articles and authors were identified. "Risk management, real options, corporate social responsibility" by Husted (2005) stands as the most cited article, with 216 citations. This work underscores the integration of real options into CSR by emphasizing the role of risk management in strategic decision-making. The most recent article, "Corporate transformation toward Industry 4.0 and financial performance: The influence of ESG" by Alkaraan et al. (2022), achieves the highest average citations per year (65.67), reflecting its immediate relevance and strong influence, particularly in linking ESG factors with Industry 4.0–driven corporate transformation.

The study "Does market competition dampen environmental performance? Evidence from China" by Duanmu, Bu, and Pittman (2018) also emerges as one of the most influential articles in the dataset, with 207 total citations and a high average citation rate (29.57). This study provides robust empirical evidence that market competition can weaken firms' environmental performance by constraining managerial discretion and long-term investment capacity. It further highlights the strategic relevance of competitive and governance-related factors in shaping ESG outcomes.

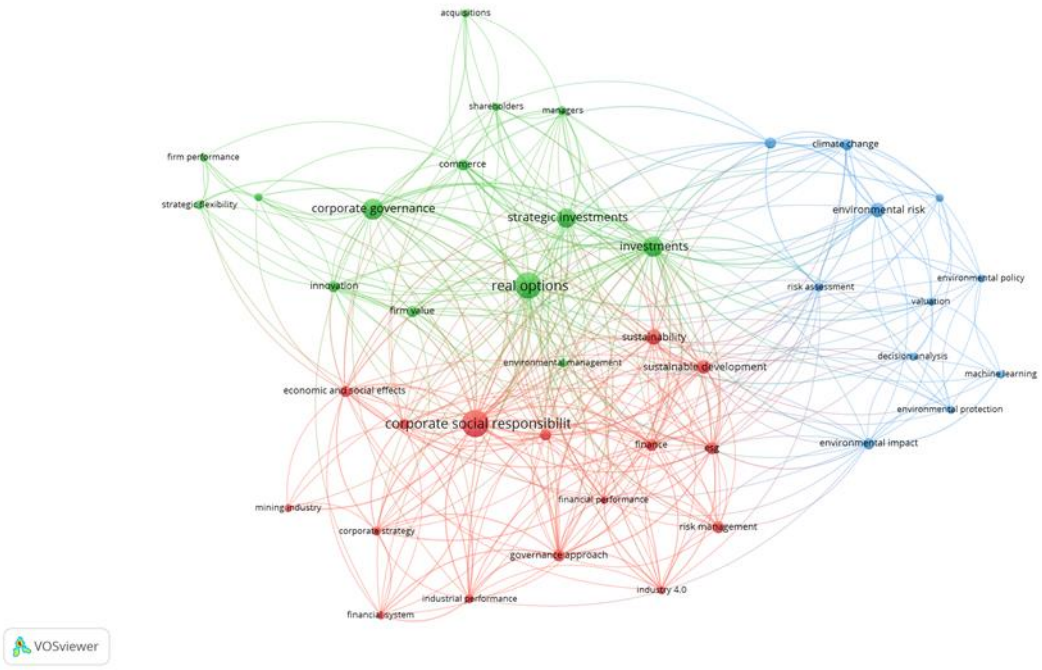
Other influential contributions, such as "Building competitive advantage: Innovation and corporate governance in European construction" (Miozzo & Dewick, 2002) and "Corporate governance, strategy and survival in a declining industry" (Filatotchev & Toms, 2003), continue to maintain scholarly impact despite having been published more than two decades ago. These works emphasize the role of corporate governance and strategic adaptability, which form important conceptual foundations for subsequent ESG-focused research. Notably, two of these highly cited articles were published in the Strategic Management Journal, highlighting its central role in fostering discourse on real options–based and ESG-related research within the strategic management domain.

3.2. Keyword Analysis

To identify key themes and research trends within a given field, keyword analysis was conducted as it enables the visualization of the intellectual structure and thematic evolution of literature (Van Eck & Waltman, 2010). Table 4 shows the identified keywords with a frequency of three or more (n≥3). The most frequently used key terms are „CSR", „real option" (31), „governance" (20) and investments (19). Figure 3 shows the keywords on occurrence level, divided into 5 clusters.%

The analysis revealed 41 items, 346 links, and a total link strength of 566. This indicates a moderately dense network where the elements (e.g., publications, keywords, authors) are highly interconnected. The total link strength reflects the intensity of these connections, suggesting strong relationships within the topic. Such results highlight an active research area with significant interrelations and collaboration.

Figure 3: Network visualization map

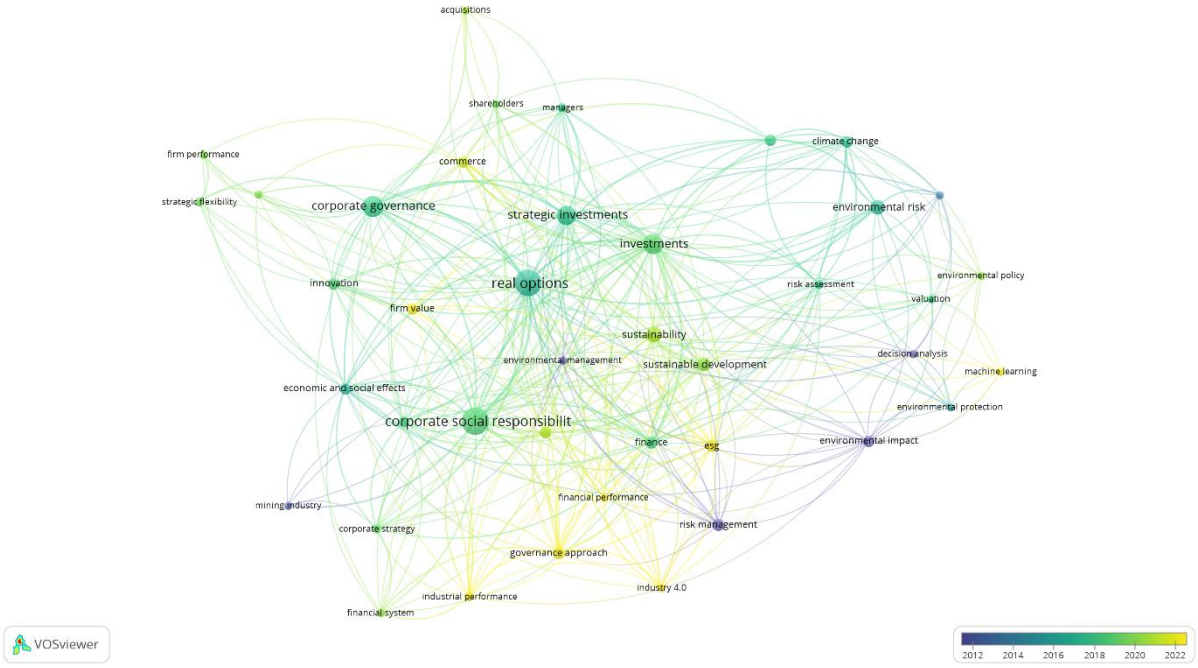


Source: Authors

The overlay visualization provides additional analysis options. This method lies in associating additional temporal or contextual information (e.g., average publication year or other attributes) with the elements displayed on a bibliometric map, such as keywords, authors, or

publications. Using a color scale, this method visualizes when a particular element was most active or relevant (Van Eck & Waltman, 2010). This type of visualization is particularly suitable for illustrating the evolution of research trends and the renewal of examined topics over time. On Figure 4, the blue and green represent earlier publications, while yellow marks more recent ones. The real options and CSR have a longer-standing presence in the research literature, while ESG have gained prominence in recent years.

Figure 4: Overlay visualization map



Source: Authors

Cluster 1: Environmental Risks and Sustainable Decision-Making

The central theme of the first cluster is managing environmental risks and uncertainties within the ESG framework. The most frequently occurring keywords, such as "environmental risks" (10) and "climate change" (6), indicate that the studies focus on decision-making processes and optimization strategies aimed at achieving environmental sustainability (Friede et al., 2015). Keywords like "environmental impacts" (6) and "uncertainty analysis" (6) are closely related to the assessment of environmental and sustainability-related risks in decision-making contexts, particularly under climate-related uncertainty (Sarkis & Zhu, 2018). Sarkis and Zhu (2018) integrating ESG factors into financial decision-making creates opportunities to reduce risks and promote long-term sustainability.

The frequent keywords "environmental policies" (3) and "evaluation" (3) emphasize that regulations and the financial evaluation of projects are key factors in ensuring sustainable development. The impacts of environmental policies and regulations have been studied using real options models (Trigeorgis, 1996). Lastly, recurring keywords such as "risk assessment" (4) and "environmental protection" (3) highlight the importance of environmental protection in sustainability strategies. These elements are closely tied to the practical application of the ESG framework, especially in projects aimed at resource efficiency and long-term economic value creation.

Cluster 2: Sustainability Strategies and ESG Frameworks

The central theme of the second cluster is the integration of sustainability and ESG-based strategies in relation to corporate performance and risk management. Keywords such as "sustainability" (11), "sustainable development" (9), and "ESG" (7) highlight the significance of sustainable development and ESG frameworks in strategic decision-making (Eccles et al., 2014). The presence of "finance" (7) and "financial performance" (3) indicates that ESG approaches can positively impact financial outcomes (Aydogmus et al., 2022) and minimize risks. Keywords like "risk management" (7) and "corporate governance" (7) emphasize the role of corporate governance in addressing ESG-related risks. Simultaneously, the keywords "strategic approach" (6) and "Industry 4.0" (3) suggest an emerging and increasingly discussed relationship between sustainability strategies and Industry 4.0 technologies.

Cluster 3: Real Options and Corporate Governance

The third cluster focuses on corporate decision-making flexibility, particularly in the context of real options and corporate governance. The dominant keyword, "real options" (31), highlights the role of real options in ensuring strategic flexibility and managing uncertainties (Dixit & Pindyck, 1994). Keywords like "corporate governance" (20) and "managers" (4) are prominent, as the studies often explore the relationship between strategic investments and governance practices (Shleifer & Vishny, 1997). The emphasis on "agency theory" (3) reflects its significance in governance-related research, focusing on the interactions between managers (4) and shareholders (3). Keywords like "strategic flexibility" (4) and "innovation" (6) underline the importance of adaptability in business decisions, especially in rapidly changing economic environments. Additionally, "acquisitions" (3) and "commerce" (6) indicate a broader investigation into corporate acquisitions and business strategies.

Cluster 4: Corporate Social Responsibility (CSR) and Financial Impacts

The fourth cluster revolves around corporate social responsibility (CSR), which is the most frequently mentioned keyword (34). This suggests that the cluster mainly focuses on strategies and impacts related to CSR, particularly considering economic and social aspects. The keyword "economic and social impacts" (6) emphasizes that CSR activities have effects not only at the corporate level but also on broader societal and economic scales (Carroll, 1979; Friede et al., 2015). The presence of "profitability" (5) and "corporate strategy" (4) suggests that CSR strategies not only serve social goals but also positively influence long-term profitability and strategic positioning. Keywords like financial system (3) and industry performance (4) indicate that the studies also examine sector-specific CSR practices and the financial repercussions of such initiatives (Margolis et al., 2009).

Cluster 5: Investment Decisions and Strategic Investments

The core element of the fifth cluster is corporate investments and related decision-making processes, with a particular focus on strategic investments and managerial roles. Dominant keywords like "investments" (19) and "strategic investments" (17) indicate that the studies primarily analyze corporate investment decisions, focusing on their strategic significance. Keywords like "acquisitions" (3) and "shareholders" (3) suggest that the studies consider the role of corporate acquisitions and shareholder interests in investment decisions. The keyword "managers" (4) emphasizes the role of managers in decision-making, particularly in overseeing strategic investments. This implies that the cluster analyzes the relationship

between managerial decisions and corporate strategy, especially in uncertain economic environments where flexibility is crucial (Malmendier & Tate, 2005).

3.2.1. Concluding Remarks on Bibliometric Analysis

The combined use of bibliometric techniques, systematic screening, and performance analyses offers a robust framework for understanding how real options research is merging with ESG themes in academic literature. By evaluating leading authors, institutions, and journals, as well as identifying thematic clusters, we gain insight into the intellectual structure of this emerging research stream. These findings provide a basis for future investigations on how real option frameworks can integrate sustainability and governance dimensions more effectively, thereby shaping both scholarly work and corporate practice in an era of heightened ESG awareness.

At the same time, several methodological considerations should be acknowledged. First, the analysis is based exclusively on the Scopus database, which, despite its broad coverage, may not capture all relevant publications indexed elsewhere. Second, the study deliberately focuses on peer-reviewed English-language journal articles in order to ensure consistency and comparability within the bibliometric sample. Third, bibliometric methods are particularly useful for identifying structural patterns, citation relationships, and thematic developments, but they do not provide in-depth qualitative insights into the theoretical or empirical substance of individual studies. Accordingly, the results should be interpreted as a structured overview of the field rather than an exhaustive conceptual assessment.

4. Conclusion

Building on the preceding bibliometric results, this study synthesizes the emerging body of literature at the intersection of real options theory and environmental, social, and governance (ESG) considerations. By applying bibliometric techniques to a systematically selected sample of 116 peer-reviewed articles, the analysis reveals not only the thematic structure of this research field but also its conceptual fragmentation and developmental trajectory. The findings suggest that while real options theory and ESG research have evolved largely independently, their convergence has accelerated in response to growing uncertainty surrounding sustainability-related investment decisions.

A central insight emerging from the identified thematic clusters is the prominence of uncertainty as a unifying analytical concern. Environmental risk, regulatory volatility, technological disruption, and stakeholder pressure occur across multiple clusters, underscoring that ESG-related challenges are increasingly framed as strategic uncertainty rather than purely ethical or compliance issues (Busch et al., 2015; Kapil & Rawal, 2023). This shift helps explain the growing relevance of real options theory, which explicitly treats uncertainty as a source of managerial value rather than as a factor to be eliminated. From this perspective, ESG investments are increasingly conceptualized not as static commitments, but as dynamic strategic positions that embed future choice.

The environmental risk and sustainable decision-making cluster illustrates how real options logic is applied to climate-related uncertainty and environmental regulation. Studies in this cluster frequently emphasize the irreversibility of environmental investments and the long-term consequences of early strategic choices, particularly in contexts such as renewable energy, emissions reduction, and environmental protection (Trigeorgis, 1996; Martínez

Ceseña et al., 2013). The bibliometric evidence suggests that real options models are increasingly used to evaluate staged investment strategies, allowing firms to defer or scale sustainability initiatives as regulatory clarity improves or technologies mature. This approach contrasts sharply with traditional capital budgeting methods, which tend to undervalue flexibility and may discourage proactive environmental investment under uncertainty.

The sustainability strategies and ESG frameworks cluster highlights a complementary but distinct research stream, in which ESG is framed as a strategic resource rather than a risk management constraint. Studies in this cluster link ESG engagement to financial performance, access to capital, and long-term competitive advantage (Friede et al., 2015; Hartzmark & Sussman, 2019; Lee et al., 2021). However, the bibliometric results also reflect ongoing debate regarding the optimal level and configuration of ESG investment. The inverted U-shaped relationship identified in prior empirical research suggests that while ESG engagement can enhance firm value, excessive or misaligned investment may generate diminishing returns (de la Fuente et al., 2022). Real options theory offers a conceptual mechanism for addressing this tension by enabling firms to calibrate ESG investments incrementally, preserving flexibility while accumulating strategic capabilities over time.

Corporate governance emerges as a key linking element between real options and ESG across multiple clusters. The prominence of governance-related keywords indicates that managerial discretion, incentive alignment, and organizational structures play a critical role in shaping how firms respond to ESG-related uncertainty (Shleifer & Vishny, 1997; Brogi & Lagasio, 2025). From a real options perspective, governance mechanisms influence not only whether firms engage in sustainability initiatives, but also how effectively they can exercise strategic options such as deferral, expansion, or abandonment. Weak governance may lead to either underinvestment in ESG due to short-termism or overinvestment driven by managerial self-interest, while strong governance structures can facilitate balanced, flexibility-oriented decision-making.

The cluster focusing on corporate social responsibility (CSR) and financial impacts reflects the historical roots of ESG research and its normative foundations. While earlier CSR-oriented studies often emphasized ethical responsibility and stakeholder value creation (Carroll, 1979; Margolis et al., 2009), more recent contributions increasingly frame CSR activities as strategic investments with option-like characteristics. The bibliometric results suggest a gradual shift from purely normative interpretations toward hybrid perspectives that integrate ethical considerations with strategic adaptability. Real options theory provides a unifying framework capable of reconciling these perspectives by valuing both moral commitment and future strategic flexibility.

The identified clusters reveal a research field that is intellectually rich but methodologically fragmented. While real options models are well developed in specific application domains—such as energy, infrastructure, and environmental policy—their integration with ESG measurement frameworks remains limited. One persistent challenge concerns the monetization of ESG outcomes, particularly social and governance-related benefits that are difficult to quantify and context-dependent (Eccles et al., 2014). As a result, many studies apply real options logic conceptually without fully operationalizing ESG metrics within valuation models. This gap represents both a limitation of the current literature and a promising avenue for future research.

From a practice-oriented point of view, the findings underscore the relevance of real option thinking for managers navigating sustainability-related investment decisions. Bibliometric evidence suggests that firms increasingly face ESG challenges characterized by long horizons, irreversible commitments, and evolving stakeholder expectations. In such environments, flexibility-oriented strategies—such as staged investment, pilot projects, and modular implementation—can help reconcile sustainability objectives with financial discipline (Agaton, 2022). By viewing ESG initiatives as portfolios of real options rather than fixed projects, managers can better align sustainability efforts with broader corporate strategy under uncertainty.

For policymakers and regulators, the results highlight the importance of regulatory stability and transparency in shaping the option value of ESG investments. Uncertain or inconsistent policy signals can delay investment by increasing the value of waiting, while credible long-term commitments may encourage firms to exercise growth options in sustainable technologies (Nishihara, 2023). Understanding these dynamics can support the design of regulatory frameworks that incentivize proactive ESG investment without imposing excessive rigidity.

Overall, this study demonstrates that real options theory provides a powerful integrative lens for understanding ESG-related investment decisions under uncertainty. By reframing sustainability initiatives as portfolios of strategic options rather than fixed commitments, the findings highlight how managerial flexibility can reconcile long-term ESG objectives with short-term performance pressures. For both scholars and practitioners, the results underscore the value of moving beyond static evaluation frameworks toward adaptive, uncertainty-aware approaches to sustainable strategy.

AI STATEMENT

Generative AI tools were used solely for language refinement and stylistic editing. The authors remained fully responsible for the conceptualization, analysis, interpretation, and final content of the manuscript.

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A scientific paper

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ANALYSIS OF THE IMPACT OF SUPPLY CHAIN MANAGEMENT FACTORS ON THE COMPETITIVE ADVANTAGE OF LODGING UNITS UTILIZING THE AIRBNB PLATFORM

ABSTRACT

The objective of this research is to examine the influence that the implementation of supply chain management has on the competitive advantage of housing units that are making use of the Airbnb platform. A survey was administered to the managers of lodgings in the counties of Zadar and Lika-Senj in order to conduct the research. The total number of responders was 89. Information technology, relationships with customers and suppliers, and value-added processes are supply chain management factors that were analyzed in the poll. The research approaches that were utilized were descriptive statistics, factor analysis, and regression analysis. All of the factors that were analyzed were shown to have a statistically significant and favorable impact on competitive advantage, according to the results of the study. The most significant contribution is made by the supplier relationship. The results of the research show that successful management of all facets of the supply chain is a critical factor for achieving long-term success and sustainability in the hospitality industry, which is presently undergoing a period of growing digitization. The results that have been discovered are able to serve as a framework for managers and can provide information that is beneficial for making business decisions that are meant to boost competitiveness and customer satisfaction in the hospitality industry.

Key words: *Supply chain management, hospitality industry, Airbnb, competitive advantage.*

1. Introduction

In recent years, the growth and transformation of the tourism industry, driven by advanced digital platforms, have radically changed traditional business models and business processes within the short-term rental sector. Airbnb, as one of the world's leading platforms, has enabled a wide range of private hosts to access the global market, but at the same time has brought new challenges in terms of supply chain management, supplier relationships and guest expectations (Li et al., 2023). At the heart of these changes is primarily information technology (IT), which has become a key tool for successful business on Airbnb. Information and communication systems enable the automation of reservations, dynamic pricing, monitoring of reviews and ratings, digitalization of the billing process, and real-time availability management and communication with guests. Successful hosts use various software tools to optimize logistics, purchase consumables, plan maintenance and analyze market trends, thereby increasing the efficiency and precision of their operations. The relationship with suppliers plays an extremely important role in creating a competitive advantage on the Airbnb platform (Mirakhor, 2021). Coordination with suppliers for cleaning,

maintenance, delivery of consumer goods and specialized services becomes the basis for continuous quality of the offer, speed of reaction to unexpected situations and adaptation to seasonal fluctuations. Building long-term partnerships with suppliers contributes to standardization and reduction of operating costs and enables the introduction of innovations such as contactless check-in and smart home solutions (Norfariza et al., 2022).

On the other hand, the relationship with customers (guests) is the basis for differentiation and long-term success in the digital environment (Seo and Kim, 2025). Digital technology enables personalized communication, rapid exchange of information and instant support before, during and after the stay. Feedback management, systematic collection of reviews and proactive resolution of complaints are key to maintaining high ratings, guest loyalty and creating a positive image of the host. In addition to optimizing internal processes and relationships with various stakeholders, modern supply chain management on Airbnb contributes to adding value to all participants (Dolnicar, 2020). Through the integration of digital tools, professionalization of the supply chain and a focus on the user experience, hosts not only increase their own competitiveness, but also contribute to the overall quality of tourism services and the sustainable development of the local community. Added value processes is manifested through better adaptation to individual guest needs, flexibility of offer, innovative service and transparency of business (Guttentag, 2019). This research aims to analyze in detail how the modern concept of supply chain management, supported by information technology, relationships with suppliers and customers, value added processes affects the competitive advantage of accommodation units operating through the Airbnb platform.

2. Literature Review

The application of the concept of supply chain management (SCM) in the hospitality industry is still under-researched compared to other sectors such as the automotive, forestry or textile industries. As Jenkins et al. (2015) point out, research on SCM in the hospitality and catering industries is underdeveloped, partly because these supply chains are often less complex and involve fewer participants through the stages of resource-to-service transformation. Therefore, implementing all the factors of supply chain management is not as easy to implement as in other industries.

2.1. Information Communication Technology (ICT)

Information-communication technology (ICT) has become a key infrastructure for supply chain management in the hospitality industry because it enables the integration of information, material and financial flows between hotels and suppliers and the coordination of decision-making in real time (Saha and Biswas, 2025; Xie and Chen, 2024). Digitization of the supply chain and its phases from procurement, storage and distribution through different versions of software solutions, B2B portals, IoT sensors and mobile technologies reduces the costs of doing business within the supply chain, increases the flow of supplies and improves the compliance of supply with changing demand, which is particularly important for perishable products such as food and seasonal oscillations that are characteristic of the hotel industry. At the same time, ICT improves the resilience of hotel supply chains by increasing visibility along the chain, facilitating scenario planning, and enabling rapid rerouting of orders or adjustment of supply in the event of disruptions, thus directly contributing to the competitiveness of large hotel chains in the global market (Xie and Chen, 2024; Zhang and Li, 2023; Saha and Biswas, 2025).

2.2. Supplier Relationship

Good supplier relationships are crucial for the efficiency and sustainability of supply chains in the hospitality industry, as they affect costs, delivery reliability, input quality and the innovation of the hotel offering (Espino-Rodríguez and Gebril, 2022; Pirmanta et al., 2021). Recent research in the hotel sector shows that strategic partnerships and collaborative practices with suppliers (joint planning, information exchange, joint product development) strengthen internal and upstream integration of the chain, which indirectly improves the operational and sustainable performance of the hotel (Pirmanta et al., 2021; Al-Harbi, 2023). At the same time, studies in the wider tourism-hospitality chain emphasize that long-term, cooperative relationships with suppliers increase the chain's agility and resistance to disruptions, reduce cost volatility, and enable hotels to more easily respond to guests' demands for safe, ethical and "green" offerings (Vu et al., 2024; Njeru, 2022; Shahab, 2025).

2.3. Customer Relationship

Customer relationships in hospitality supply chains are increasingly recognized as the starting point for the design and management of the entire chain, from capacity planning and procurement to logistics performance and service quality standards (Priyanto et al., 2021; Al-Kharabsheh, 2024). Recent empirical research shows that the combination of developed SCM practices and a strong customer orientation significantly improves the operational performance of hotels because decisions on assortment, service level and inventory level are made based on real guest preferences (Priyanto et al., 2021; De Castro, 2021). Key customer-orientation practices in this context include a high level of service, offering “best-in-class” products and services, and systematically collecting and using market and guest information, which directly contributes to the efficiency of hotel operations and strengthening competitiveness (Priyanto et al., 2021).

In parallel, contemporary work on CRM in the hospitality industry emphasizes that personalization of services, friendliness and helpfulness of staff, and quick response to guest requests have the strongest positive impact on customer satisfaction and loyalty, with loyalty being the main mechanism through which customer relationships are transformed into a more stable flow of demand and long-term profitability (Amin et al., 2025; El-Shimy, 2023). Technologically supported CRM that includes digital platforms, cloud solutions, and omnichannel communication further facilitates customer retention and building long-term relationships, which in conditions of strong competition is seen as a key strategic advantage for hotel companies (El-Shimy, 2023). Furthermore, developed ICT capabilities within the supply chain enhance the impact of CRM on chain performance by enabling the conversion of guest information into more accurate demand forecasting and optimization of orders and inventory, thereby simultaneously reducing costs and increasing the availability of requested products and services (Zulkifli and Charoensukmongkol, 2020).

2.4. Value-Adding Process

Value-added processes in the hospitality industry encompass all activities that the guest perceives as useful and for which he is willing to pay, with the focus shifting from the physical accommodation service itself to the entire experience created along the supply chain (Umbrex, 2025). Analyses of the hotel value chain show that the core value is generated in operational processes on site (check-in, housekeeping, additional services), but that activities such as procurement, inventory management, supplier relations and branding are crucial for

consistency of quality and overall perceived value (Umbrex, 2025; HFTP, 2025). Recent works on lean management in the hospitality industry emphasize that the goal is to systematically identify and eliminate activities that do not add value from the guest's perspective (waiting, unnecessary movements, errors, excessive inventory) and to direct resources to processes that improve service quality, speed and reliability, i.e. what the guest is willing to pay for (Vaia, 2023; Performance Magazine, 2023). Applications of value stream mapping in hotels show that optimizing the process flow, from order to service, can significantly reduce waiting time and "non-value-added" time while simultaneously increasing service accuracy and guest satisfaction (Sivarajan, 2021).

2.5. Competitive Advantage

Recent literature emphasizes that well-designed and managed supply chains are becoming a source of competitive advantage in the hospitality industry, not just a "backend" function that supports operations (Mirakhor, 2021). An empirical study on a sample of managers of 4- and 5-star hotels shows that key dimensions of the supply chain management function (e.g. integration with suppliers and customers, inventory management, transportation and information coordination) have a strong positive impact on supply chain performance, competitive advantage, and overall organizational performance of the hotel (Mirakhor, 2021). In particular, it is emphasized that integration with internal and external customers and suppliers creates distinctive agility and reliability capabilities that are difficult for competitors to imitate, which is consistent with the resource-based view of the enterprise.

More recent work highlights that supply chain resilience and excellence also act as a strategic capability that generates competitive advantage as it enables hotels to maintain service continuity, minimize risks and quickly adapt to disruptions (Ammar et al., 2024). In a study of five-star hotels in Cairo, it was shown that greater chain resilience (diversified sources, cooperation with multiple suppliers, digital technologies for visibility and forecasting) significantly contributes to "supply chain excellence", and thus to the overall competitiveness of hotels in turbulent markets (Ammar et al., 2024). Similarly, studies on supply chain drivers in the Malaysian hospitality industry show that effective management of key supply chain drivers, locations (facilities), inventory, transportation, information, procurement and pricing helps hotels achieve a better balance between efficiency and responsiveness, which differentiates them from the competition (Norfariza et al., 2022).

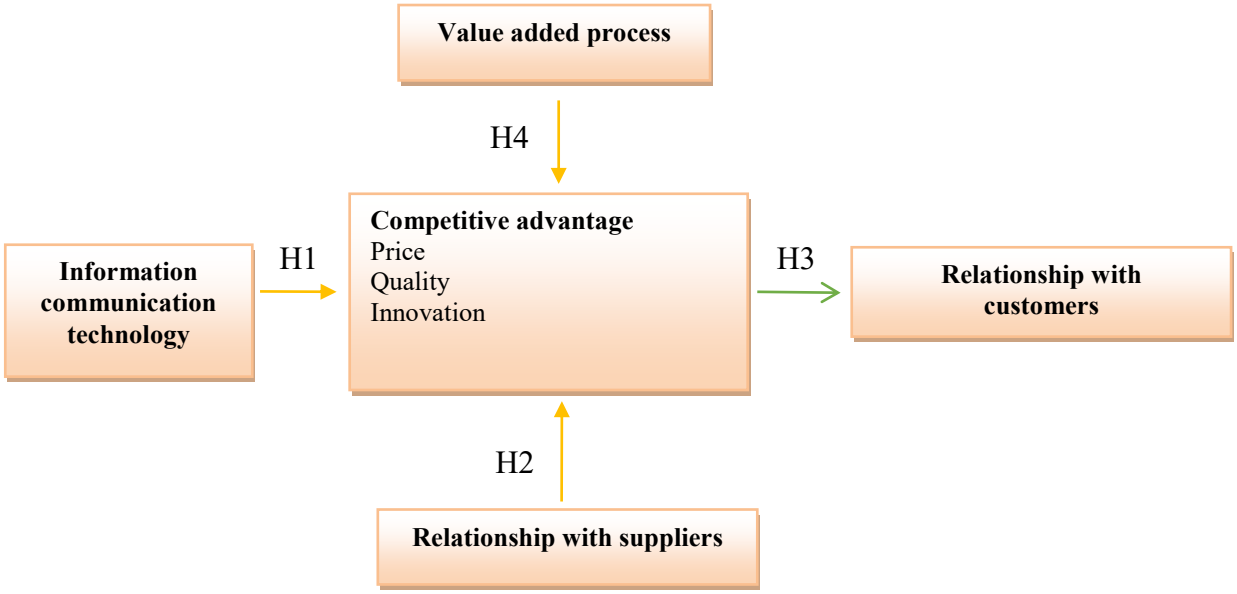
Strategic reviews and advisory works further point out that advanced technologies (AI, IoT, integrated ERP/SCM systems) are turning hotel supply chains into a source of competitive advantage through real-time visibility, better demand forecasting and faster response to changes in guest preferences and market conditions (NetSuite, 2025). In this context, competitive advantage comes from a combination of robust chain relationships, digital integration, and the ability to align logistics and procurement decisions with guest expectations and brand strategic goals (Eschenbrenner et al., 2023; Tan, 2025).

Based on previous research and analysis of available literature, four model hypotheses were defined:

H1: Information technology strongly and positively contributes to the competitive advantage
H2: Supplier relationship strongly and positively contributes to the competitive advantage
H3: Customer relationship strongly and positively contributes to the competitive advantage

H4: The value-adding process strongly and positively contributes to the competitive advantage

Figure 1: Research model



Source: Author

3. Research Methodology

3.1. Questionnaire Design and Pilot Study

This study is based on a survey questionnaire. It was chosen because supply chain practices have been studied by other researchers such as Samaržija (2014) and Vučetić (2021) who also based their findings on survey research. The aforementioned authors identified and analyzed the most commonly used supply chain factors that can be used as a basis for studying their application in tourism.

In order to determine the purpose of the research, a questionnaire was first created and then distributed. The first part of the questionnaire was used to collect information about the respondent, such as gender, age, level of education, type of facility in which he works, period of time in which he is employed and what his position is in the accommodation facility. The second part of the questionnaire collected information of the supply chain factors, information communication technology, value added processes, supplier relationship, customer relationships and competitive advantage.

The work of Vučetić (2021) has proven to be most relevant for this study, as he analysed the contribution of various supply chain management factors to competitive advantage in small hotels. In order to test the research model, the author created and distributed a questionnaire to obtain socio-demographic data on the respondents and their opinions (on a 5-point Likert scale) on 42 claims related to supply chain management factors. Claims were partly taken from questionnaire: ‘Strategija postizanja konkuretnskih prednosti malih hotela Jadranske

regije Republike Hrvatske' (Vučetić, 2021). The questionnaire particles were formed in line with the regulations and recommendations for questionnaire design (Nunnally and Bernstein, 1994). Five Managers of Airbnb units from Adriatic Croatia participated in the pilot study. The data collected by the pilot test were also subjected to psychometric testing.

3.2. Data Collection

Managers of accommodation units who advertise their facilities through the Airbnb platform participated in the survey. The contacted facilities provide catering services in the area of Zadar County and Lika Senj County. After defining the sample, the questionnaire was constructed using SurveyMonkey and was sent by the Airbnb platform to companies / private entities accompanied by an explanation and description of research objectives. The respondents, who had not completed the questionnaires in the first round, were sent a reminder after three weeks to participate in the study by filling in the questionnaire and a network link to the questionnaire. The survey was conducted from September 1 to October 15, 2024. year. Out of the total number of surveyed companies (300), 94 questionnaires were received, which amounts to a 31.33% response rate. Upon screening, 5 questionnaires were found to be completed incorrectly and were eliminated from further analysis. Therefore, the final response rate of correctly completed questionnaires was 29.66% (89 questionnaires).

4. Research Results and Discussion

4.1. Descriptive Statistics

The data from the first part of the questionnaire were summarized in such a way as to be as clear as possible and to describe the collected data as well as possible. Thus, the collected data were grouped according to the following criteria: gender, age, education level, type of facility, working time in facility and position in facility. The collected data are presented in table 1.

Table 1: Descriptive statistics

Variables	**Levels**	**N**	**%**
Gender	Male	70	78,65
	Female	19	21,35
Age	18-24	16	17,98
	25-34	28	31,46
	35-44	31	34,83
	45-54	14	15,73
Education level	Doctoral studies / master of science	0	0,00
	Secondary school	18	20,22
	Graduate	28	31,46
	Undergraduate	43	48,31
Type of facility you work in	Apartman	80	89,89
	House	9	10,11
How long have you been working in your current facility?	11-20 years	26	29,21
	5-10 years	55	61,80
	Less then 5 years	8	8,99
What is your position in the facility?	Administrative and accounting	6	6,74

Variables	Levels	N	%
	worker		
	Top-level manager	5	5,62
	Lower-level manager	48	53,93
	Mid-level manager	30	33,71

Source: Author

A total of 89 respondents participated in the study, the majority of whom were male, 70 respondents (78.65%), while 19 were female (21.35%). In terms of age structure, the largest share was made up of respondents aged 35 to 44 (34.83%) and 25 to 34 (31.46%), while the least represented group was 45 to 54 (15.73%) and respondents younger than 25 (17.98%).

In terms of educational level, most respondents have completed undergraduate studies (48.31%), followed by graduate studies (31.46%) and high school (20.22%), while none has completed a doctoral or master's degree. According to the type of facility they work in, apartments dominate, with 80 respondents (89.89%) employed, while 9 (10.11%) work in holiday homes. An analysis of the length of service in the current facility shows that the majority of respondents have between 5 and 10 years of experience (61.80%), 29.21% have been working in the same facility for between 11 and 20 years, while a smaller proportion (8.99%) have been working for less than 5 years. In terms of job position, more than half of the respondents hold a lower management position (53.93%), a third is in middle management (33.71%), while 6.74% of the respondents perform administrative and accounting tasks, and 5.62% of the respondents work in top management. These data show that the sample consists mainly of highly educated men between the ages of 25 and 44, with many years of experience working in apartments and predominantly employed in lower and middle-level managerial and executive positions.

4.2. Factor Analysis

In order to examine the factor structure of the subscales, an exploratory factor analysis was conducted. The criteria for the number of factors to be retained were the values of the characteristic root, which should be at least 1 (Kaiser-Guttman criterion). The factor structure and reliability for each subscale individually will be presented below, primarily due to the sample size.

Factor: relationship with customers (guests). An exploratory factor analysis of the results on the subscale, which includes five items, determined a single-factor structure. The analysis showed satisfactory internal homogeneity of the Cronbach Alpha (α): 0.771, as can be seen from Table 2. All items show statistically significant factor saturations with the extracted factor, ranging from -0.17 to -0.79.

Table 2: Factor structure for " Relationship with customers"

Statements	F1
We collect feedback from guests about the services in the accommodation facility	-0,48
We regularly inform guests about new services	-0,17
We seek guest opinions when introducing innovations	-0,79
We consult with our guests when developing new services	-0,65
We are focused primarily on meeting the needs of our guests	-0,46
Value of the characteristic root	**2,01**

Percentage of explained variance	**42,38**
Cronbach Alfa	**0,771**
Average correlation between particles	**0,44**

Source: Author

Exploratory factor analysis was conducted on five statements measuring the orientation of the accommodation facility towards guests and their involvement in the service development process. All measurement items were saturated on one factor (F1), with the characteristic root value being 2.01 and the percentage of explained variance being 42.38%, indicating a satisfactory explanation of the variability of data within the social sciences.

The highest factor loadings were recorded for the statements "We seek the opinion of guests when introducing innovations" (–0.79) and "We consult with our guests when developing new services" (–0.65), suggesting that these items measure the latent construct most strongly. The obtained Cronbach alpha coefficient of 0.771 shows good internal consistency of the scale, while the average inter-item correlation is 0.44 and indicates moderate to high correlation of items, without excessive redundancy of measurement statements.

Based on the results, it can be concluded that the analyzed statements form a reliable single-factor scale that measures the dimension of guest orientation and that it is most evident through the active involvement of guests in service innovation and development processes.

Factor: "relationship with suppliers" – An exploratory factor analysis including five items revealed a single-factor structure. The analysis showed a satisfactory high internal homogeneity of the Cronbach alpha (α): 0.832, as can be seen from Table 3. All items show statistically significant high factor loadings with the extracted factor, ranging from -0.65 to -0.86.

Table 3: Factor structure for „relationship with suppliers"

Statements	**F1**
We develop business strategy together with suppliers	-0,74
Suppliers are informed about the planning of our new services	-0,65
We inform suppliers about all changes in our business	-0,80
We work closely with suppliers during the development of the accommodation service	-0,86
We integrate suppliers into our marketing plan	-0,70
Value of the characteristic root	**3,45**
Percentage of explained variance	**69,19**
Cronbach Alfa	**8,823**
Average correlation between particles	**0,69**

Source: Author

Exploratory factor analysis was conducted on five statements measuring the level of cooperation between the accommodation facility and its suppliers. The analysis showed that all statements saturate on one factor (F1) with very high factor loadings, ranging from –0.65 to –0.86, with the highest loadings for the statements "We work closely with suppliers during the development of the accommodation service" (–0.86) and "We inform suppliers of all changes in our business" (–0.80). The negative sign is a result of the way the statements are coded and does not affect the strength of the association between the items and the factors.

The characteristic root value was 3.45, and the percentage of explained variance was as much as 69.19%, which in the field of social sciences is considered an exceptionally high share of explaining data variability. The obtained Cronbach α coefficient is 0.823, which indicates a high internal consistency of the scale. The average correlation between items is 0.69, confirming a very strong interconnection of the statements, without excessive redundancy.

Based on the results obtained, it can be concluded that the analyzed statements form a reliable and homogeneous single-factor scale that measures the construct of supplier relationship, with this dimension most clearly manifested through continuous information exchange and close collaboration with suppliers during service development, including their integration into marketing and business strategies.

Factor: information and communication technology. Exploratory factor analysis of the scale, which includes a total of ten items, determined a single-factor structure. The analysis showed satisfactory internal homogeneity of the Cronbach alpha (α): 0.778, as can be seen from Table 4. All items show statistically high significant factor loadings with the extracted factor, ranging from -0.28 to -0.82.

Table 4: Factor structure for „information and communication technology“

Statements	**F1**
We are developing a long-term plan for the development of information technologies in our facility	-0,58
We train and prepare staff to work on computer equipment	-0,36
We invest in computer equipment	-0,69
Guests throughout the facility have access to wireless (Wi-Fi) Internet	-0,82
We have fast and unlimited Internet in the facility	-0,76
We continuously invest in information technology	-0,70
We have an online reservation system	-0,33
We have a system for collecting information about guests (database)	-0,28
We use modern software solutions in our business	-0,80
We use software solutions for the security system	-0,55
Value of the characteristic root	**4,55**
Percentage of explained variance	**48,29**
Cronbach Alfa	**0,778**
Average correlation between particles	**0,58**

Source: Author

An exploratory factor analysis was conducted on a set of ten statements measuring the level of investment and application of information technologies in the observed facility. The analysis identified one significant factor (F1) with a characteristic root of 4.55, which explains 48.29% of the total variance. The factor represents a dimension that can be interpreted as information communication technology.

Absolute values of factor loadings ranged from 0.28 to 0.82, with the highest values recorded for the statements related to internet availability, use of modern software solutions and continuous investment in IT. The lowest correlations were observed for the statements about the existence of a guest database and an online reservation system. The measured construct shows good internal consistency (Cronbach $\alpha = 0.778$) and medium to high average correlation between items ($\bar{r} = 0.58$), which indicates the reliability of the scale and the

consistency of the measurement. The obtained results indicate that the information technology infrastructure in facilities is a relatively homogeneous dimension that integrates multiple aspects of investment, equipment and software solutions.

Factor: value-adding process. Exploratory factor analysis of the results, which includes eight items, revealed a single-factor structure. All items show statistically significant factor loadings with the extracted factor, ranging from -0.24 to -0.75. Item analysis (reliability analysis) revealed satisfactory internal homogeneity of the Cronbach alpha (α): 0.813 and satisfactory average correlation between items, as can be seen in table 5.

Table 5: Factor structure for „value added process“

Statements	F1
We can accommodate non-standardized guest orders	-0,44
We are ready to meet personalized guest needs	-0,58
We are ready to quickly introduce new services to the market	-0,62
We are ready to respond to all the needs and desires of our target market	-0,58
We have a quality certificate or are in the process of certification	-0,24
We measure the quality of our services	-0,77
We collect and manage customer feedback	-0,75
Employees in our facility are trained and valued	-0,58
Value of the characteristic root	**3,54**
Percentage of explained variance	**44,68**
Cronbach Alfa	**0,813**
Average correlation between particles	**0,44**

Source: Author

An exploratory factor analysis was conducted on eight statements measuring the facility's orientation to service quality and flexibility towards guests. The analysis identified one significant factor (F1) with a characteristic root of 3.54, which explains 44.68% of the total variance. The factor can be interpreted as “operational and strategic focus on service adaptation, quality monitoring and responding to guest needs”.

Absolute values of factor loadings ranged from 0.24 to 0.77, with the highest values recorded for statements related to “measuring service quality” (-0.77), “collecting customer feedback” (-0.75) and “rapid introduction of new services to the market” (-0.62). The lowest correlation was shown by the statement about “possession of quality certificates” (-0.24), which suggests a lower correlation of formal certification with the measure of operational flexibility and adaptability.

The reliability of the scale is very good (Cronbach $\alpha = 0.813$), and the average correlation between items ($\bar{r} = 0.44$) indicates a medium-strong connection between the statements while maintaining their specificity. The results show that the quality of service and the flexibility of the facility is a homogeneous, clearly recognizable dimension that integrates multiple aspects of adaptation, proactive approach and monitoring of guest satisfaction.

Factor: competitive advantage. Exploratory factor analysis determined a three-factor structure, and the factors, considering the content of the items that saturate, can be defined as competitive advantage reflected in the price, quality and innovation of the service.

Table 6: Factor structure for „competitive advantage“

Statements	F3	F2	F1
We offer the lowest possible price for accommodation compared to the competition	0,103	0,010	0,326
We offer prices that are similar to our competition	0,009	0,07	0,512
We adjust the room price to the guest's profile	0,121	0,039	0,354
We dynamically adjust the price of the room to market demand	0,033	0,018	0,600
We offer discounts to our guests (for longer periods of stay, larger groups of guests, etc.)	0,056	0,169	0,461
We adjust the price of the accommodation to the quality of the service	0,301	0,189	0,405
We strive to provide service within the promised time	0,181	0,781	0,128
The staff is always ready to solve the problem of every guest	0,501	0,581	0,121
In accordance with the agreement with the guest, we deliver our service	0,182	0,816	0,098
We are always willing to help our guest	0,231	0,802	0,18
Our employees respond quickly to guests' requests	0,401	0,761	0,127
We continuously control internal processes in the facility	0,566	0,401	0,118
We offer our guests a unique experience and service	0,584	0,241	0,016
We offer our guests a high level of hospitality and a family atmosphere	0,801	0,351	0,098
In addition to standard services, we are ready to offer our guests additional services upon their request	0,788	0,268	0,101
We continuously implement the service innovation process with the aim of improving quality	0,684	0,181	0,169
We include our guests in the service innovation process	0,482	0,021	0,185
We are ready to offer our guests some free services (welcome drink, souvenir, organization of excursions, ticket reservation, etc.)	0,658	0,312	0,168
We enable technological innovations faster and more accessible service	0,512	0,189	0,231
Value of the characteristic root	**4,32**	**3,26**	**1,65**
Percentage of explained variance	**22,74**	**17,17**	**8,70**
Cronbach Alfa	**0,701**	**0,658**	**0,812**
Average correlation between particles	**0,51**	**0,61**	**0,71**

Source: Author

An exploratory factor analysis of the data from the survey questionnaire was carried out with the aim of revealing the main dimensions of the competitive advantage of facilities that offer their services on the Airbnb platform. Three interrelated but conceptually different factors were singled out. The first dimension is service innovation (22.74% of explained variance; α=0.701; r=0.51) – which emphasizes personal approach, additional services, innovation and unique experience. The second factor is quality (17.17% of the explained variance; α=0.658; r=0.61), which focuses on accuracy, the staff's willingness to help and timely implementation of requests. The last factor is price (8.70% of the explained variance; α=0.812; r=0.71) – and it includes flexible price formation strategies, discounts and adjustment of the offer to the market. Together, these three dimensions explain 48.6% of the total variance and have acceptable to high internal consistency.

The table also lists the values of the average inter-item correlation (r - the average correlation between the statements within each factor). The innovation dimension r = 0.51 for the innovation dimension shows moderate correlation between the items. The items are related

enough to measure the same dimension, but not so much that they are completely redundant. The quality dimension r = 0.61 indicates a strong average correlation. The items measure the same construct well, but there is less diversity of content within the factor. Finally, price r = 0.71 indicates a very strong average correlation. The items of this factor are very closely related and consistent - they measure a very specific and clearly defined dimension.

4.3. Testing Model Hypotheses By Multiple Regression Analysis

As part of this scientific research, a multiple regression analysis was conducted to determine the shares and significance of the contributions of the examined factors to the competitive advantage of facilities that offer their services via the Airbnb platform. By testing the correlation (r) and contribution (R2) of the factors value-added process, information technology, supplier relationship, customer relationship and competitive advantage, results were obtained that indicate the impact of applying the supply chain management concept on the effectiveness of facilities that offer accommodation services.

Table 7: Contribution shares of the examined factors to competitive advantage

Factor	β	SEβ	P	R	Contribution share % (R2)
Information Technology	0,216	0,098	0,033*	0,833	18,0
Value-Adding Process	0,191	0,084	0,027*	0,785	15,0
Supplier Relationship	0,525	0,105	<0,001*	0,900	28,2
Customer Relationship	0,325	0,088	0,020*	0,865	20,0

β - regression coefficient
SE_β- standard error β regression coefficient
r- correlation coefficient between the examined factor and competitive advantage
* - statistically significant *P*

Source: Author

The results of a multiple regression analysis conducted on a sample of Airbnb accommodation providers showed that all analyzed supply chain management factors have a positive and statistically significant impact on the competitive advantage of accommodation facilities ($p < 0.05$). The largest individual contribution to competitive advantage was shown by supplier relationship ($\beta = 0.525$; $R = 0.900$; $p < 0.001$), with a share in explaining the variance of 28.2%. This is followed by relationship with customers ($\beta = 0.325$; $R = 0.865$; $p = 0.020$) with a share of 20.0%, information technology ($\beta = 0.216$; $R = 0.833$; $p = 0.033$) with 18.0%, and the value-added process ($\beta = 0.191$; $R = 0.785$; $p = 0.027$) with a contribution of 15.0%.

About 18% of the explained variance of competitive advantage in the model belongs to ICT. In practice, this means that ICT has a significant, but not the largest, impact on competitive advantage. The value-adding process explains 15% of the variability of competitive advantage. Service personalization, authentic offer and creation of added value contribute, but less compared to other factors. – 28.2%. The largest individual contribution is from partnership with suppliers and this factor explains almost a third of the variance. This means that high-quality, stable and effective cooperation with the supplier is a key source of increasing competitive advantage. Relationship with customers explains a fifth of the total variance of competitive advantage (20%). Building loyalty and quality communication with guests also strongly contributes to success.

These results suggest that developing stable and effective relationship with suppliers and proactive relationship with customers are crucial for strengthening the competitiveness of

properties through the Airbnb platform, while investments in information technology and value-adding processes represent additional important factors in building competitive advantage.

4.4. Discussion

The results of the conducted research confirm all the hypotheses and clearly indicate a positive and statistically significant influence of all observed supply chain management factors on the competitive advantage of accommodation facilities that operate through the Airbnb platform. It was determined that partnership with suppliers shows the largest individual contribution (β=0.525; R^2=28.2%), which is in line with theoretical considerations and earlier research in the field of tourism and catering (Avelini-Holjevac, 1996; Samaržija, 2014). Long-term, stable and transparent relationship with suppliers allow accommodation facilities to standardize quality, timely delivery of services and flexibility in adapting to seasonal fluctuations, which in the dynamic environment of a platform like Airbnb can be considered crucial for maintaining a competitive advantage.

Relationship with customers also showed a significant impact (β=0.325; R^2=20.0%), confirming the importance of customer orientation and user involvement in the process of creating and improving services. This finding is in line with the concepts of total quality management (TQM) and modern approaches to customer experience management, according to which regular feedback collection and personalization of services directly affect the perception of quality and customer loyalty (Vrtiprah and Sladoljev, 2012).

Information technology showed the third strongest contribution to competitive advantage (β=0.216; R^2=18.0%). Although its impact is not the largest, the findings suggest that digital infrastructure, including fast and reliable internet connectivity, online reservation systems and advanced software solutions, is a key support for operational efficiency and differentiation in the market. The result is in line with the conclusions of Žilić (2012) and numerous studies in the field of e-tourism, which emphasize the importance of technological readiness for increasing transparency, reducing operational costs, and faster adaptation to market changes.

In the end, the process of adding value (β=0.191; R^2=15.0%) confirms the thesis that investment in quality and an expanded range of services can result in increased competitiveness, although its contribution turned out to be somewhat smaller than other factors. This may point to the fact that guests on the Airbnb platform more often associate the competitive advantage with the overall experience of the stay and the reliability of the service than with individual additional benefits.

Factor analysis of competitive advantage extracted three dimensions—service innovation, quality, and price—which together explain 48.6% of the total variance. These findings indicate that landlords shape their competitive advantage by combining creative and innovative solutions (eg free additional services, personalized offers), maintaining a high level of quality, and developing flexible pricing strategies. It is particularly interesting that the price dimension, although it captures a smaller part of the explained variance, shows a marked internal consistency (α=0.812; r=0.71), which suggests that pricing strategies among Airbnb hosts have a clearly defined and homogeneous structure.

Compared to previous research in the hospitality and tourism industry, the results confirm the model according to which competitive advantage in the modern digital platform environment

stems from integrated management of relationships with key stakeholders and the use of technological support at all stages of the supply chain. However, it is evident that operational factors such as supplier and customer relationship have a slightly greater direct impact than technological or value-added processes, which may be a consequence of the specificity of the Airbnb market, where direct user experiences and operational reliability often determine the assessment of the service.

A limitation of this research relates to the size and structure of the sample (N=89), which, although representative of active service providers on the Airbnb platform, does not include all types of facilities or geographical regions. Future research could expand the analysis to a larger sample and introduce a longitudinal approach to examine the stability of the effects of the observed factors over time. Also, the inclusion of additional variables such as environmental sustainability, reputation management or the integration of artificial intelligence into business processes could contribute to an even more comprehensive understanding of creating competitive advantage in the context of the sharing economy.

5. Conclusion

The research confirmed that all observed supply chain management factors relationship with customers and guests, information technology, and value-added processes have a positive and statistically significant impact on the competitive advantage on accommodation facilities operating through the Airbnb platform. The results of multiple regression analysis showed that relationship with suppliers is the strongest single predictor of competitive advantage, while relationship with customers, ICT, and value added processes also contribute to success, although to a somewhat lesser extent.

By analyzing the dimensions of competitive advantage, three main factors — innovation, quality and price — were singled out, which together explain almost half of the total variance. These findings suggest that successful lessors combine creative and differentiated offer elements with a high level of operational reliability and adaptive pricing strategies. This confirms the thesis that competitive advantage in the digitally mediated short-term rental market cannot be built solely on one element, but on a balanced combination of relations with stakeholders, technological support and orientation to user experience.

The practical implications of the results point to the need for strategic investment in developing partner networks with key suppliers, systematically collecting and using guest feedback, and continuously modernizing IT infrastructure. This way, it is possible to achieve sustainable competitiveness and increase user satisfaction, which in the context of platforms like Airbnb results in higher ratings, higher capacity occupancy, and long-term business success.

The limitations of the research relate primarily to the size and territorial scope of the sample, which does not cover all market segments or all types of accommodation units. Future research should include a larger and more heterogeneous sample, apply a longitudinal approach, and include additional variables such as sustainability, cultural factors, and the application of artificial intelligence in business processes. By integrating these aspects, it is possible to obtain an even more precise model that explains the mechanisms of creating and maintaining competitive advantage in the sharing economy sector.

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A scientific paper

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INTERNATIONALISATION AND SOCIAL LICENCE TO OPERATE IN THE LITHIUM INDUSTRY: STAKEHOLDERS' PERSPECTIVES FROM THE PORTUGUESE CONTEXT

ABSTRACT

The worsening of climate change and the need for global decarbonisation have driven an energy transition based on new technologies and the use of critical raw materials. Among these, lithium has become central due to its important role in the production of batteries and energy storage systems, gaining economic and geopolitical relevance. The lithium industry is characterised by strong geographical asymmetries in the distribution of reserves and the control of the value chain, which fuel geopolitical rivalries and influence corporate internationalisation strategies.

In the European context, Portugal emerges as a relevant territory due to the size of its reserves, which opens opportunities for foreign direct investment crucial for regional development, but also generates environmental, social, territorial, and governance challenges. Recently, international mining groups have shown growing interest in lithium exploration in the northern region of Barroso, bringing these challenges to the forefront of public debate and raising concerns among local communities.

This study seeks to understand how geographical and territorial factors influence the internationalisation strategies of international lithium companies, how the literature discusses the role of Corporate Social Responsibility and Social Licence to Operate in managing socio-environmental impacts, and which stakeholders have the greatest influence on the governance and social acceptance of the mining projects in Portugal.

The methodology follows a qualitative, exploratory and descriptive approach, based on the analysis of secondary sources, including academic publications, institutional reports and relevant regulatory frameworks.

This paper aims to contribute to the understanding of the lithium industry by discussing how geographical asymmetries and territorial challenges may shape internationalisation strategies. It also explores the role of the Social Licence to Operate in the literature, whose effectiveness appears limited in fragile contexts, and examines how stakeholders are framed in relation to governance and social acceptance of mining projects, specifically in Portugal.

Key words: *Lithium Industry, Corporate Social Responsibility, Social Licence to Operate, Internationalisation Strategy, Stakeholders.*

1. Introduction

In recent decades, climate change has taken centre stage in public, scientific and political debate, leading to growing environmental awareness and a clear perception of the urgency of decarbonising the planet (Barbosa et al., 2025; European Parliament, 2025; Tabelin et al., 2021). This context has driven the so-called Global Energy Transition, based on the progressive replacement of fossil fuels with alternative energy sources and more sustainable technological solutions. As a result, demand has intensified for critical raw materials, which are essential to produce batteries for the technology industry, electric vehicles and energy storage systems (Kelly et al., 2021). Among these resources, lithium stands out as a strategic mineral, currently considered the most viable solution to support the energy transition (Tabelin et al., 2021). This importance has made its exploitation a topic of high economic and geopolitical relevance, influencing industrial policies, business strategies, and international relations (Sanchez-Lopez, 2023).

The concentration of extraction in the Lithium Triangle (Argentina, Bolivia, and Chile) (Jerez et al., 2021; Souza et al., 2025), combined with Chinese dominance in the processing and refining stages, has exposed significant vulnerabilities in the global supply chain (Bos & Forget, 2021). These strategic differences have motivated other regions, such as the European Union, to seek alternatives that strengthen security of supply and reduce external dependencies (Heredia et al., 2020). In this context, lithium has been classified as a critical raw material by several economies, highlighting the need to assess not only its economic viability but also its environmental, social and territorial impacts (Barbosa et al., 2025; Souza et al., 2025).

It is in this scenario that Portugal emerges as a territory of strategic interest. According to Barreira et al. (2022), the country has some of the largest lithium reserves in Europe, with the potential to integrate advanced stages of the value chain. This context opens opportunities for foreign direct investment and regional development, but at the same time poses complex environmental, social, territorial and governance challenges. The expansion of mining activity, therefore, requires a rigorous assessment of its impacts and the capacity of local communities to cope with profound changes in their ways of life and their territories (De Oliveira et al., 2020).

As seen in the case of the Barroso Mine Case, in the mining industry, project viability depends on Corporate Social Responsibility (CSR) and The Social License to Operate (SLO) to build trust and legitimacy with affected communities (Dall-Orsoletta et al., 2025; Dunlap & Riquito, 2023; Santos & Simões, 2025).

Given this context, the primary objective of this study is to explore how social responsibility and stakeholder relationship strategies are used by mining companies, particularly in the lithium sector, as instruments of legitimisation in the process of internationalisation and obtaining a social license to operate in Portugal. To this end, the study is guided by the following research question: **How do Internationalisation strategies, Corporate Social Responsibility (CSR) practices, and stakeholder relationship management influence the attainment and maintenance of a Social Licence to Operate (SLO) within the context of lithium exploration in Portugal?** In doing so, the study aims to offer an integrated reading of business internationalisation, social legitimacy and territorial governance in a key sector for the European energy transition.

To address the research question, this study is structured around the following specific objectives:

O1: To analyze Portugal's position within the global lithium values chain and the strategic implications of internationalisation within the sector.

O2: To examine how Corporate Social Responsibility (CSR), stakeholder dynamics, and the Social Licence to Operate (SLO) are conceptualized and interrelated in the literature on extractive industries.

O3: To assess how CSR practices and stakeholder engagement strategies influence the construction of social legitimacy in contested territorial contexts, focusing on the Portuguese case.

O4: To explore the tensions between global energy transition goals and local socio-territorial dynamics, highlighting governance challenges for sustainable resource extraction.

By adopting this multidimensional approach, the article contributes to the literature on the lithium industry by proposing a clear integrated analysis that connects internationalisation strategies, CSR, SLO and stakeholder dynamics. This addresses the fragmentation seen in earlier research.

Through a Portuguese case study from the Barroso region in the North of the country, the article offers an analysis in the local context, showing how vital local legitimacy is developed in extractive industries. Finally, it looks closely at the weakness of CSR and SLO as tools for gaining social acceptance in situations marked by power imbalances and governance difficulties.

The study is structured in five main sections. It begins with a contextual overview of the mining industry in Portugal. The next subsection examines the internationalisation strategies of mining companies. The third subsection presents a review of Corporate Social Responsibility, including the concept of Social Licence to Operate. This is followed by a subsection dedicated to Stakeholder Theory, with a particular focus on lithium mining in Portugal. The article concludes with the methodology, discussion and the presentation of the main conclusions.

2. Theoretical Background

2.1. The Mining Industry in Portugal – Contextualisation and International Strategies

2.1.1. The Mining Industry in Portugal

In Portugal, mining has a long historical trajectory, with evidence of activities dating back to the Bronze Age and intensifying during the Roman period particularly in the Iberian Pyrite Belt (Matos et al., 2012). The sector expanded significantly in the 19th century, especially in the exploitation of pyrite and copper in the Alentejo region and was consolidated through large modern deposits during the 20th century (De Oliveira et al., 2020; Quintas & Pereira, 2016).

This historical development left a complex legacy of industrial infrastructure and mining communities, alongside significant environmental liabilities, including water acidification, heavy metal contamination, soil and ecosystem degradation (Abreu et al., 2011).

According to De Oliveira et al. (2020), in recent decades the identification of lithium deposits, mainly hard-rock pegmatites, concentrated in northern and central Portugal, has driven geological research and sustainability assessments aligned with the Energy Transition (Secretary of State for Energy, 2017). Within this context, the Barroso lithium project, in the North region of Portugal, has emerged as a focal case, attracting extensive scientific attention, public debate, and social contestation (Saleth et al., 2023; Savannah Resources Plc, 2025).

2.2. Internationalisation Strategies of Mining Industry Companies

In a globalized economy, internationalisation has become a central strategy for firms' access to resources, markets and technological capabilities, materialising through activities such as foreign production, strategic alliances and foreign direct investment (Lamb et al., 2011; Miura, 2024; Tabares et al., 2021).

These strategies are shaped by firms' internal capabilities, financial resources, regulatory environments and the access to critical inputs, with location decisions often influenced by logistics costs, resource availability and government incentives (Vivoda, 2011).

In the mining industry, and particularly in lithium extraction, internationalisation dynamics are more complex due to the geographical immobility of mineral resources. Companies must negotiate not only with host governments but also with local communities to ensure licenses, mitigate social tensions and ensure operational continuity. Consequently, international expansion in this sector increasingly incorporates social and environmental commitments aimed at reducing risk and enhancing legitimacy, rather than relying solely on legal compliance (Atienza et al., 2020; Haslam et al., 2019).

The global lithium industry is structured through highly interconnected production networks, characterised by vertical and horizontal integration strategies designed to control multinational firms and emerging actors, particularly in China, have reshaped these networks through acquisitions, joint ventures and strategic partnerships, while national states have assumed a more active role via regulation, incentives and direct participation in extraction projects (Al Bouchi & Caraway, 2024; Bos & Forget, 2021).

At the political level, the energy transition reinforced lithium's status as a critical raw material, prompting governments and supranational actors, most notably the European Union, to promote domestic extractions, value-chain integration and supply-chain resilience through regulatory frameworks and strategic policies (Regulation (EU) 2024/1252, 2024; Reich & Simon, 2025; Riofrancos, 2023). In this context, internationalisation strategies in the lithium sector are increasingly shaped by the interaction between corporate decision-making and public policy objectives, underscoring the strategic importance of aligning business expansion with regulatory, territorial and societal constraints (Sun et al., 2024).

In Portugal, internationalisation in the lithium sector has largely taken the form of foreign direct investment and concession-based arrangements shaped by national policy and European critical raw material strategies (Barreira et al., 2022; European Parliament, 2025). Within the EU's

pursuit of supply chain and strategic autonomy, Portugal has emerged as a potential extraction hub (Riofrancos, 2023).

However, projects such as those in Barroso, in North of Portugal, have exposed tensions between extractive development and territorially embedded socio-environmental concerns. Lithium exploration has become increasingly politicized, generating local resistance and public debate (Araújo et al., 2022; Dunlap & Riquito, 2023). The dynamics suggest that internationalisation in this sector is not merely an economic or regulatory process, but a socially embedded and politically contested one.

As foreign firms expand into new jurisdictions, the need to overcome liability of foreignness reinforces the importance of local legitimacy (Haslam et al., 2019). Securing a social license to operate, therefore, becomes central to project viability, extending beyond formal approval to encompass community acceptance and trust (Owen & Kemp, 2013; Prno, 2013).

This strategic expansion, however, encounters significant barriers in the form of local resistance, necessitating a shift towards social legitimacy frameworks, such as the Social License to Operate.

2.3. Corporate Social Responsibility and Social License to Operate

2.3.1. Concept of CSR, importance and application to the mining industry

According to Carroll (1999, 2025), the concept of corporate social responsibility has a long and multifaceted history, based on four categories of obligations that companies have towards society: i) economic responsibility, ii) legal responsibility, iii) ethical responsibility, and iv) discretionary or philanthropic responsibility. The first three form the indispensable basis for the survival and legitimacy of the company, while the philanthropic dimension is optional and guided by social values and expectations.

Social, economic and sustainable development concerns began to feature in corporate strategies and policies, with a view to differentiation and awareness that companies must create wealth for all stakeholders (Le et al., 2023) and not just from the perspective of 'clearing the conscience' of shareholders, as mentioned by Freeman & Dmytriyev (2017).

Considering the mining industry, particularly the exploitation of lithium and critical minerals, it cannot be seen as merely an economic opportunity; concrete adoption of structured and continuous CSR practices is required.

In the case of Portugal, with imminent lithium mining projects, namely the Barroso Mine in Boticas, in the north of the country, the social dimension is particularly relevant because the viability of the project may be compromised if trust and fairness are not reflected in the process through a relationship between companies, the state and local communities (Dall-Orsoletta et al., 2025). Mere technical or environmental approval does not guarantee social acceptance (Dunlap & Riquito, 2023; Santos & Simões, 2025).

2.3.2. Concept of Social Licence to Operate, importance and relationship with CSR

According to Eerola et al. (2023), the long-term sustainability of lithium mining projects in Europe depends heavily on obtaining a 'Social License to Operate,' that is real acceptance by

the community and society, as legal compliance or sustainability rhetoric is not sufficient. In this context, CSR is an instrument that must integrate governance, transparency, communication and community participation, mitigation of environmental impacts and commitment to local development, not just a set of one-off initiatives or 'greenwashing'.

The Social Licence to Operate is now a central concept in the analysis of the viability and sustainability of mining activities, particularly in sectors associated with high environmental and social impacts, such as lithium mining. Unlike legal or environmental licences, the SLO is a social process built on the acceptance, approval and trust of local communities and society in general (Eerola et al., 2023; Prno, 2013).

The literature converges on the idea that SLO is neither a fixed state nor a definitively achieved goal. It is a dynamic process, continuously renegotiated, which depends on how companies manage the impacts of their operations, communicate with stakeholders and respond to social expectations over time (Owen & Kemp, 2013; Prno & Scott Slocombe, 2012). This dynamic makes SLO particularly sensitive to governance failures, episodes of conflict or perceptions of injustice, which can lead to its weakening or even withdrawal (Dall-Orsoletta et al., 2025).

In the context of the current mining industry, and in particular the exploitation of minerals associated with the energy transition, SLO takes on added importance. Studies show that these projects are often seen as bringing global benefits (decarbonisation and energy security) but also as generating significant local costs with greater implications for the communities directly affected (Dunlap & Riquito, 2023; Owen & Kemp, 2013). This balance between benefits and impacts tends to intensify social conflicts, especially in rural or sparsely populated areas, where mining can profoundly alter ecosystems, ways of life and territorial identity.

In this context, CSR emerges as a fundamental strategic approach for building and maintaining SLO. Owen & Kemp (2013) note that the instrumentalization of SLO, without any substantive commitment to social and environmental justice, tends to generate mistrust and increased resistance on the part of local communities. Thus, achieving SLO requires the integration of CSR into the company's core strategy, including real mechanisms for community participation, transparency in decision-making processes, benefit sharing and consistent mitigation of environmental impacts (Eerola et al., 2023).

The Portuguese case is an illustrative example of these dynamics. Lithium mining in Barroso - Boticas, north of Portugal, has been widely debated in the public and academic spheres, which shows that the social legitimacy of mining projects depends heavily on the perception of procedural, distributive and territorial justice among local populations (Santos & Simões, 2025; Dall-Orsoletta et al., 2025; Dunlap & Riquito, 2023).

In summary, SLO is a critical element for the viability and sustainability of lithium exploration projects in Portugal. Thus, a consistent and long-term commitment on the part of companies, based on meaningful social responsibility practices, structured dialogue with stakeholders, and recognition of territorial specificities, enables SLO to be achieved. In an industry that is strategic for the European energy transition, neglecting the social dimension compromises the economic viability of projects and undermines the very sustainability objectives that lithium mining aims to serve.

2.4. Stakeholder Theory: framework, importance and contextualisation in the mining industry

Stakeholder Theory demonstrates that all organisations have stakeholders and that these are groups or individuals who affect and are affected by the fulfilment of the organisation's missions (Freeman, 1988).

Companies, as organisations, and from a business perspective, must build relationships and create value for all their stakeholders, and their strategies must commit to treating all stakeholders as equally important (Freeman & Dmytriyev, 2017).

The mining sector is shaped by a diverse set of stakeholders, including the government, local communities, NGOs, the media, and shareholders. These stakeholders exert significant power and influence over the direction, scope and success of CSR policies adopted by mining companies (Mbilima, 2021).

The government and regulatory bodies also play a key role in overseeing and guiding the implementation of CSR in the mining sector (Nuswantara & Pramesti, 2020). Fair, impartial and transparent state oversight is considered essential to ensure that companies comply with sustainable CSR practices and that benefits are distributed equitably among all stakeholders (Setyawan, 2025).

Furthermore, Saenz (2023) notes that the mining industry is undergoing a transition from a traditional stance focused on minimum compliance to a more holistic, multi-stakeholder-oriented approach. This evolution reflects a growing corporate awareness of the strategic role of local communities in the viability and sustainability of mining operations.

Thus, stakeholders play a decisive role in the mining industry. The active participation of local communities, the existence of strict government regulations, and responsible corporate management are essential elements for the development of sustainable and effective CSR programmes. A broader, more inclusive and continuous engagement process ensures that CSR goes beyond mere legal compliance, effectively contributing to the generation of significant social and environmental benefits for all parties involved (Setyawan, 2025).

2.4.1. Stakeholders in Lithium Exploration and the Portuguese Context

Lithium exploration in Portugal involves a complex network of stakeholders, whose interests, levels of power, and degrees of influence vary significantly throughout the life cycle of mining projects (Araújo et al., 2022). As in other extractive industries, the dynamics between stakeholders play a decisive role in social acceptance, governance, and obtaining and maintaining the Social Licence to Operate (Barakos & Mischo, 2021).

In the Portuguese context, the State emerges as a central stakeholder, performing regulatory, promotional and mediating functions. It is responsible for defining the legal and institutional framework for mining activity, including concession regimes, environmental impact assessment and land use planning. On the other hand, it plays an active role in attracting foreign direct investment by aligning lithium exploration with national and European strategic objectives (Barreira et al., 2022; Eyselein & Dorn, 2025). This dual role can, however, generate perceptions of conflict of interest, especially when decision-making processes are perceived as

lacking transparency or being overly centralised, which undermines the confidence of local communities (Dall-Orsoletta et al., 2025).

The stakeholders most affected by lithium mining projects are local communities. In regions such as Barroso – Boticas, in the north of Portugal, which is characterised by strong ties to the territory, a rural-based economy and heritage recognition, mining is often perceived as a threat to traditional ways of life, local ecosystems and cultural identity (Saleth et al., 2023).

Additionally, the literature shows that social opposition in these territories stems not only from the expected environmental impacts, but also from the perception of exclusion from decision-making processes and the unequal distribution of costs and benefits (Dunlap & Riquito, 2023; Santos & Simões, 2025).

The promoting companies, mostly multinationals, are another group of stakeholders with high economic and technological power. Their activities in Portugal are conditioned by national regulatory requirements, but also by their global strategies for internationalisation and integration into lithium value chains. The literature emphasises that these companies tend to adopt CSR practices as a way of mitigating reputational risks, reducing social conflicts and enhancing operational predictability (Eerola et al., 2023; Haslam et al., 2019). However, the effectiveness of these practices depends heavily on their perception by local communities.

Non-governmental organisations, civic movements and local associations play an important role in the Portuguese context, as they act as mediators, supervisors and amplifiers of social and environmental concerns. In the case of lithium mining, these actors have contributed to the politicisation of public debate, mobilising technical, legal and scientific knowledge and pressuring both the state and companies for greater transparency and accountability (Dunlap & Riquito, 2023). Their influence is significant in contexts where local communities have limited resources to make their voices heard in formal institutional processes.

The European Union is also emerging as an indirect but increasingly influential stakeholder. Initiatives such as the Critical Raw Materials Act reflect a strategic orientation towards strengthening security of supply and promoting the internal exploitation of critical materials, including lithium (Riofrancos, 2023). This European framework introduces new pressures on Member States by encouraging the acceleration of extractive projects.

The interaction between these different stakeholders in the Portuguese context shows a structural asymmetry of power, in which local communities and civic actors occupy positions of less formal influence compared to the state and multinational companies. According to Lin et al. (2019), a stakeholder's ability to influence decisions depends not only on their economic or institutional power, but also on the legitimacy of their claims and the urgency of the issues raised. In Portugal, environmental, territorial and cultural concerns are perceived by communities as urgent and existential.

In summary, lithium mining in the Portuguese context highlights the centrality of stakeholder management as a critical element of mining project governance. Achieving SLO depends on the ability of companies and the state to recognise the diversity of interests, reduce power differences and promote effective dialogue and participation processes. The absence of this recognition and the failure to implement strategies that promote it means that energy transition projects are persistent sources of social conflict.

2.5. Integrated Analytics

To tackle the fragmentation in the existing literature, this study suggests a clear integrated analysis that connects internationalisation, CSR, SLO and stakeholder dynamics. In this approach, internationalisations are seen not just as an economic process but as one deeply rooted in social aspects. Here, internationalisation drives entry into new markets; CSR serves as the strategic tool to manage stakeholders' expectations; and SLO emerges as a dynamic outcome of these interactions.

Social legitimacy stops being just an extra measure and becomes a key requirement for a project's success, especially in situations where power imbalances between the state, companies, and local communities, like in Barroso in the Northern Portugal, are more pronounced.

3. Research Methodology

This study adopts a qualitative and exploratory approach, suitable for the analysis of complex economic, social, territorial and environmental phenomena (Porak & Reinke, 2024), focusing on the Portuguese context of lithium exploration, specifically the case of the Barroso Mines in the Northern Portugal.

The methodology is based on document analysis through the content analysis technique (Bowen, 2009). To ensure methodological rigor and transparency, a systematic document analysis was conducted. Data was retrieved from the *Web of Science* database and supplemented by institutional repositories to capture a multi-dimensional view of the industry. The search timeframe spanned from 2009 to 2025, ensuring the inclusion of the most recent regulatory developments, such as the *Critical Raw Materials Act* (Regulation (EU) 2024/1252, 2024).

The search strategy employed a combination of the following keywords: "*lithium mining", "internationalisation strategies", "corporate social responsibility", "social license to operate",* and *"stakeholders"*. To maintain the level of rigour analysis, inclusion and exclusion criteria were applied:

- Inclusion: Peer-reviewed articles focusing on the extractive sector, official EU and national regulatory frameworks, and technical reports specifically related to Portuguese lithium projects.
- Exclusion: Studies unrelated to the extractive industry, duplicate entries, and documents that did not offer substantial evidence regarding the four conceptual pillars of this research.

As shown in Table 1, a total of 50 documents were selected for final analysis.

Table 1: Documents selection

Document Category	**Quantity**	**Primary Role in the Analysis**	**Key sources/ Examples**
Scientific Articles	43	Providing the theoretical foundation and critical global perspectives on the four research axes	Web of science indexed articles (e.g., Carroll, 1999: Owen & Kemp, 2013; Haslam et al., 2019, Setyawan, 2025)

Document Category	Quantity	Primary Role in the Analysis	Key sources/ Examples
Regulatory Frameworks	3	Defining the legal and strategic constraints at European and National levels.	*Critical Raw Materials Act, European Green Deal* and National Mining Dispatches
Technical & Institutional Reports	4	Providing empirical data and case-specific details on the Portuguese lithium sector	DGEG/LNEG reports and *Savannah Resources* technical documentation

Source: Authors

The analysis followed a deductive thematic coding procedure. The coding frame was constructed *a priori*, manually, derived directly from the research question to ensure that the analysis remained focused on the core objectives.

The coding process was executed in three distinct phases:

1. Initial Coding: Documents were screened to identify "units of meaning", sentences or paragraphs, that addressed the primary axes: *Internationalisation, CSR, SLO* and *Stakeholders*.
2. Category Refinement: Themes were defined based on theoretical constructs. For instance, segments discussing the internationalisation theories and concepts were categorised under *Internationalisation*, while those regarding "community trust" and "procedural justice" were coded under *SLO.*
3. Synthesis and Derivation of Conclusions: Conclusions were derived through a thematic synthesis of the coded data. This involved triangulating information from different source types. By identifying patterns of convergence and contradiction between these sources, particularly regarding the Barroso region, the study was able to move beyond descriptive summary to offer a critical analysis of the tensions within the Portugues Lithium context.

The structured approach ensures that the findings are grounded in a transparent and replicable process, providing a robust conceptual foundation despite the absence of primary empirical data.

4. Discussion

This research was based on a qualitative and exploratory analysis of 50 documents. It aims to explore how internationalisation strategies, Corporate Social Responsibility (CSR) practices, and stakeholder relationship management affect the attainment and maintenance of a Social License to Operate (SLO) in the context of lithium exploration in Portugal. To achieve this, the documentary analysis focuses on four key themes derived deductively from the research question: i) internationalisation strategies in the lithium industry; ii) CSR in extractive contexts; iii) SLO as a condition of project legitimacy and iv) stakeholder dynamics in the Portuguese context.

The examination of internationalisation strategies reveals that, in the lithium industry, these strategies mainly respond to resource concentration and geopolitical vulnerability. Studies emphasize the importance of foreign direct investment, vertical integration and state-supported expansion for securing access to critical raw materials (Bos & Forget, 2021; Sun et al., 2024;

Vivoda, 2011). At the European level, regulations such as Regulation (EU) 2024/1252 and broader policy aimed at strategic autonomy strengthen the political aspect of international expansion.

The analysis reveals a fundamental tension between the EU's strategic drive for supply-chain autonomy and the territorial identity of the Barroso region (Barreira et al., 2022; Riofrancos, 2023). While internationalisation strategies are framed as essential for the global energy transition, the Barroso case demonstrates that a significant tension becomes evident (Araújo et al., 2022; Dunlap & Riquito, 2023).

The "liability of foreignness" in mining (Haslam et al., 2019) cannot be overcome by legal compliance alone. The conflict documented in Northern Portugal underscores a procedural injustice: local communities perceive themselves as excluded from a centralised decision-making process that prioritises global mineral security over local heritage and ecosystems. Thus, the analysis indicates that internationalisation in the lithium sector is not merely an economic or geopolitical process, but also a social one influenced by local legitimacy (Owen & Kemp, 2013; Prno, 2013).

The second thematic analysis shows that in contested contexts, CSR initiatives may be perceived as insufficient or strategically instrumental, particularly when they fail to address deeper issues such as procedural justice, transparency and power asymmetries. However, the document analysis reveals a gap between normative CSR models and critical perspectives emerging from extractive contexts. Research on lithium exploration in Portugal suggests that CSR initiatives may seem inadequate or strategically driven when they fail to tackle deeper issues of procedural justice and power asymmetry (Dall-Orsoletta et al., 2025; Dunlap & Riquito, 2023). Reflecting the theoretical categories of CSR previously discussed, the analysis shows that these initiatives in Portugal often fail to secure acceptance because they do not address power asymmetries.

This comparison shows that CSR, while necessary, is not automatically sufficient to secure social legitimacy (Owen & Kemp, 2013; Eerola et al., 2023). Its success depends on how well it integrates into essential corporate governance practices and on its perceived authenticity in affected territories. Therefore, CSR should not be viewed just as a reputation tool, but as a structural requirement for aligning global investment strategies with local needs.

The third theme centres on the SLO concept. Foundational literature defines SLO as a Dynamic, relational and informal form of community acceptance (Owen & Kemp, 2013; Prno & Scott Slocombe, 2012). The reviewed European studies confirm that legal authorisation does not equal social approval (Eerola et al., 2023).

When analysing the Portuguese case, the findings reinforce that SLO remains a fragile and contingent process in the Barroso region, where legal compliance has proven insufficient to replace genuine community trust (Araújo et al., 2022; Santos & Simões, 2025).

The findings suggest that the Social License to Operate should not be interpreted as a direct outcome of CSR implementation. SLO emerges as a contingent and relational process shaped by stakeholder perceptions, institutional trust, and governance quality. In contexts characterised by asymmetries between multinational corporations, the state, and local communities, SLO remains fragile and subject to continuous renegotiation (Owen & Kemp, 2013; Prno & Scott Slocombe, 2012; Dall-Orsoletta et al., 2025).

The final theme concerning stakeholder relationships shows that stakeholder theory (Freeman, 1988; Freeman & Dmytriyev, 2017) provides a framework for understanding how organisations need to create value across multiple affected groups. In extractive industries, the diversity of actors, including governments, local communities, NGOs and international organizations, creates complex governance environments (Mbilima, 2021).

In Portugal there are structural asymmetries between multinational corporations, state authorities and local communities. The State has dual role as both regulator and promoter of critical mineral extraction (Barreira et al., 2022). This positioning can lead to a perception of conflict of interest and weaken trust in institutions (Dall-Orsoletta et al., 2025).

The analysis of stakeholder-oriented literature (Lin et al., 2019) indicates that influence comes not only from formal authority but also from legitimacy and urgency. In Barroso, north of Portugal, local identity and environmental preservation are viewed as vital concerns, which increases local activism (Araújo et al., 2022; Dunlap & Riquito, 2023).

This thematic line underscores that managing stakeholders in lithium projects must evolve from mere consultation towards participatory governance structures. Without this change, internationalisation strategies remain vulnerable to disruption.

5. Conclusion

This study set out to analyse Portugal's position within the global lithium value chain, examine how internationalisation strategies, Corporate Social Responsibility (CSR), stakeholder dynamics, and the Social Licence to Operate (SLO) interact, and explore how these dimensions shape the construction of legitimacy in contested territorial contexts. By focusing on the Portuguese case, particularly the Barroso region, the study provides a territorially grounded perspective on the tensions between global energy transition objectives and local socio-territorial realities.

The findings show that internationalisation, CSR, SLO and stakeholder dynamics are closely interconnected in the governance of lithium extraction. The Portuguese context illustrates that the viability of extractive projects cannot be understood solely through economic or geopolitical lenses but depends fundamentally on the ability to secure social legitimacy within specific local contexts.

A central insight emerging from this study is the structural tension between global energy transition goals and local experiences of extractive development. While lithium is framed as a strategic resource for decarbonisation and energy security, local communities often perceive exclusion from decision-making processes, as well as an uneven distribution of impacts and benefits. This reinforces the idea that the legitimacy is not an automatic outcome of regulatory compliance or CSR implementation, but rather a dynamic and negotiated process shaped by stakeholder perceptions, trust, and power relations.

From a practical perspective, the findings suggest that companies operating in the lithium sector need to move beyond a purely instrumental approach to CSR. Instead of functioning primarily as a reputational tool, CSR should be embedded in core strategic decision making. Early, continuous, and meaningful stakeholder engagement, combined with transparent

communication and genuine consideration of local concerns is essential to reduce conflict and enhance project viability, particularly in contested regions such as Barroso.

At the policy level, the findings highlight the need for more robust, transparent, and participatory governance frameworks. Public authorities should ensure that decision-making processes are inclusive and capable of addressing power asymmetries between stakeholders. At the same time, the dual role of the state, as both a promoter and regulator of mining projects, must be carefully managed to avoid perceptions of conflict of interest and to strengthen institutional trust. Ensuring a fair distribution of benefits and burdens is also critical to align national strategic objectives with local expectations.

In terms of internationalisation, the study shows that the access to critical raw materials is not determined just by resource availability or positioning within global value chains. Rather, it is increasingly conditioned by the ability of firms and states to secure legitimacy. This suggests that internationalisation strategies, in the extractive industries, must integrate social and territorial dimensions as core elements, rather than treating them as secondary or external constraints.

Finally, this study highlights the need for further research based on in-depth case study approaches. While the document analysis adopted here provides a broad and structured understanding of the topic, future research would benefit from qualitative methods, such as interviews and fieldwork, to capture more fully the complexity of stakeholder interactions and governance dynamics at the local level, such as Barroso, that could offer valuable insights into how legitimacy is constructed, contested, and negotiated in practice, helping to bridge the gap between global strategic narratives and local realities.

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A scientific paper

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CROSS-CULTURAL CHALLENGES IN AI-DRIVEN MARKETING CAMPAIGNS: STRATEGIES FOR EFFECTIVE LOCALIZATION AND CONSUMER ENGAGEMENT

ABSTRACT

Artificial intelligence (AI) has transformed global marketing by enabling large-scale personalization, predictive analytics, and automated content generation. However, the effectiveness of AI-driven campaigns varies across cultural contexts, as cultural norms, trust perceptions, and privacy expectations shape how consumers interpret algorithmically generated messages. This paper examines the main cross-cultural challenges in AI-driven global marketing and identifies factors that influence effective localization and consumer engagement. The study applies a quantitative research design grounded in Hofstede's cultural dimensions and the Technology Acceptance Model. Data was collected through an online survey of 238 digital consumers from multiple countries. The analysis includes descriptive statistics, reliability testing, exploratory factor analysis (EFA), one-sample t-tests, and multiple regression. The findings show that perceived cultural relevance, personalization acceptance, and positive ad attitudes significantly predict engagement and purchase intent, where trust in AI and privacy concerns do not have a direct effect when cultural and attitudinal variables are included in the model. The study contributes to the literature by showing that AI personalization is most effective when it is culturally aligned, transparent, and responsive to local expectations. The results support the strategic importance of glocalization in international AI-driven marketing.

Key words: *AI-driven marketing; Cross-cultural marketing; Cultural relevance; Consumer engagement..*

1. Introduction

Artificial intelligence (AI) is reshaping contemporary marketing by improving how organizations analyze data, segment audiences, personalize messages, and automate content delivery. Advances

in machine learning, predictive analytics, and automation enable firms to respond to consumer behavior in real time and optimize communication across multiple digital channels (Chaffey, 2022; Davenport & Ronanki, 2018). As a result, AI has become a central tool in global marketing practice, especially in recommendation systems, programmatic advertising, and customer interaction platforms.

At the same time, the global expansion of AI-driven marketing has exposed an important limitation: campaigns that are technically effective are not always culturally effective. AI systems often operate on datasets, assumptions, and behavioural patterns shaped by dominant markets, especially Western ones. This creates risks when campaigns are transferred across countries with different values, languages, social norms, and privacy expectations (Okazaki & Taylor, 2022; Shrestha et al., 2019). A message that appears relevant and persuasive in one cultural environment may be perceived as intrusive, inappropriate, or simply irrelevant in another.

This issue is particularly important because marketing communication is not interpreted only through data patterns. It is also filtered through cultural expectations, symbolic meanings, and local understandings of trust and relevance. Previous research in cross-cultural marketing has shown that consumer reactions are shaped by differences in individualism, uncertainty avoidance, power distance, communication style, and social norms (de Mooij, 2019; Hofstede et al., 2010). In AI-driven settings, these differences become even more significant because algorithms personalise messages automatically, often without sufficiently accounting for local meanings.

The practical implications are substantial. While firms increasingly invest in AI-enabled personalization and automation, poorly localized campaigns can undermine engagement, weaken trust, and damage brand reputation. The topic is therefore relevant not only from a technological perspective but also from a managerial and societal one. Academically, it addresses a gap between AI marketing research, which often focuses on performance metrics, and cross-cultural research, which emphasises human interpretation and context. Managerially, it speaks to the challenge of balancing global scalability with local relevance. Socially, it relates to concerns about fairness, inclusiveness, and privacy in data-driven communication. Against this background, the paper examines how cultural relevance, trust in AI-generated content, personalization acceptance, privacy concerns, and ad attitudes shape consumer engagement in AI-driven marketing. The study is guided by the following research questions:

RQ1: What are the main cultural challenges that AI-driven marketing campaigns face in international markets?
RQ2: How do cultural contexts influence consumer trust, acceptance, and engagement with AI-generated marketing content?
RQ3: What strategies can companies adopt to localize AI-driven campaigns effectively across different cultural environments?

2. Literature Review and Theoretical Framework

2.1. AI in Global Marketing

Artificial intelligence has transformed global marketing by enabling advanced predictive analytics, dynamic content automation, omnichannel integration, and highly personalized consumer experiences. Recommendation algorithms on platforms like Netflix and Spotify deliver customized content at scale, while programmatic advertising tools such as Google Ads and Facebook Ads optimize bidding, targeting, and content delivery in real time. Brands like Sephora, H&M, and KLM also use AI-powered chatbots to provide 24/7 customer support and personalized recommendations, improving efficiency and customer satisfaction (Rust, 2020; Huang & Rust, 2021).

Recent industry reports emphasize AI's growing impact: McKinsey (2023) notes that AI-driven personalization can increase marketing ROI by 10–15%, Gartner (2022) reports that over 70% of high-performing marketing organizations use AI for insights and segmentation, and the Harvard Business Review (2021) finds that more than 80% of retail executives plan to expand investment in AI automation.

However, many AI systems prioritize technical optimization, improving click-through rates, conversions, and return on ad spend, while neglecting cultural adaptation (Okazaki & Taylor, 2022). Even globally popular tools require localization: for example, Spotify must adapt playlist names, featured artists, and artwork to align with local cultural preferences (Tschang, 2022). Without such cultural awareness, even well optimized campaigns risk failing to connect with consumers or causing reputational harm (Robertson, 2020).

2.2. Cross-Cultural Challenges in Marketing

Cross-cultural marketing research shows that consumer responses to advertising are shaped by values, communication styles, symbolic codes, and social norms. Culture influences what is perceived as persuasive, respectful, trustworthy, or intrusive (de Mooij, 2019). These differences become especially important in AI-driven communication because algorithms automate decisions about tone, targeting, imagery, and timing at scale. A central challenge is that many AI systems are trained on data reflecting dominant cultural assumptions. When such systems are exported to different environments, they may reproduce cultural bias or overlook locally meaningful cues (Shrestha et al., 2019). This problem is not only linguistic. It also affects humour, authority cues, social identity markers, holiday references, emotional tone, and privacy expectations. As a result, campaigns may appear generic in one market and inappropriate in another.

Hofstede's cultural dimensions remain useful for explaining why such differences matter. In more individualistic societies, personalized communication may be interpreted as useful and self-relevant. In more collectivist settings, the same message may require stronger social or contextual framing. Similarly, consumers in high uncertainty-avoidance cultures may be more sceptical of opaque algorithmic decisions, especially when the logic of personalization is unclear. Power distance also matters because communication styles involving authority, expertise, or direct persuasion may be interpreted differently across hierarchical and egalitarian contexts.

The literature therefore suggests that AI-driven campaigns face at least three interrelated cross-cultural challenges: first, ensuring that the content is culturally relevant rather than merely personalised; second, addressing different levels of trust in automated communication; and third, managing privacy expectations that vary across societies. These challenges are closely related but should not be treated as identical. A consumer may recognise that a message is culturally relevant while still distrusting AI as a source of communication or may appreciate personalization while feeling uncomfortable with the data practices behind it.

2.3. Localization and Glocalization in AI Marketing

Localization in AI marketing involves much more than translation. It includes the adaptation of visual cues, language, symbols, tone, timing, and platform-specific communication patterns to local expectations (Liu et al., 2021; Okazaki & Taylor, 2022). In practice, successful localization often depends on combining algorithmic efficiency with human cultural knowledge. This is why the concept of glocalization is particularly useful: global technological capabilities are retained, but campaign execution is adapted to local meanings and contexts.

Examples from practice illustrate this logic. Netflix localises not only content recommendations but also artwork and promotional framing. Amazon and Alibaba adapt recommendation systems to local shopping routines, payment norms, and sales events. Such cases suggest that AI can support localization effectively, but only when local cultural interpretation is built into the system or its managerial use.

At the same time, localization is not automatically guaranteed by personalization. Personalization tends to infer individual preferences from data history, whereas localization requires sensitivity to shared social and cultural meanings. A campaign can therefore be personalised without being culturally appropriate. This distinction is important for theory and for practice, because it implies that technical precision alone is insufficient for international effectiveness.

2.4. Theoretical Framework

This study combines Hofstede's cultural dimensions with the Technology Acceptance Model (TAM) and broader consumer behaviour research. Hofstede's framework helps explain why cultural environments shape reactions to AI-generated content. TAM contributes by focusing on how users evaluate technological systems through perceptions of usefulness, ease, trust, and risk. Consumer behaviour
research complements these perspectives by explaining how relevance, emotion, and attitudes influence engagement and purchase-related outcomes.

The integration of these frameworks supports a model in which consumer engagement with AI-driven marketing is not determined by technology alone. Instead, engagement depends on whether the communication is culturally meaningful, personally acceptable, and positively evaluated at the attitudinal level. Trust in AI and privacy concerns remain important contextual factors, but they may function more as background conditions than as direct drivers of engagement when other variables are considered.

2.5. Hypothesis Development

Perceived cultural relevance and engagement

The literature consistently suggests that marketing communication is more effective when it reflects local meanings, symbols, and values. In AI-driven environments, cultural relevance becomes especially important because automated systems can otherwise produce content that appears detached from the consumer's social context. If consumers perceive AI-generated marketing as culturally adapted, they are more likely to evaluate it as relevant and respectful. This should increase willingness to engage with the ad and the brand.

H1: Perceived cultural relevance of AI-driven marketing positively influences consumer engagement and purchase intent.

Personalization acceptance and engagement

Personalization is one of the most widely cited benefits of AI in marketing, but its effectiveness depends on whether consumers accept personalised communication as beneficial rather than intrusive. When consumers perceive personalization as useful and convenient, they are more likely to respond positively to recommendations and targeted messages. This relationship is consistent with the logic of TAM and with prior work on the personalization–privacy paradox.

H2: Personalization acceptance positively influences consumer engagement and purchase intent in AI-driven marketing.

Ad attitude and engagement

Consumer behaviour theory suggests that favourable attitudes toward advertising increase the likelihood of behavioural response. In AI-driven contexts, positive ad attitudes may reflect perceived usefulness, interest, entertainment, or relevance. If consumers evaluate AI-enabled advertising positively, they should be more likely to click, purchase, or recommend.

H3: Positive attitudes toward AI-enabled advertising positively influence consumer engagement and purchase intent.

Trust in AI and privacy concerns are included in the model as control variables. Prior research suggests that both shape the broader evaluation of AI-mediated communication, but their direct influence on engagement may weaken when more proximal predictors such as cultural relevance, personalization acceptance, and ad attitudes are included.

3. Research Methodology

3.1. Research Design

This study employs a quantitative research design to examine how AI-driven marketing is perceived across different cultural contexts and how these perceptions shape consumer attitudes

and engagement. The framework draws on Hofstede's cultural dimensions, the Technology Acceptance Model (TAM), and the personalization paradox, which together guide both the conceptual model and hypothesis development. A quantitative, cross-sectional online survey was chosen because it effectively identifies cultural patterns, group differences, and correlations at a single point in time (Malhotra et al., 2017; Steenkamp, 2001).

Online distribution enables participation from diverse, geographically dispersed respondents and supports the use of standardized measurement tools common in international research (Bryman & Bell, 2019; ESOMAR, 2023). The conceptual model is based on the literature reviewed above. Perceived cultural relevance, personalization acceptance, and ad attitude are treated as the main explanatory variables. Trust in AI and privacy concerns are included as control variables to isolate the effects of cultural relevance, personalization, and ad attitude on engagement, while accounting for broader perceptions of AI-related trust and privacy concerns

3.2. Target Population and Sampling

The target population consisted of adult digital consumers aged 18 years or older who had exposure to online advertising and AI-driven recommendations. Because the study focuses on cross-cultural marketing, respondents were recruited from multiple countries. The sample included 238 valid responses. Although the participant pool is culturally diverse, it is strongly concentrated in Germany, followed by Serbia and Montenegro, with smaller representations from several other countries.

A combination of convenience and purposive sampling was used. The survey was distributed through university mailing lists, LinkedIn, and social media channels. This approach was chosen to reach digitally active respondents who regularly encounter personalized advertising and recommendation systems. While non-probability sampling limits generalizability, it is appropriate for exploratory work on a contemporary topic where digital exposure is a key inclusion criterion.

3.3. Survey Instrument and Data Collection Procedure

The survey instrument draws on established, validated scales adapted for the AI-marketing context. It includes seven sections: informed consent, demographics, digital behavior, key constructs measured with Likert-type scales, scenario-based items, behavioral intentions, and one open-ended question. Most constructs use five-point Likert scales, following best practices in cross-cultural consumer research (Steenkamp & Baumgartner, 1998). It measured six constructs: perceived cultural relevance (PCR), trust in AI marketing (TAI), personalization acceptance (PA), privacy concerns (PC), ad attitude (AA), and purchase/engagement intent (PI).

Data collection is conducted online via Google Forms and distributed through academic partners, professional marketing networks, and targeted online communities to ensure culturally diverse participation. Recruitment messages emphasize voluntary and anonymous participation in line with ethical standards (ESOMAR, 2023). Screening questions confirm that respondents are at least 18 years old and have exposure to digital marketing. All responses are kept fully anonymous. The only personal detail collected is country of residence for cross-country comparison. No sensitive information (such as names or IP addresses) is gathered. Data is encrypted and stored on secure

university servers in compliance with GDPR and institutional policies (European Commission, 2021).

3.4. Data Analysis Plan

The data were analyzed in several stages. First, the dataset was screened for completeness and basic consistency. Descriptive statistics were then calculated for the demographic profile and for each construct. Internal consistency was assessed using Cronbach's alpha. Because the constructs are theoretically related, the analysis also considered the need for closer inspection of how the variables behave in the regression model. One-sample t-tests were used to compare construct means with the neutral midpoint of the scale, not as a substitute for normality testing, but to show whether respondents tended toward agreement, disagreement, or neutrality on the measured constructs. Multiple regression was then used to evaluate the hypotheses, with purchase/engagement intent as the dependent variable. Model diagnostics were examined before the interpretation of the regression coefficients. In addition to reliability testing, an exploratory factor analysis (EFA) was conducted to examine the underlying structure of the measurement items and assess construct validity prior to regression analysis.

3.5. Ethical Considerations

This research adheres to strict ethical guidelines, including obtaining informed consent, ensuring voluntary participation, and protecting respondent anonymity. Information sheets detail participants' rights, including the right to withdraw at any point and the option to skip questions without penalty. Data collection and storage are compliant with the GDPR, and no personal identifiers are recorded. Ethical approval will be sought from the home institution's review board prior to launch. Any adverse events or participant concerns will be addressed promptly, and findings will be disseminated transparently (ESOMAR, 2023).

4. Research Results

4.1. Sample Profile

The survey produced 238 valid responses. The sample was dominated by respondents from Germany (71.7%), followed by Serbia (8.0%) and Montenegro (4.6%), with smaller shares from other countries. In age terms, the sample was overwhelmingly young: 61.3% of respondents were aged 18–24 and 36.6% were aged 25–34. Gender distribution was relatively balanced, with a slight female majority. Most respondents were also highly active online, and most reported frequent exposure to personalised advertising.

This profile is useful for interpreting the findings. On the one hand, the sample is appropriate for studying AI-driven marketing because it consists largely of digitally active users who regularly encounter algorithmic recommendations. On the other hand, the dominance of Germany and the concentration in younger age groups limit the extent to which the findings can be presented as fully cross-cultural in a comparative sense. The study is therefore better interpreted as cross-cultural in scope and intent than as a balanced cross-national comparison. This directly addresses one of the reviewers' concerns and should be stated clearly in the revised version.

4.2. Reliability Analysis

Table 1 presents the Cronbach's alpha coefficients for the six constructs.

Table 1: Reliability analysis of study constructs

Construct	Cronbach's Alpha	Interpretation
Perceived Cultural Relevance (PCR)	0.623	Acceptable (exploratory)
Trust in AI Marketing (TAI)	0.780	Good reliability
Personalization Acceptance (PA)	0.699	Acceptable reliability
Privacy Concerns (PC)	0.826	High reliability
Ad Attitude (AA)	0.844	High reliability
Purchase/Engagement Intent (PI)	0.720	Good reliability

Source: Authors

The reliability results are satisfactory overall. Most constructs meet or approach the conventional threshold of 0.70, while privacy concerns and ad attitude show particularly strong internal consistency. The alpha value for perceived cultural relevance is lower than the others, but remains acceptable for exploratory research, especially in a study dealing with culturally variable interpretations. These results justify the use of the constructs in the subsequent analyses.

4.3. Exploratory factor analysis (EFA)

An exploratory factor analysis (EFA) was conducted to examine the underlying structure of the measurement items and to assess construct validity. The analysis was performed using principal component analysis with varimax rotation.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were used to evaluate the suitability of the data for factor analysis. The results indicate that the data are appropriate for factor analysis, as shown in Table 2.

Table 2: KMO and Bartlett's test

Test	Value
Kaiser-Meyer-Olkin (KMO)	0.869
Bartlett's Test χ^2	1872.33
df	153
Sig.	<0.001

Source: Authors

The KMO value of 0.869 indicates strong sampling adequacy, while Bartlett's test is statistically significant ($p < 0.001$), confirming that the correlations between variables are sufficiently large for factor analysis.

Table 3: Total variance explained

Factor	Eigenvalue	% of Variance	Cumulative %
1	6.234	34.64	34.64
2	2.348	13.04	47.68
3	1.506	8.37	56.04
4	1.126	6.26	62.30
5	1.028	5.71	68.01

Source: Authors

The results in table 3 show that five factors with eigenvalues greater than 1 were extracted, explaining 68.01% of the total variance. This indicates that the factor structure captures a substantial proportion of the variance in the data.

The rotated component matrix (main loadings) is presented in Table 4, showing that items load strongly on their respective constructs.

Table 4: Rotated component matrix

Construct	Items	Loadings
Perceived Cultural Relevance	PCR1, PCR2	0.820 – 0.715
Trust in AI Marketing	TAI1, TAI2, TAI3	0.726 – 0.797
Personalization Acceptance	PA1, PA3	0.817 – 0.837
Privacy Concerns	PC1, PC2, PC3	0.838 – 0.879
Ad Attitude	AA1, AA2, AA3	0.699 – 0.768
Purchase Intent	PI1, PI2	0.717 – 0.832

Source: Authors

The results presented in Table 4 indicate that the items load strongly on their respective constructs, with all reported factor loadings exceeding the recommended threshold of 0.5. This suggests that the measurement items are appropriately associated with their intended constructs. However, some overlap is observed among attitudinal variables such as trust in AI, ad attitude, and engagement, indicating that these constructs are empirically related. This is consistent with their theoretical interdependence in the context of AI-driven marketing.

Overall, the EFA results support the adequacy of the measurement model and confirm that the constructs are suitable for further statistical analysis, including regression.

4.4. Descriptive Statistics

Table 5: Descriptive statistics for the main constructs

PCR	**238**	**3.10**	**0.78**	**0.050**	**2.996**	**3.194**
TAI	238	2.59	0.89	0.057	2.474	2.699
PA	238	3.12	0.86	0.055	3.013	3.232
PC	238	4.03	0.97	0.062	3.90	4.152
AA	238	2.90	0.92	0.059	2.780	3.015
PI	238	2.90	0.82	0.053	2.793	3.002

Source: Authors

The descriptive results show a clear pattern. Respondents reported the highest mean for privacy concerns, suggesting that discomfort with data use remains strong in AI-driven marketing. Personalization acceptance and cultural relevance are both slightly above the neutral midpoint, indicating cautious but present openness to AI-enabled relevance when it is seen as meaningful. Trust in AI marketing is below neutral, suggesting skepticism about algorithmic credibility. Ad attitude and engagement intent are both close to neutral, which implies that respondents are neither strongly positive nor strongly negative overall. This pattern is useful because it shows that consumers may appreciate relevance without necessarily trusting the system behind it.

4.5. One-sample t-tests

To determine whether the construct means differed significantly from the scale midpoint, one-sample t-tests were conducted using 3 as the test value. “This approach allows for a straightforward interpretation of whether respondents’ perceptions significantly deviate from neutrality, complementing the regression analysis.

Table 6: One-sample t-tests against the neutral midpoint

Construct	N	Mean	SD	t	df	Sig. (2tailed)	Mean Difference
PCR	238	3.095	0.778	1.887	237	0.06	0.095
TAI	238	2.587	0.886	-7.196	237	0	-0.413
PA	238	3.123	0.86	2.211	237	0.028	0.123
PC	238	4.029	0.969	16.388	237	0	1.029
AA	238	2.898	0.923	-1.708	237	0.089	-0.102
PI	238	2.898	0.822	-1.918	237	0.056	-0.102

Source: Authors

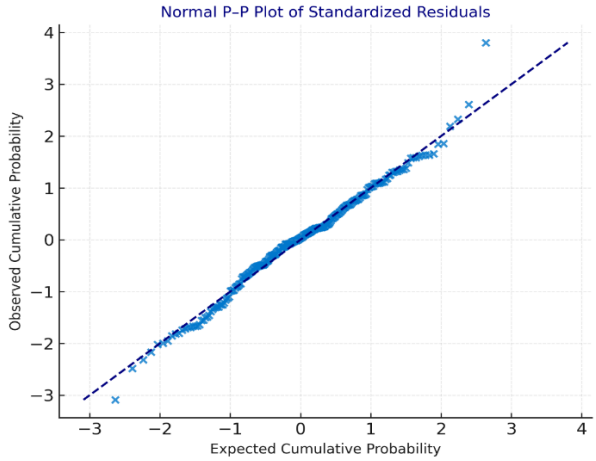
These tests show that trust in AI is significantly below neutral, while privacy concerns are significantly above neutral. Personalization acceptance is slightly but significantly above the midpoint. By contrast, perceived cultural relevance, ad attitude, and purchase/engagement intent do not differ significantly from neutrality. This suggests that respondents are not fully convinced

that AI-driven marketing is culturally adapted or behaviourally persuasive, even though they do recognise some value in personalization.

4.6. Model Diagnostics

Before interpreting the regression model, diagnostic checks were conducted to verify that the assumptions of multiple regression were adequately met.

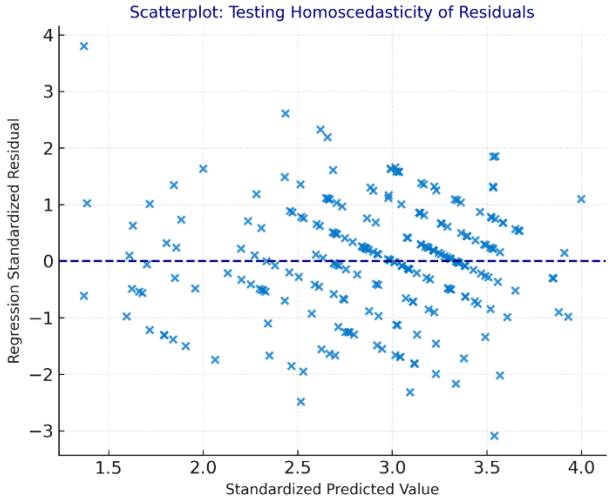
Figure 1: Normal P–P plot of regression standardized residuals



Source: Authors

The normal P–P plot (Figure 1) indicated that the standardized residuals followed the diagonal line closely, suggesting that the residuals were approximately normally distributed.

Figure 2: Scatterplot of standardized residuals vs. predicted values



Source: Authors

The scatterplot of standardized residuals against predicted values (Figure 2) showed a random pattern around zero, which supports the assumption of homoscedasticity. No serious outliers or influential cases were identified, and multicollinearity remained within acceptable limits, with variance inflation factors below 3.

4.7. Multiple Regression Analysis

The multiple regression model used purchase/engagement intent (PI) as the dependent variable. Perceived cultural relevance (PCR), personalization acceptance (PA), and ad attitude (AA) were included as the main independent variables. Trust in AI marketing (TAI) and privacy concerns (PC) were included as control variables because theory suggests that they shape broader consumer perceptions of AI-driven communication.

The overall model was statistically significant, $F(5, 232) = 37.07$, $p < 0.001$, with $R^2 = 0.444$ and adjusted $R^2 = 0.432$. This indicates that the model explains approximately 44% of the variance in purchase/engagement intent.

Table 7: Multiple regression results predicting purchase/engagement intent

Variable	Coefficient	Std. Error	t	p
PCR	0.231	0.058	3.978	<.001
TAI	0.016	0.065	0.255	.799
PA	0.184	0.062	2.954	.003
PC	0.032	0.042	0.746	.457
AA	0.347	0.068	5.095	<.001

Source: Authors

The results support all three hypotheses. Perceived cultural relevance is positively associated with purchase/engagement intent, which supports H1. Personalization acceptance also has a significant positive effect, supporting H2. Ad attitude is the strongest predictor in the model, which supports H3 and suggests that the emotional or evaluative response to AI-enabled advertising is particularly important for behavioural intention.

By contrast, trust in AI and privacy concerns do not have statistically significant direct effects in the full model. This does not mean that they are unimportant. Rather, it suggests that their influence may be indirect or may operate through broader evaluative mechanisms. In other words, consumers may remain sceptical of AI and concerned about privacy but still engage when they perceive the content as culturally relevant, useful, and positively framed.

5. Discussion

The findings provide a more nuanced view of AI-driven marketing than a purely technical interpretation would suggest. The results indicate that engagement is not driven simply by the

presence of AI or by the automation of personalization. Instead, consumer response depends on whether the marketing communication is perceived as culturally relevant, personally useful, and positively experienced at the attitudinal level.

The significance of perceived cultural relevance is especially important. It supports the argument that AI-generated communication must be interpreted within cultural contexts rather than treated as universally transferable. This finding is consistent with cross-cultural marketing theory, which emphasises that values, norms, and symbolic meanings affect how messages are decoded. It also supports the logic of glocalization: AI can generate scale, but local cultural interpretation remains essential for effectiveness. The results of the exploratory factor analysis (EFA) further support the adequacy of the measurement model, although some overlap among attitudinal constructs was observed, reflecting their theoretical interdependence.

The positive effect of personalization acceptance is also theoretically meaningful. It suggests that personalization can improve engagement when consumers view it as relevant rather than intrusive. This aligns with the personalization–privacy paradox literature, where the benefits of personalization coexist with discomfort about surveillance and data collection. In the present study, consumers showed relatively high privacy concerns, but those concerns did not directly predict engagement once other variables were included. This implies that privacy matters as a contextual condition but may not be the immediate determinant of behavioural intention.

Ad attitude emerged as the strongest predictor in the regression model. This highlights the role of emotional and evaluative reactions in AI-driven marketing. Even highly targeted communication may fail if it is perceived as dull, repetitive, intrusive, or culturally tone-deaf. For managers, this means that technical personalization should not replace creative and culturally informed communication design.

At the same time, the results must be interpreted with appropriate caution. The sample is not balanced across countries, and the dominance of respondents from Germany limits the strength of any cross-cultural generalisation. The study therefore identifies cross-cultural challenges more convincingly than it performs strict cross-country comparison. This distinction should be made explicit in the revised paper to avoid overstating the claims, as the reviewers pointed out.

6. Conclusion, Implications, Limitations and Further Research

6.1. Conclusion

This study examined how consumers respond to AI-driven marketing across culturally diverse settings, with a focus on cultural relevance, personalization acceptance, trust in AI, privacy concerns, ad attitudes, and engagement intent. The results show that perceived cultural relevance, personalization acceptance, and ad attitude are the main predictors of purchase and engagement intent. Trust in AI and privacy concerns, while clearly important in the broader consumer evaluation of AI-driven marketing, do not have a direct effect in the final model.

The main contribution of the study lies in showing that AI-driven marketing effectiveness depends not only on technical optimization but also on cultural alignment. The findings therefore support

the idea that successful international AI marketing requires a combination of global technological capability and local cultural adaptation.

6.2. Managerial Implications

The findings suggest several implications for practice. First, firms should move beyond generic personalization and invest in culturally adaptive systems. This includes not only language adjustment but also attention to imagery, social references, tone, timing, and symbolic cues that resonate within local contexts. Campaigns that are technically personalised but culturally neutral are unlikely to generate strong engagement.

Second, marketers should recognise that positive ad attitudes remain essential in AI-driven environments. AI should not be used only to optimise efficiency metrics; it should also support communication that is relevant, credible, and appealing. Human oversight remains important in this process because local cultural interpretation often exceeds what an algorithm can infer reliably from behavioural data.

Third, the high level of privacy concern in the sample suggests that transparency should remain a strategic priority even if privacy does not directly predict engagement in the regression model. Brands should communicate clearly how data are used and should offer visible user control. Such measures can strengthen legitimacy and reduce the risk of backlash, especially in markets where data sensitivity is high.

6.3. Limitations

Several limitations should be acknowledged. The most important is the composition of the sample, which is heavily dominated by respondents from Germany and younger age groups. This limits the extent to which the results can be generalised across cultures or age cohorts. In addition, the use of self-reported survey data introduces the usual risks of subjective bias, including social desirability and differences in interpretation. The cross-sectional design also captures perceptions at only one point in time and cannot account for how responses to AI-driven marketing may evolve as technologies and user expectations change. Although the EFA supports construct validity, some overlap among variables suggests that future research could apply confirmatory factor analysis (CFA) for further validation.

A further limitation is that the study does not include a full cross-country comparative model, despite its cross-cultural orientation. This should be stated clearly rather than hidden, because it strengthens the credibility of the paper and directly answers the reviewer concern about overstated claims.

6.4. Suggestions for Further Research

Future research should build on this study in three ways. First, it should use more balanced international samples to test cross-country differences directly. Second, it should examine whether the effects observed here vary by age, platform type, or level of digital literacy. Third, future studies could strengthen construct validation by applying exploratory or confirmatory factor analysis more extensively and by testing mediation or moderation effects between trust, privacy, personalization,

and engagement. Longitudinal research would also be valuable because consumer expectations regarding AI are evolving rapidly.

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A scientific paper

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MACHINE LEARNING APPLICATIONS IN VEHICLE INSURANCE: A BIBLIOMETRIC REVIEW OF RESEARCH TRENDS

ABSTRACT

In recent years, vehicle insurance has been profoundly shaped by rapid digitalization, the emergence of usage-based insurance models, and the integration of telematics data. At the same time, machine learning techniques have been increasingly adopted for pricing, risk assessment, fraud detection, and claims management. Yet, the rapid technological progress has outpaced academic consolidation, leaving unresolved how machine learning is altering established actuarial procedures and shaping new standards in vehicle insurance pricing and risk assessment, while simultaneously shifting the paradigm of traditional actuarial practice and influencing methodological development. This study presents a bibliometric overview of the key research areas and current trends in actuarial methods applied to vehicle insurance. The review is structured around core concepts that link mandatory motor third-party liability insurance and voluntary motor hull insurance with a broad spectrum of machine learning approaches, illustrating how data-driven methods are increasingly embedded in modern actuarial research and practice. A corpus of 358 publications retrieved from the Scopus database for the period 1990-November 2025 forms the basis for identifying the most influential research themes, authors, journals, and institutions. The bibliometric analysis, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, is carried out using VOSviewer and the R package Bibliometrix with the Biblioshiny interface. By integrating machine learning techniques into an actuarial framework for vehicle insurance, this study illustrates how data-driven methods are transforming traditional actuarial modelling practices and broadening the set of analytical tools applied in actuarial research on vehicle insurance.

Key words: *machine learning, vehicle insurance, actuarial methods, bibliometric analysis.*

1. Introduction

The insurance industry is being profoundly reshaped by the digitalization of society, driven by advances in information technology, the development of advanced statistical methods, modern programming languages, and the increasing availability of large-scale data sources. To handle and analyse such data, artificial intelligence (AI) and machine learning (ML) algorithms are increasingly adopted across the insurance sector. Recent literature shows that ML techniques are being applied within insurance, including premium pricing and reserving, claim modelling, fraud detection, and enhanced risk assessment, thereby improving the accuracy and robustness

of predictive models compared to traditional methods (Blier-Wong et al., 2020; Brati et al., 2025). Vehicle insurance has been particularly affected by these changes, with ML algorithms driving the development of advanced actuarial modelling approaches, including telematics-based and usage-based insurance (UBI) models, as well as sensor-based solutions (Grize et al., 2020). In this context, vehicle insurance pricing and risk assessment have undergone particularly profound transformations, becoming increasingly sophisticated and data-driven, thus shifting the paradigm of traditional actuarial practice and influencing methodological development within the actuarial science community. By leveraging the vast datasets they routinely collect in vehicle insurance, insurers can apply ML to detect hidden patterns, better understand customer behaviour, and achieve more accurate, individually tailored risk assessments (Śmietanka et al., 2021). Predictive modelling in actuarial science has long focused on estimating the probability of discrete outcomes that inform underwriting, pricing, and risk classification decisions. In particular, actuarial techniques are widely applied to binary variables of interest, such as predicting policyholder purchasing behaviour, customer churn, the likelihood of a claim being fraudulent, or whether a claimant will initiate legal action (Charpentier, 2015). These classification tasks are central to portfolio management and risk segmentation. At the same time, actuarial modelling also addresses continuous outcomes, including claim frequency, claim severity, aggregate loss amounts, and ratemaking. Such regression-based applications form the foundation of tariff construction and reserving practices. Together, these classification and regression tasks illustrate the central role of probabilistic modelling and statistical inference in actuarial science, a framework that is increasingly being extended and enhanced through the integration of advanced ML methodologies. Apart from generalized linear models (GLM), which remain the standard for risk assessment, a wide range of supervised and unsupervised ML methods is employed in vehicle insurance. While GLM continue to represent the benchmark framework in actuarial modelling, the methodological landscape has expanded considerably. Actuarial practices include a variety of classification and regression trees (CART), ensemble methods such as random forests and gradient boosting machines, (XGBoost), neural networks, support vector machines (SVM), and clustering techniques, among others.

ML methods, now widely used in actuarial practice, are often criticized as “black-box” models, raising concerns about transparency and interpretability (Lorentzen & Mayer, 2020). The growing focus on ML applications is driven by the increasing need for highly accurate predictive models, supported by the rising dimensionality and complexity of data resulting from the expansion of telematics (Kuo & Lupton, 2023) and other advanced data collection methods. These developments enable the use of large and granular datasets, leading to increasingly complex data environments in which ML approaches demonstrate clear advantages over traditional actuarial methods, particularly in predictive performance and their ability to capture complex, non-linear relationships. However, their lack of transparency poses significant challenges in highly regulated environments, which has contributed to the broader development and adoption of Explainable Artificial Intelligence (XAI) paradigm in vehicle insurance, as a means of addressing these issues (Lozano-Murcia et al., 2025). Consequently, beyond the transition from traditional to ML methods, ensuring model interpretability has emerged as a key concern in modern actuarial practice.

Vehicle insurance is one of the largest lines of business in the insurance sector in most countries (OECD, 2020), with compulsory MTPL coverage accounting for a substantial share of annual non-life premium income (Denuit et al., 2007). It is therefore essential to examine the key research areas and current trends shaping contemporary actuarial practice in the vehicle insurance sector. This study focuses on vehicle insurance and ML applications, where the term

vehicle insurance refers to both compulsory Motor Third-Party Liability (MTPL) insurance and motor hull insurance. Motor hull insurance (also known as casco) provides coverage for damage to the insured vehicle arising from accidents, theft, natural hazards, or other unforeseen events. Mandatory MTPL insurance, on the other hand, covers losses inflicted on third parties, thereby transferring the legal liability of the vehicle owner or driver to the insurer.

Bibliometric analysis examines phenomena such as authorship, publications, and citation behaviour. The most frequently applied techniques in bibliometric analysis include citation analysis, co-citation analysis, bibliographic coupling, authorship analysis, co-word analysis, co-authorship analysis, co-occurrence analysis, and historiographic mapping (Smajlović et al., 2025, p. 17). Although a substantial body of research has explored ML applications in specific insurance domains, ranging from big data analytics in automotive, health, and property insurance to fraud detection in vehicle insurance (Benedek et al., 2022; Bhattacharya et al., 2025; Mall et al., 2023), a comprehensive bibliometric analysis of ML adoption across the vehicle insurance sector remains lacking. Given the increasing use of ML methods in this field, a bibliometric review is essential for mapping existing research. Despite the rapid expansion of studies in this area, bibliometric analyses that systematically examine ML applications in vehicle insurance are still scarce. To the best of our knowledge, this study represents the first effort to employ bibliometric techniques to summarize ML applications in vehicle insurance. This novel bibliometric assessment not only identifies influential research and authors but also highlights emerging trends and methodological innovations, providing a foundation for future research and practical applications in actuarial science. This study contributes to the literature by offering a bibliometric review of research on ML applications and trends in actuarial methods within vehicle insurance. This review aims to examine the insurance risk literature focusing on the application of ML-based methods in vehicle insurance and search for possible research gaps and opportunities for further exploration in this field. Through a bibliometric approach based on keyword co-occurrence, relevant authors, and the analysis of the most prominent journals, emerging trends and the thematic evolution of the field are explored. To accomplish the research objective, several research questions (RQs) are addressed:

RQ1: How have publication volume, growth trends, and distribution patterns evolved in research on the application of ML–based actuarial methods in vehicle insurance?

RQ2: Which authors have made the most substantial contributions to ML research in the vehicle insurance domain?

RQ3: Which publications have received the greatest scholarly attention?

RQ4: Which journals serve as the primary outlets for this line of research?

RQ5: Which research topics are emerging as key trends over time?

RQ6: Which keywords most commonly characterize the existing literature?

RQ7: What are the key themes and established research topics in the application of data-driven actuarial methods to vehicle insurance?

The paper is structured in four sections. Section 2 reviews the existing literature on ML applications in vehicle insurance, focusing on shifts in modelling approaches and analytical reasoning in vehicle insurance. Section 3 outlines the data and bibliometric methodology. Section 4 presents the results of the bibliometric network analysis, maps the scientific structure of the field, and discusses the main research themes. Finally, the conclusion presents the key findings, limitations and outlines directions for future research.

2. Theoretical Background and Literature Review

The insurance industry, particularly the vehicle insurance segment, was among the earliest sectors to adopt information technology on a large scale (Habart-Corlosquet & Janssen, 2018). Based on an overview of the field, two important developments can be observed in actuarial applications for vehicle insurance. The first is the evolution toward more sophisticated analytical frameworks, with increasing adoption of ML techniques. The second reflects the resulting conceptual shift in statistical reasoning, moving from theory-driven, parametric modelling toward data-driven and algorithmic approaches.

In the context of evolving toward more sophisticated ML methods, these approaches in vehicle insurance are built on traditional actuarial practices, strengthening and expanding their application. Traditional data sources have typically included policyholder characteristics (e.g., age, gender), vehicle attributes such as model or engine power, and geographic factors like the population density of the policyholder's residential area (Ohlsson & Johansson, 2010). Beyond these, non-traditional data sources have emerged, including Internet of Things (IoT) sensors that record driving behaviour through telematics devices (The Insurance Institute of Canada, 2021). These sources complement rather than replace traditional insurance data, offering more granular information about risk-related behaviour (EIOPA, 2019; IAIS, 2020). Actuaries increasingly apply ML and advanced methods to manage volatility, skewness, and temporal patterns in claims data (Diana et al., 2019). The complexity of big data explains the necessity for advanced analytical methods, including ML and data mining, to extract relevant information and price risk more precisely (Grize, 2015; *What is big data analytics?*, 2025). In this context, and given recent advancements in predictive modelling and actuarial science, vehicle insurance stands out as a line of business with substantial potential for innovation, shaping developments across the broader insurance sector. The rapid digitalization of the insurance industry and the growing availability of large, heterogeneous datasets have introduced new analytical challenges for actuarial practice. Modern ML methods, including regression trees, bagging, random forests, boosting algorithms, and neural networks, have emerged as powerful non-parametric or semi-parametric techniques capable of extracting complex patterns from data without requiring strong distributional assumptions (Wuthrich & Buser, 2017). In this sense, ML approaches can be viewed as natural extensions of classical actuarial models: while grounded in the same statistical foundations, they prioritize predictive accuracy through flexible algorithmic structures and the optimization of data-driven objective functions.

Next, the evolution toward advanced ML methods have fundamentally reshaped analytical paradigms, driving a broader conceptual shift in statistical reasoning. Statisticians and actuaries as well, are increasingly required to detect structure in complex datasets, identify patterns, and interpret underlying trends, activities collectively referred to as "learning from data" (Hastie et al., 2009). It is important to note that actuarial vehicle insurance pricing has traditionally relied on classical statistical frameworks, most notably GLM, introduced into actuarial science by Nelder and Wedderburn (1972) and further developed by numerous authors (Anderson et al., 2007; McCullagh & Nelder, 1989; Ohlsson & Johansson, 2010). GLM provide a parametric and interpretable foundation for modelling claim frequency and severity. As the cornerstone of traditional actuarial modelling, GLM assume a pre-specified distribution for the response variable and estimate parameters that describe the relationship between risk characteristics and expected losses. Over time, this parametric framework has become fundamental to establishing a rigorous statistical basis for insurance pricing. However, with the emergence of large and complex datasets, the limitations of purely parametric modelling have become increasingly apparent, paving the way for ML approaches in vehicle insurance. A broader paradigm shift in

statistical thinking was articulated by (Breiman, 2001) in his landmark discussion on the "two cultures". Traditionally, the data-modelling culture has dominated actuarial work, emphasizing parametric assumptions, interpretability, and statistical inference. In contrast, the rise of ML has shifted attention toward the algorithmic-modelling culture, where predictive accuracy becomes the primary goal, and the specification of a functional form is of secondary importance. As insurance datasets grow in volume and complexity, originating from diverse sources such as telematics, digital claims processing, and increasingly granular customer information, this shift becomes particularly relevant for non-life actuaries and the vehicle insurance line. (Wüthrich & Merz, 2023, p. 2) address this development by examining how classical statistical methods and modern algorithmic approaches can be integrated within a unified actuarial modelling framework. Understanding how these approaches intersect, complement each other, and can be applied in practice is increasingly a key focus in vehicle insurance, highlighting the need for a systematic bibliometric review to capture and map this ongoing transition.

The substantial growth in the use of bibliometric analysis in business research in recent years is exemplified by its application in economics (Angrist et al., 2017) and finance (Goodell et al., 2021; Kumar et al., 2025; Schwert, 2021). The growing adoption of bibliometric analysis in business research is not a temporary trend; it stems from the methodology's capacity to process vast datasets and deliver research with significant scholarly impact (Donthu et al., 2021). Previous research has extensively examined the application of advanced data-driven techniques within specific insurance domains. Key studies include the work of Mall et al. (2023), who analysed big data applications in insurance. Subsequently, Petre et al. 2025 map broader digital application trends within the same sector. Expanding the scope further, Pattnaik et al. (2024) review the state of AI and ML research across the entire BFSI (Banking, Financial Services, and Insurance) sector. Bhattacharya et al. (2025) review the adoption of AI across multiple insurance lines, including automotive, health, and property insurance, emphasizing the transformative potential of AI-driven solutions. Benedek et al. (2022) investigate the use of ML techniques for automobile insurance fraud detection, demonstrating their effectiveness in identifying anomalous and fraudulent claims. Most recently, Sharma & Muthumeenakshi (2025) narrow the focus to the emergent field of Insurtech, using bibliometrics to outline its current research trajectory. As the adoption of advanced ML methods continues to expand, increasing attention has been devoted to issues of interpretability and transparency in insurance applications. Owens et al. (2022) conduct a bibliometric and systematic review of XAI applications in insurance, identifying its increasing relevance across the insurance value chain, particularly in underwriting, claims management, and pricing, where transparency and trust are critical. By focusing on the insurance sector in aggregate, these reviews create a direct opportunity for a more specialized bibliometric analysis that zooms in on the high-impact line of business: vehicle insurance.

3. Data and Methodology

Bibliometric methods employ quantitative techniques to study bibliometric data (Donthu et al., 2021) enabling a systematic examination of bibliographic information (Mukherjee et al., 2022). By integrating quantitative and qualitative methods, this methodology provides a holistic overview of the field. Bibliometric analysis has experienced widespread application over the past two decades in many disciplines (Smajlović et al., 2025, p. 16). It visualizes knowledge structures like keyword clusters, key authors, and sources (Sharma & Muthumeenakshi, 2025). Bibliometric techniques primarily serve two purposes: performance analysis and science

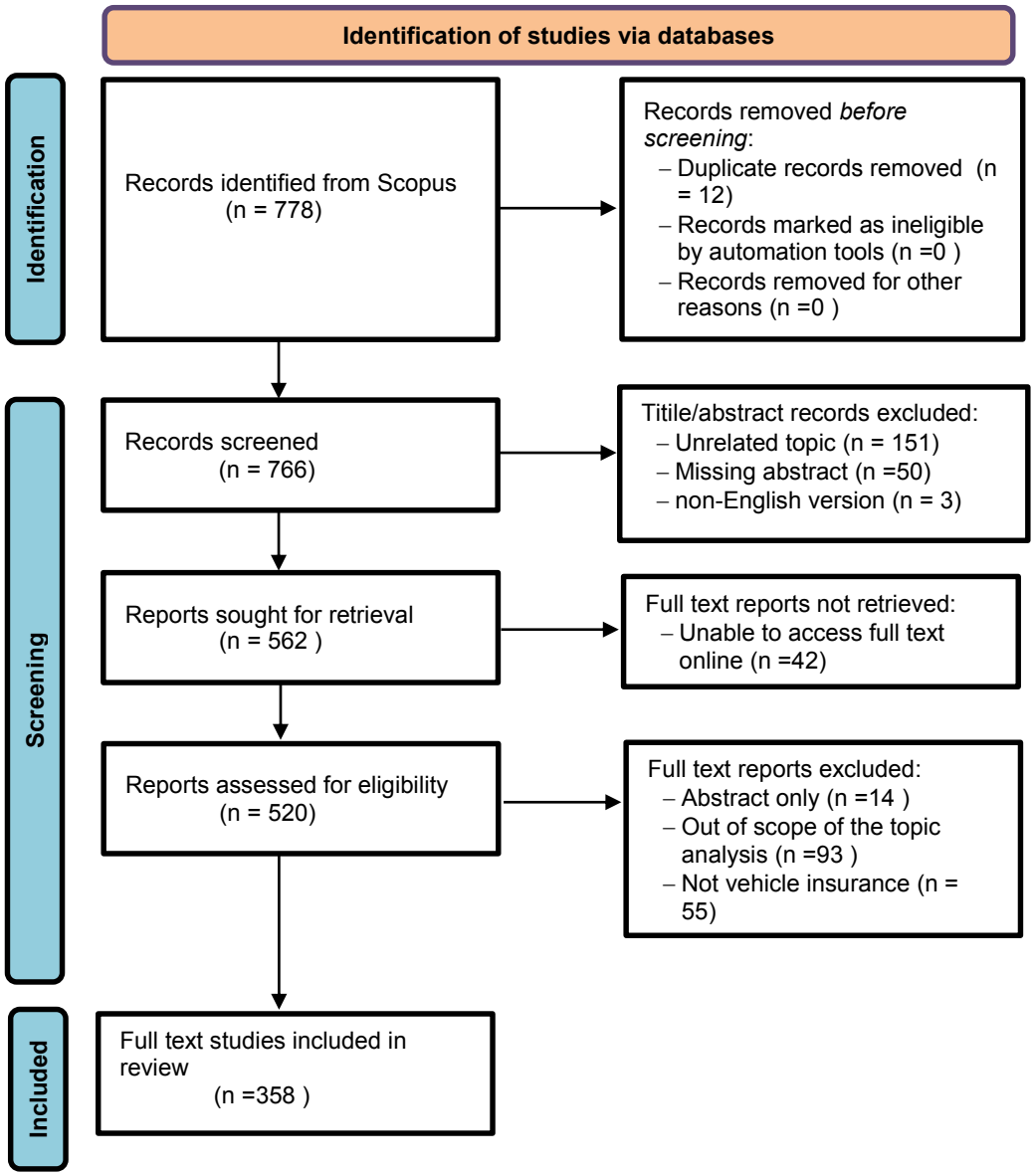
mapping. Performance analysis assesses the research output and impact of researchers and institutions, while science mapping uncovers the evolving structure and connections within scientific domains (Zupic & Čater, 2015). This study employs Biblioshiny (v. 5.0) within Bibliometrix, an open-source R package (v. 5.2.0), developed by (Aria & Cuccurullo, 2017), together with VOSviewer (v. 1.6.20), to analyse publications retrieved from the Scopus bibliometric database. The Bibliometrix package and its Shiny platform in R provide an extensive set of analytical tools combined with an accessible interface, making them highly practical for applied use (Moral-Muñoz et al., 2020) while supporting a broad range of statistical approaches and visualizations (Mall, Panigrahi, & Verma, 2023). VOSviewer complements this functionality by offering powerful visualization capabilities and broad compatibility with multiple data sources (Moral-Muñoz et al., 2020).

The dataset for this review on ML applications within actuarial methods for vehicle insurance literature was retrieved from Scopus, a widely used database in insurance (Hamid & Abdelbari, 2024; John et al., 2024; Kuzior et al., 2023; Pattnaik et al., 2024; Sharma & Muthumeenakshi, 2025; Suwanmalai & Zaby, 2024), comprising various types of documents and accompanying metadata essential for the purposes of this study.

All types of publications related to ML applications within actuarial methods for vehicle insurance literature were included in the database, and the data were collected using a search string applied to article titles, abstracts, and keywords, with the final set of publications focused on the period from 1990 to November 11, 2025. Relevant publications were identified through a combined use of insurance-related keywords. Keywords were selected to capture ML applications in actuarial methods specifically within vehicle insurance: (“motor insurance,” “MTPL,” “casco,” “financial services”) and machine-learning-related terminology applied in actuarial science. Keywords included in the search were those embedded in the predefined search string covering machine learning, actuarial applications, and vehicle insurance. The search query used for this research: ("motor insurance" OR "vehicle insurance" OR "car insurance" OR "automobile insurance" OR "auto insurance" OR "motor liability" OR "MTPL" OR "casco" OR "motor hull" OR "hull insurance" OR "automobile liability" OR "traffic insurance" OR "motor policy") AND ("machine learning" OR "artificial intelligence" OR "deep learning" OR "neural network*" OR "ANN" OR "CNN" OR "RNN" OR "LSTM" OR "SVM" OR "support vector machine*" OR "decision tree*" OR "random forest*" OR "gradient boosting" OR "XGBoost" OR "CatBoost" OR "LightGBM" OR "AdaBoost" OR "Naive Bayes" OR "k-means" OR "clustering" OR "regression tree*" OR "predictive model*" OR "data mining" OR "supervised learning" OR "unsupervised learning" OR "ensemble learning" OR "regression analysis" OR "statistical learning" OR "predictive analytics" OR "data science" OR "classification" OR "forecasting" OR "feature selection" OR "model optimization").

The types of documents included articles, books, book chapters, conference papers, and review articles, resulting in a final dataset of 358 publications. The process of searching for and screening research documents in this study was carried out in accordance with the PRISMA protocol (Moher et al., 2009) following an updated guideline for reporting systematic reviews (Page et al., 2021). Figure 1 illustrates the complete PRISMA process in this research.

Figure 1: PRISMA flow diagram



Source: Own research, following an updated guideline by Page et al. (2021)

4. Results and Discussion

4.1. Publication Volume, Growth Trends, and Distribution of Research on ML-Based Actuarial Methods in Vehicle Insurance

The overview presented in Figure 2 highlights the scope and growth of research on the integration of ML into actuarial methods for vehicle insurance over the period 1991-November 2025. A total of 358 documents published across 255 sources indicate a well-dispersed and multidisciplinary research field. The dataset includes contributions from 1.011 authors, with only 37 single-authored documents, suggesting a strong tendency toward collaborative research. This is further supported by an average of 3,22 co-authors per document and an international co-authorship rate of 12,11%, reflecting moderate but increasing global research

collaboration. The annual growth rate of publications is 11,2%, confirming a steady and accelerating expansion of scholarly interest in this topic. The average document age of 5,16 years points to the relative recency of the literature, while an average of 16 citations per document suggests a solid level of academic impact. Finally, the presence of 1.224 author keywords underscores the thematic diversity of the field and the wide range of ML techniques and actuarial applications being explored.

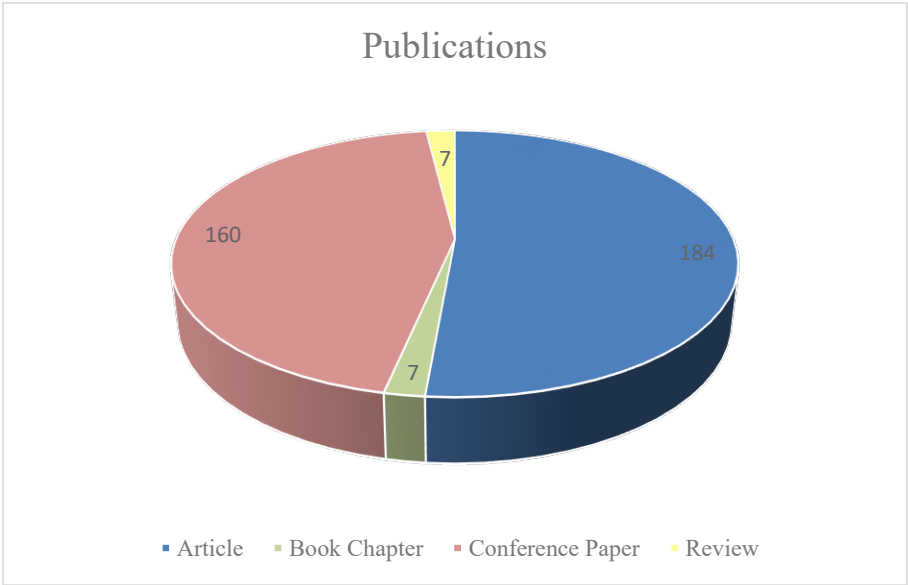
Figure 2: Overview of the integration of ML into actuarial methods for vehicle insurance (1990–November 2025)



Source: Own research, R Biblioshiny output

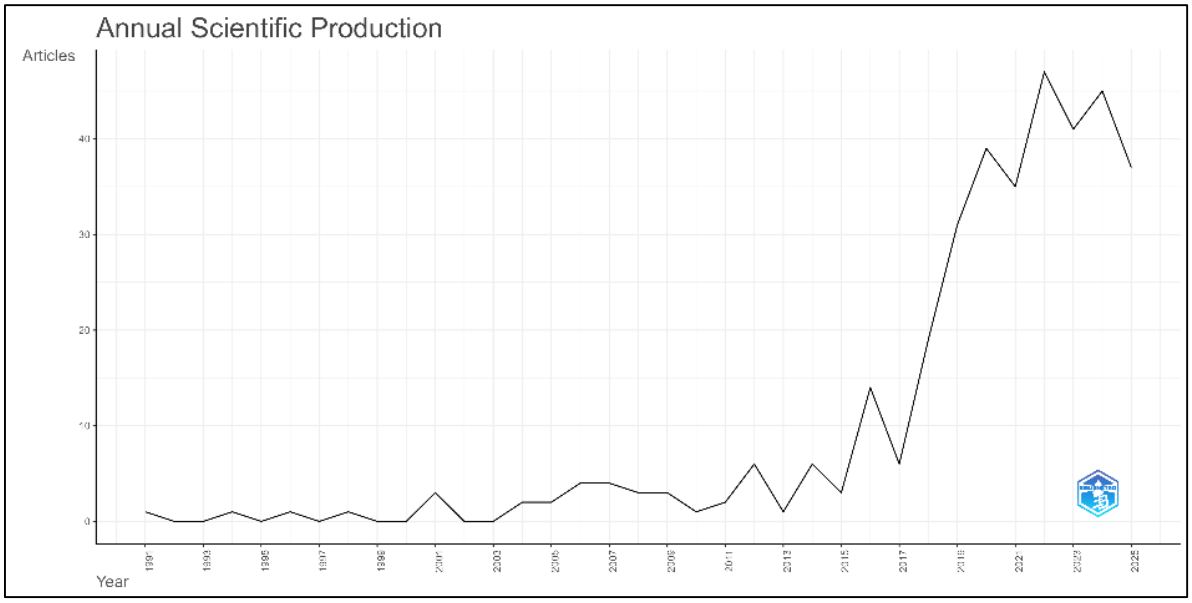
In this research, the total body of publications comprised 184 articles, 160 conference papers, 7 book chapters, and 7 review articles, as shown in Figure 3.

Figure 3: Distribution of Publications in Study



Source: Authors

Figure 4: Growth trends of ML approaches in actuarial methods for vehicle insurance literature (1990–November 2025)

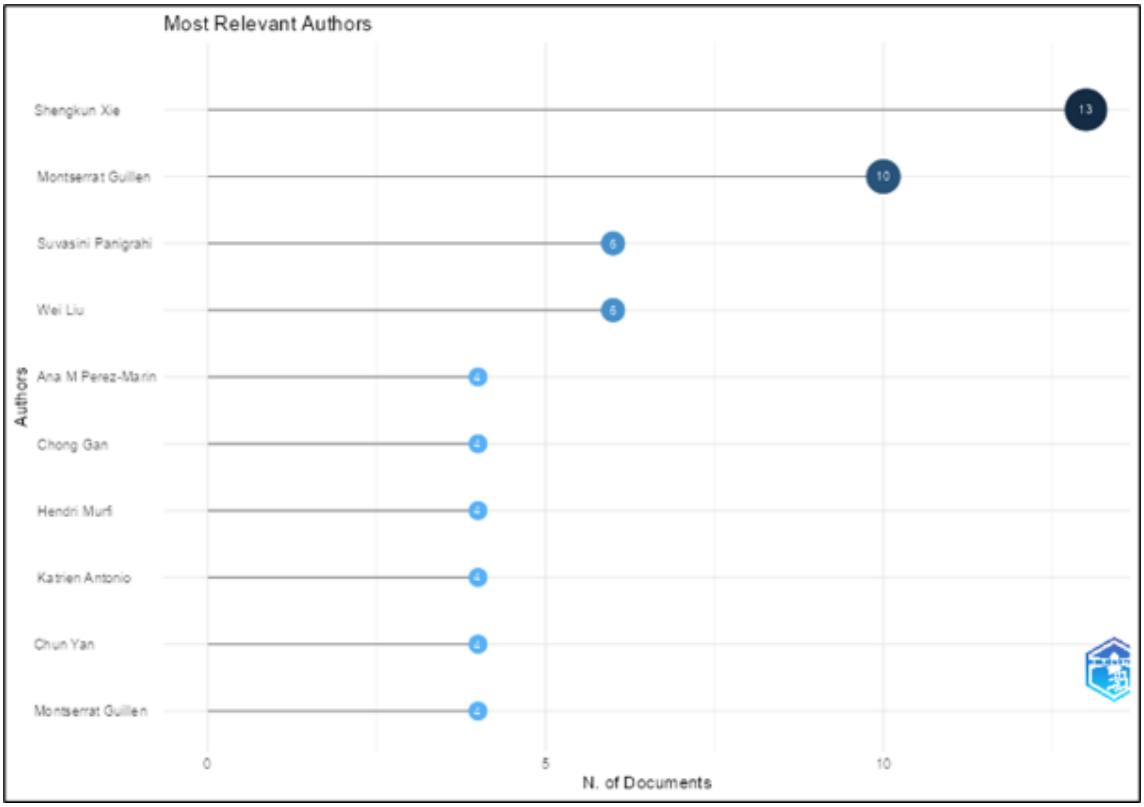


Source: Own research, R Biblioshiny output

4.2. Influential Authors in ML Applications Within Actuarial Methods for Vehicle Insurance Literature

Figure 5 presents a ranking of authors based on the number of publications in the field of ML applications in actuarial methods for vehicle insurance. The size of the circles in the chart corresponds to the number of publications, with larger circles representing a higher output. Horizontal lines facilitate comparison of publication counts across authors. Shengkun Xie ranks first with 13 publications, making them the most prolific author, showing a strong influence on the field and a significant role in shaping both theoretical and practical research trends. Montserrat Guillen follows with 10 publications, also demonstrating substantial impact within this research area. Suvasini Panigrahi and Wei Liu each have 6 publications, placing them in the mid-range. Their contributions are meaningful, though less extensive than those of the top two authors. Other authors included in the chart: Ana M. Perez-Marin, Chong Gan, Hendri Murfi, Katrien Antonio, Chun Yan, and Montserrat Guillen with a lower count of 4 publications, have fewer publications. Despite the smaller numbers, their work remains relevant and contributes to the development of the field.

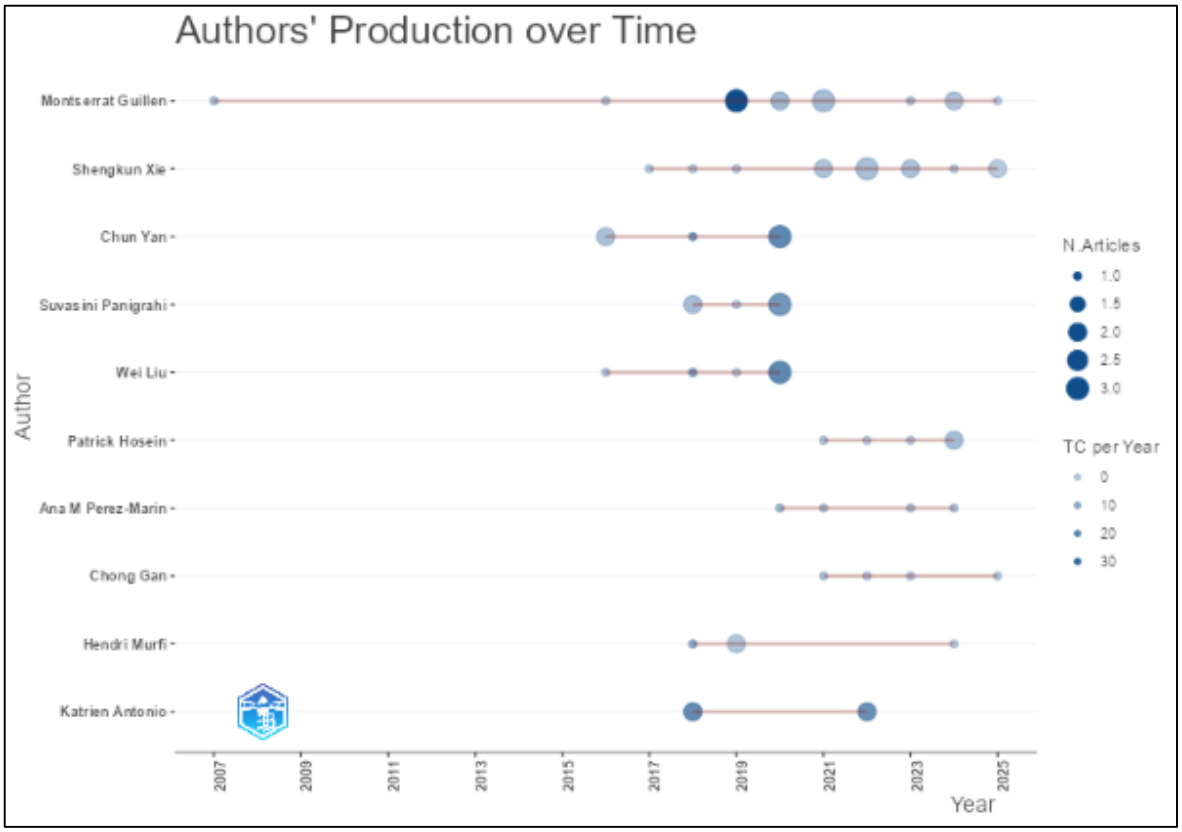
Figure 5: Most relevant authors



Source: Own research, R Biblioshiny output

Figure 6 presents the temporal distribution of publications for the most productive authors in the field. The results show that Montserrat Guillén and Shengkun Xie exhibit the most sustained and consistent publication activity over time, particularly from 2017 onward, indicating their leading role in the research area. Several authors, including Chun Yan, Suvasini Panigrahi, and Wei Liu, display more concentrated production within a limited time span, mainly between 2018 and 2021. In contrast, authors such as Patrick Hosein, Ana M. Perez-Marin, Chong Gan, and Katrien Antonio emerge more recently, with publications predominantly after 2020. Overall, the figure highlights an increase in author participation in recent years, reflecting the growing research interest and expansion of the field.

Figure 6: Author Production Trends Over Time



Source: Own research, R Biblioshiny output

4.3. Influential Publications in ML Applications Within Actuarial Methods for Vehicle Insurance Literature

This analysis evaluates the average citation performance of publications on ML applications in actuarial methods for vehicle insurance over the period 1991-November 2025. Although publication volume increases markedly in recent years, the highest peak in average annual citations is observed in 2018, indicating that studies published during this period achieved particularly strong and rapid scholarly impact. This peak, which is clearly visible in Table 1 and Figure 7, coincides with the widespread adoption of advanced ML and telematics-driven approaches, while more recent publications have not yet accumulated comparable citation levels due to shorter citable windows.

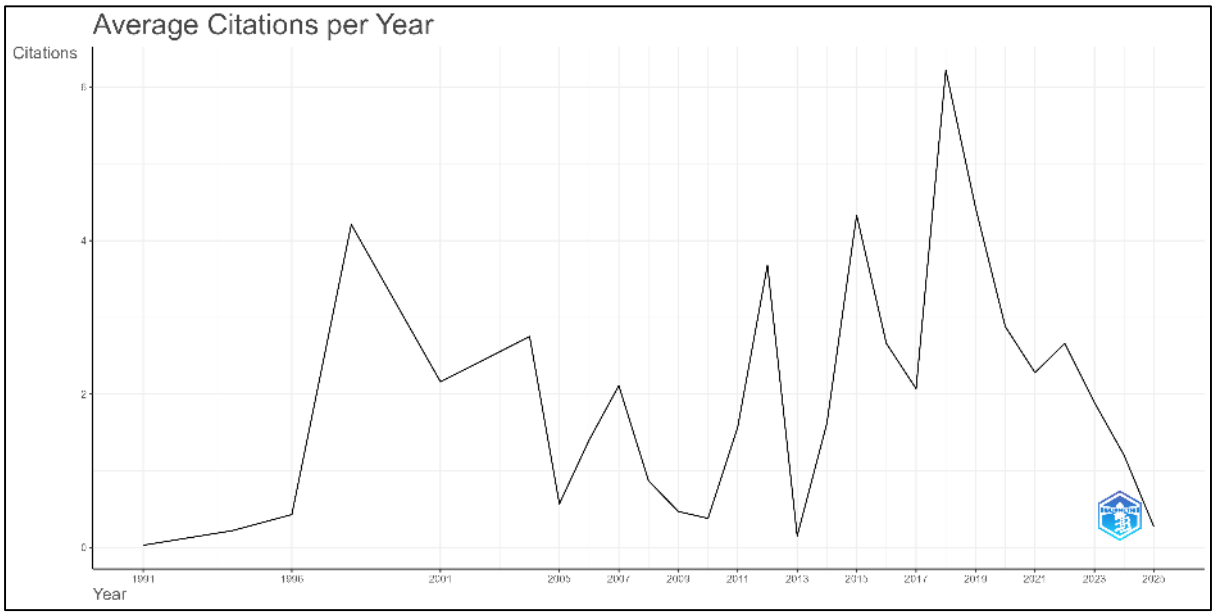
Table 1: Overview of Average Citations per Article by Publication Year

Year	Citation by article	Number of publications	Citation per year	Citable Years
1991	1	1	0,03	35
1994	7	1	0,22	32
1996	13	1	0,43	30
1998	118	1	4,21	28
2001	54	3	2,16	25
2004	60,5	2	2,75	22
2005	12	2	0,57	21
2006	28	4	1,4	20

Year	Citation by article	Number of publications	Citation per year	Citable Years
2007	40	4	2,11	19
2008	15,67	3	0,87	18
2009	8	3	0,47	17
2010	6	1	0,38	16
2011	23,5	2	1,57	15
2012	51,5	6	3,68	14
2013	2	1	0,15	13
2014	19,5	6	1,62	12
2015	47,67	3	4,33	11
2016	26,64	14	2,66	10
2017	18,67	6	2,07	9
2018	49,74	19	6,22	8
2019	31	31	4,43	7
2020	17,31	39	2,88	6
2021	11,4	35	2,28	5
2022	10,66	47	2,66	4
2023	5,66	41	1,89	3
2024	2,4	45	1,2	2
2025	0,27	37	0,27	1

Source: Own research, R Biblioshiny output

Figure 7: Trend of Average Citations per Year



Source: Own research, R Biblioshiny output

The Table 2 presents the top 10 most cited publications in the field of ML applications within actuarial methods for vehicle insurance. A notable observation is that the majority of highly cited works focus on fraud detection (e.g., Yibo Wang & Wei Xu, 2018; Yaqi Li et al., 2018; Najmeddine Dhieb et al., 2020), emphasizing the importance of advanced ML techniques such as deep learning and random forests for identifying suspicious patterns in insurance claims. Overall, the citation counts indicate that publications focusing on fraud detection, telematics,

and advanced ML algorithms have achieved the greatest scholarly attention, suggesting that these topics represent the core and high-impact areas within current research on ML-based actuarial methods in vehicle insurance.

Table 2: Top 10 cited sources in ML applications within actuarial methods for vehicle insurance literature (1990–November 2025)

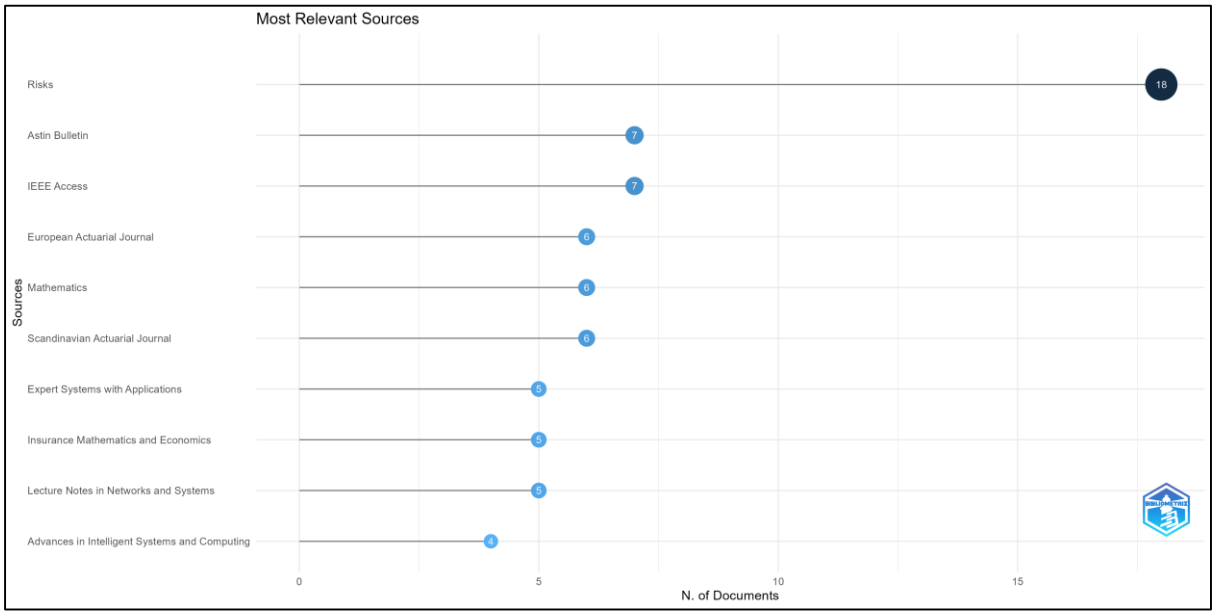
Rank	Author/s	Year	Title	Source	Citations
1	Yibo Wang; Wei Xu	2018	Leveraging Deep Learning with Lda Based Text Analytics to Detect Automobile Insurance Fraud	Decision Support Systems	274
2	Leo Guelman	2012	Gradient Boosting Trees for Auto Insurance Loss Cost Modeling and Prediction	Expert Systems with Applications	207
3	Jessica Pesantez-Narvaez; Montserrat Guillen; Manuela Alcaniz	2019	Predicting Motor Insurance Claims Using Telematics Data Xgboost Versus Logistic Regression	Risks	137
4	Najmeddine Dhieb; Hakim Ghazzai; Hichem Besbes; Yehia Massoud	2020	A Secure AI Driven Architecture for Automated Insurance Systems Fraud Detection and Risk Measurement	IEEE Access	129
5	Roel Verbelen; Katrien Antonio; Gerda Claeskens	2018	Unravelling the Predictive Power of Telematics Data in Car Insurance Pricing	Journal of the Royal Statistical Society Series C Applied Statistics	111
6	G Ganesh Sundarkumar; Vadlamani Ravi	2015	A Novel Hybrid Undersampling Method for Mining Unbalanced Datasets in Banking and Insurance	Engineering Applications of Artificial Intelligence	110
7	Yaqi Li; Chun Yan; Wei Liu; Maozhen Li	2018	A Principle Component Analysis Based Random Forest with the Potential Nearest Neighbor Method for Automobile Insurance Fraud Identification	Applied Soft Computing Journal	107
8	Faheem Aslam; Ahmed Imran Hunjra; Zied Ftiti; Wael Louhichi; Tahira Shams	2022	Insurance Fraud Detection Evidence from Artificial Intelligence and Machine Learning	Research in International Business and Finance	106
9	Subramanian Arumugam; R Bhargavi	2019	A Survey on Driving Behavior Analysis in Usage Based Insurance Using Big Data	Journal of Big Data	101
10	Yiyang Bian; Chen Yangb; J Leon Zhaoc; Liang Liang	2018	Good Drivers Pay Less a Study of Usage Based Vehicle Insurance Models	Transportation Research Part A: Policy and Practice	100

Source: Own research, R Biblioshiny output

4.4. Influential Sources in ML Applications Within Actuarial Methods for Vehicle Insurance Literature

Figure 8 presents the distribution of research papers across journals based on their relevance to the topic of ML applications in actuarial methods for vehicle insurance. The graph displays the number of papers published in each journal, with darker blue bars indicating a higher quantity and greater thematic relevance. “Risks” stands out in first place with the highest number of papers published, totalling 18 papers, thus surpassing all other journals. “Astin Bulletin-The Journal of the International Actuarial Association” and “IEEE Access” follow in second place, each with 7 papers published, while “European Actuarial Journal,” “Mathematics,” and “Scandinavian Actuarial Journal” each occupy the third tier with 6 papers. Journals represented by lighter blue bars indicate a lower quantity and relevance of publications on this topic.

Figure 8: Most relevant source

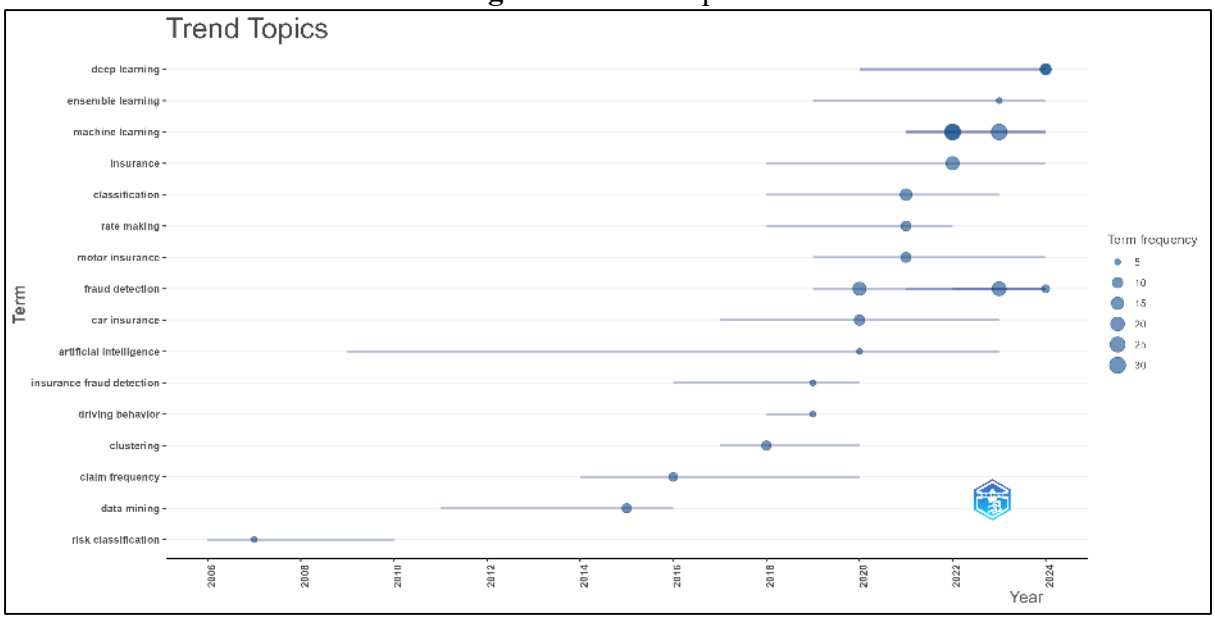


Source: Own research, R Biblioshiny output

4.5. Trend Topics in ML Applications Within Actuarial Methods for Vehicle Insurance Literature

Figure 9 illustrates the evolution of trending topics in research on ML-based actuarial methods in vehicle insurance. The horizontal axis shows publication years, and bubble size represents term frequency. Early topics such as "risk classification" and "clustering" reflect foundational actuarial developments. Later, focus shifted to "artificial intelligence" "fraud detection" "rate making" and "ensemble learning" highlighting advanced predictive techniques and their applications in pricing and fraud prevention. The figure provides an overview of the temporal development and relative prominence of key research themes in the field.

Figure 9: Trend topics



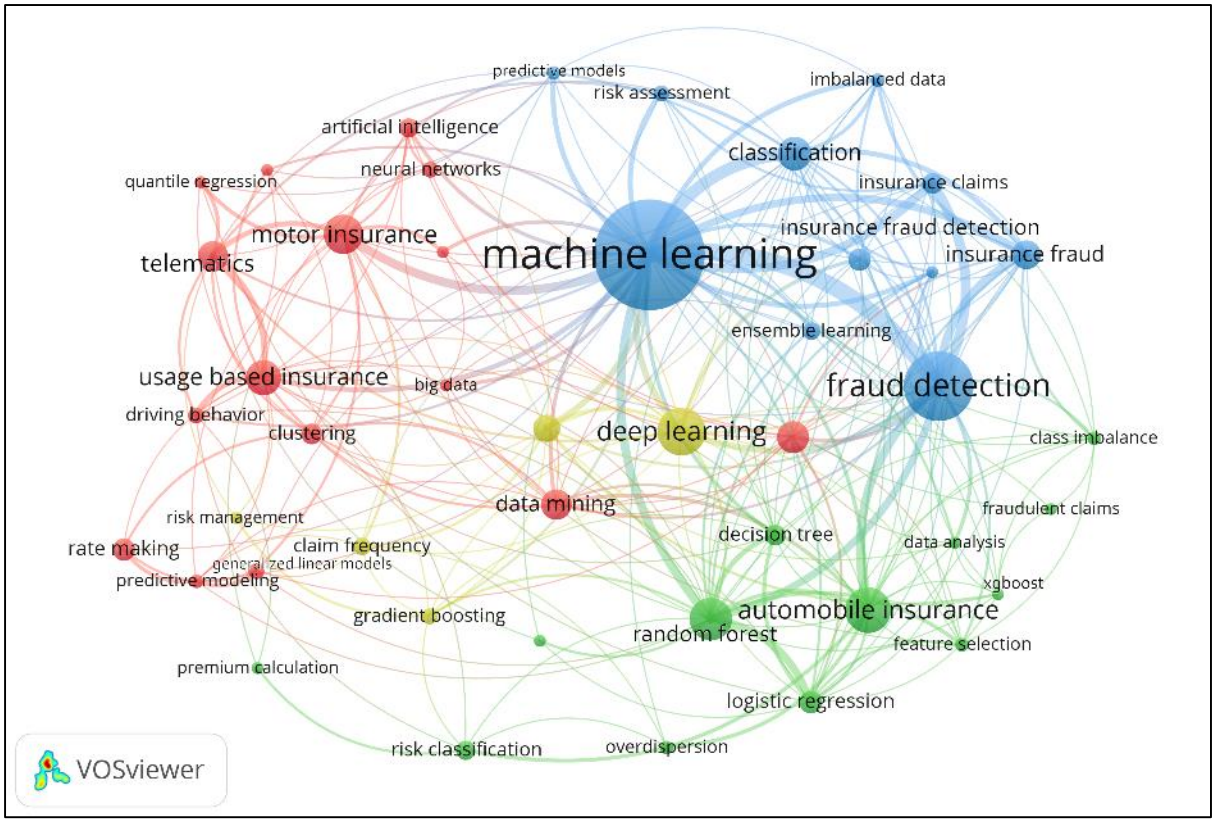
Source: Own research, R Biblioshiny output

This evolution of topics suggests a clear shift from foundational actuarial methods toward data-driven, AI-enhanced approaches. For practitioners, these trends highlight the need to address practical implementation challenges. Interpretability of data-driven actuarial methods is expected to become a priority for insurance regulators, influencing actuarial practice by encouraging transparent and explainable premium calculation and fraud detection models. XAI will be particularly important in ensuring that these models are both understandable and trustworthy. This shift is likely to drive insurers to adopt methods that not only improve predictive accuracy but also build trust among stakeholders, fostering safer and more reliable actuarial practices. Moreover, it opens the path for a stronger focus on XAI in the future, requiring the actuarial profession to adapt and proactively prepare for its integration into practice.

4.6. Keyword Co-Occurrence Analysis in ML Applications Within Actuarial Methods for Vehicle Insurance Literature

A keyword co-occurrence network using VOSviewer was constructed based on a full counting method. From this network, a set of 48 most relevant keywords was extracted for further analysis and mapping. Employing LinLog/modularity normalization, the co-occurrence network revealed five distinct thematic clusters, as shown in Figure 10.

Figure 10: Keyword Co-occurrence Network



Source: Own research, VOSviewer output

Cluster 1 “Machine learning” (blue) - The largest and most central node in the network is ML, indicating that it is the most frequently used and most strongly connected keyword across the entire dataset. Its central position demonstrates that it operates as the main analytical framework that links diverse research areas such as *fraud detection* and *risk assessment*. It is connected to

almost all other clusters, indicating that ML methods reach all major topics in vehicle insurance. At the same time, keywords like *fraud detection*, *insurance fraud detection*, and *fraudulent claims* show that ML is extensively used to identify suspicious patterns.

The central role of ML suggests that actuarial practice is becoming increasingly reliant on data-driven techniques, requiring actuaries to move beyond traditional statistical tools toward more flexible and computationally intensive methods. The relaxation of parametric assumptions further facilitates actuarial modelling, enabling the use of flexible, non-parametric methods that can better capture complex relationships, provide more robust and accurate estimation of the dependent variable, and support the automation of the actuarial processes.

Cluster 2 "Telematics & usage-based insurance" (red) - This cluster captures the modern segment of vehicle insurance that is strongly driven by behavioural and sensor-generated data. The cluster includes concepts such as *telematics*, *rate making*, *predictive modelling* and *risk management*, all of which illustrate the shift from traditional pricing approaches toward dynamic, data-driven models. This cluster highlights the rapid evolution of vehicle insurance enabled by telematics technologies, driving behaviour analytics, and usage-based insurance programs.

The prominence of telematics highlights a shift toward individualized and behaviour-based pricing, implying that future actuarial models will need to incorporate real-time and high-frequency data, fundamentally changing risk assessment practices. This represents a particular challenge for small or underdeveloped markets, where limited data availability, lower technological infrastructure, and less mature regulatory frameworks may slow the adoption of these advanced, data-driven approaches.

Cluster 3 "Vehicle Insurance & Classical Actuarial Models" (green) represents the traditional actuarial and statistical modelling domain, where established techniques such as logistic regression and GLMs remain central. The cluster reflects the foundations of conventional risk classification and pricing approaches, forming the methodological baseline upon which more advanced developments, such as telematics and detection of fraudulent claims, are later built.

The continued presence of classical models indicates that traditional actuarial methods remain essential as a benchmark, suggesting that future practice will likely involve hybrid approaches combining statistical foundations with advanced ML techniques. In the context of small or underdeveloped markets, these classical models remain a crucial foundation, providing a reliable starting point for gradually adopting more complex ML approaches. Moreover, regardless of the sophistication of ML methods, traditional actuarial judgment and understanding remain vital to interpret results and make informed decisions in vehicle insurance.

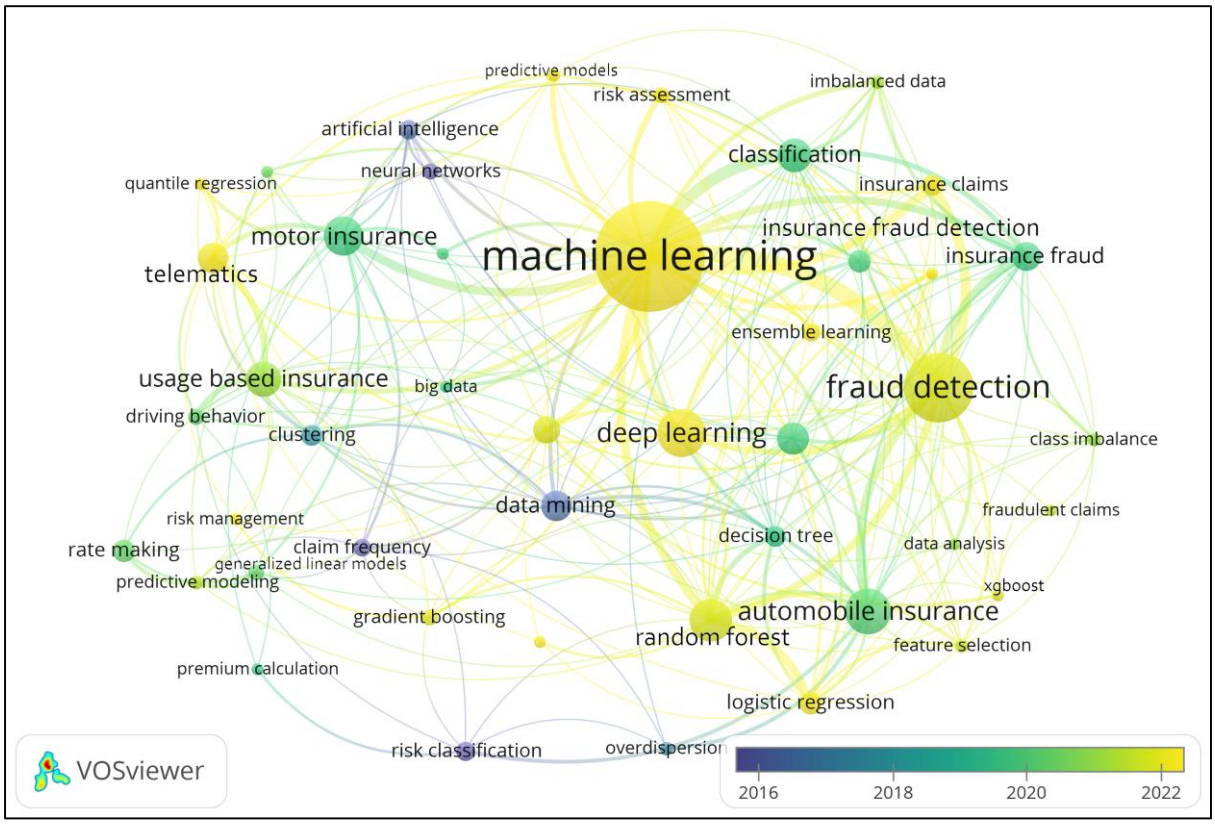
Cluster 4 "Advanced ML Methods & Data Mining" (yellow) - This cluster highlights the cutting-edge evolution in vehicle insurance through advanced ML algorithms. It reflects recent trends toward deep learning, gradient boosting and other modern analytic techniques, indicating a transition in research focus toward more sophisticated predictive models and big-data analysis.

The growing importance of advanced ML methods reflects a shift toward more complex and high-performing models, but also introduces challenges related to interpretability, model governance, and regulatory compliance. For the future of actuarial practice, this implies that

actuaries will need to combine strong statistical foundations with ML expertise, ensuring that models are not only accurate but also transparent and compliant. In vehicle insurance, these developments open opportunities for more individualized and behaviour-based pricing, enhanced risk prediction, and innovative products, while simultaneously requiring careful oversight to balance model complexity with regulatory and operational requirements.

When overlaid by publication year, the VOSviewer visualization in Figure 11 reveals a clear temporal gradient, showing how research in vehicle insurance has progressively shifted toward advanced analytics and ML techniques. Recent publications cluster around terms such as "machine learning", "deep learning", "fraud detection," "gradient boosting" and "random forest" indicating a transition toward data-driven modelling and automation. These keywords reflect the growing relevance of telematics, behavioural data, and usage-based insurance, signalling a move toward predictive analytics and personalized pricing. In contrast, earlier terms such as "logistic regression", "generalized linear models", "rate making" and "risk classification" represent the traditional actuarial foundation that dominated the pre-big-data era and continues to serve as a methodological baseline. Fraud-related terms, decision-tree methods, and data mining persist across the timeline, underscoring their sustained importance in risk assessment and claims management.

Figure 11: Overlay Visualisation of Keyword Co-occurrence Network



Source: Own research, VOSviewer output

Assessing term frequency provides an overview of the dominant themes in the current research using the Bibliometrix R package (and Biblioshiny interface). Figure 12 presents a word cloud of the most frequently used keywords in ML applications within actuarial methods for vehicle insurance. The most prominent terms include "machine learning" with strong emphasis on "fraud detection", "insurance fraud", "deep learning" and "telematics." These patterns indicate

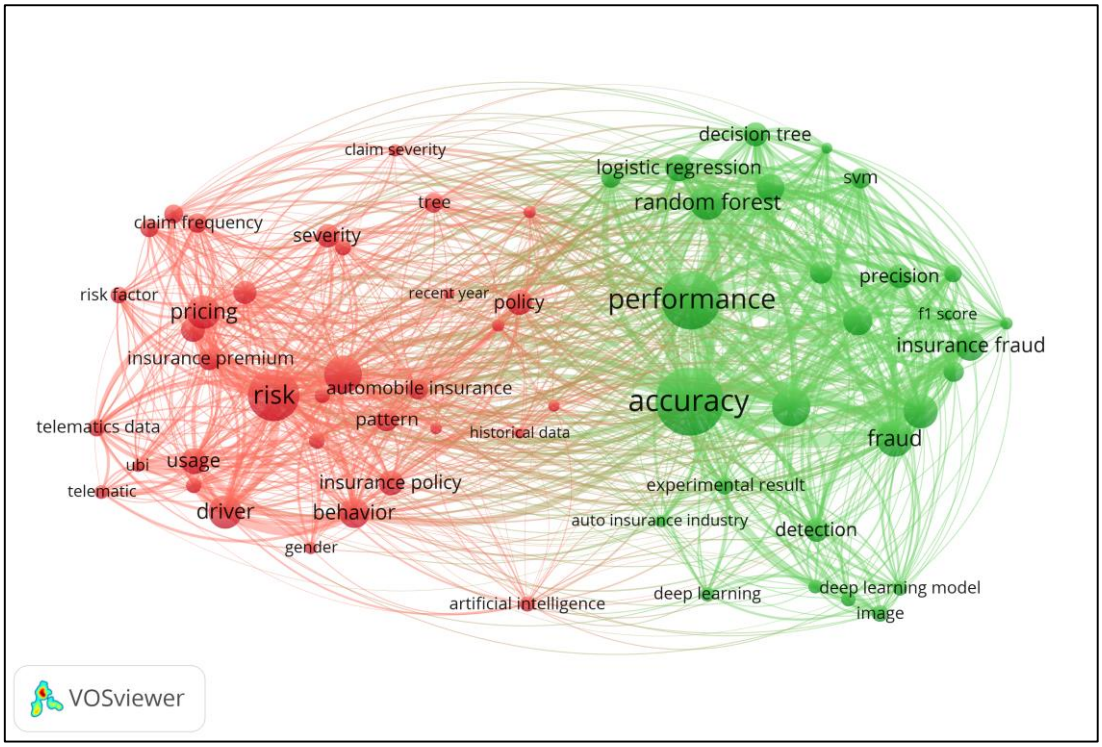
that recent studies increasingly focus on applying ML techniques to improve fraud detection and prevention. Future developments may risk prioritizing predictive performance and model accuracy at the expense of interpretability and transparency.

Figure 12: Word Cloud



Source: Own research, R Biblioshiny output

Figure 13: A term co-occurrence map based on Abstract data



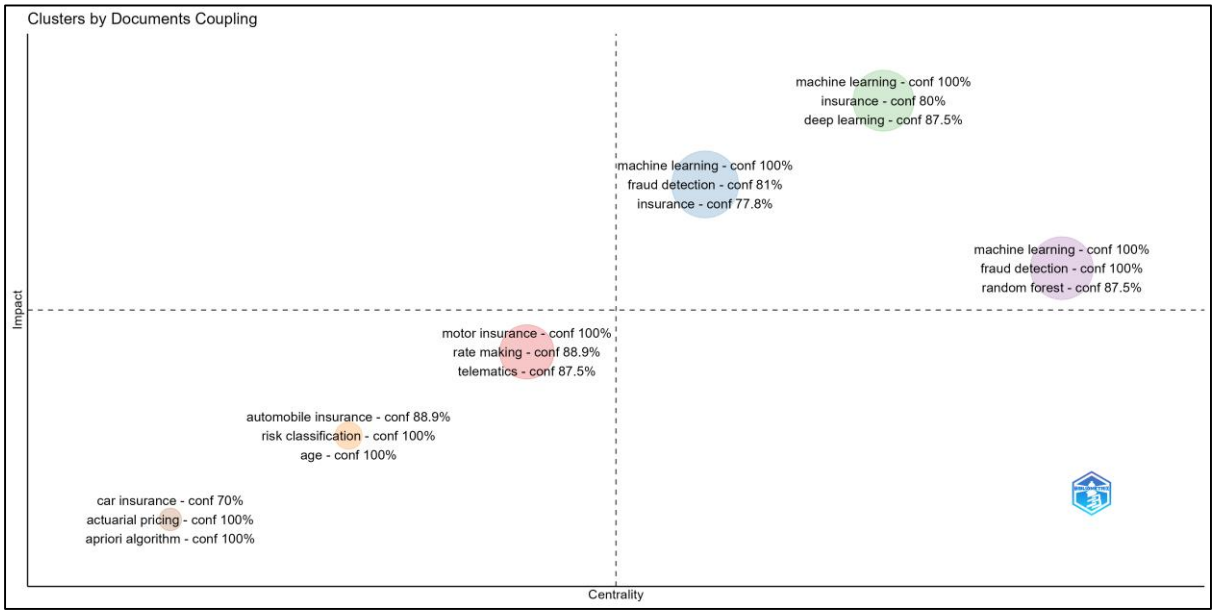
Source: Own research, VOSviewer output

The term co-occurrence map using VOSviewer based on abstract data with binary counting and LinLog/modularity normalization, revealing two prominent clusters, (a) core ML concepts (red) and (2) fraud detection and insurance-specific applications (green) as shown in Figure 13. Cluster core ML concepts includes terms related to risk assessment, feature selection, usage-based insurance and telematics. The separation into these two clusters underscores the dual nature of current research: one stream is methodological, advancing ML techniques and complementing traditional actuarial methods, while the other focuses on risk model performance and accuracy, reflecting a move toward optimizing predictive performance and precision through advanced deep learning models in practical vehicle insurance applications. The two clusters highlight that methodological advances and practical applications complement each other. Their integration will shape the future of vehicle insurance, enabling more accurate, transparent, and reliable risk assessment and pricing.

4.7. Thematic Map

Thematic mapping is used to depict the current structure of a research field and to provide insights into its future trajectory. Thematic analysis identifies themes by clustering authors' keywords based on their interrelationships and characterizes them using two structural dimensions: centrality and impact (or density). Centrality, represented on the horizontal axis, indicates a theme's relevance and connectedness within the field, while impact, shown on the vertical axis, reflects its internal cohesion and level of development. The thematic map therefore enables an intuitive assessment of the importance and maturity of research themes (Agbo et al., 2021).

Figure 14: Thematic map



Source: Own research, R Biblioshiny output

Document coupling based on centrality and relative importance identified six distinct clusters, as shown in Figure 14. According to their position within the four quadrants, the themes can be interpreted as follows. (1) Upper-right quadrant – Motor themes (High Impact, High Centrality): This quadrant is dominated by ML, deep learning, GLM, insurance, automobile insurance, and fraud detection. These themes show strong internal development and high connectivity, indicating that ML-based actuarial modelling and fraud detection represent the core of contemporary vehicle insurance research. Their position reflects the maturity and

widespread adoption of these methods in pricing, risk assessment, and claims analysis. (2) The absence of themes in the upper-left quadrant (high impact, low centrality) indicates that the literature does not exhibit well-developed but isolated or highly specialized niche themes. This suggests that methodological advances in the field are not evolving in isolation but are strongly connected to the main research focus. (3) The lower-left quadrant (emerging or declining themes, typically representing emerging research directions or topics losing relevance) contains more traditional or narrowly applied topics such as actuarial pricing, apriori algorithms, and claims forecasting. Their peripheral position suggests either early-stage exploration or gradual replacement by more complex ML approaches. This quadrant highlights the transition from traditional a priori pricing approaches toward posteriori telematics-based and usage-based insurance models, reflecting the growing reliance on dynamic, data-driven risk assessment. (4) Lower-right quadrant - Basic themes (Low Impact, High Centrality): The lower-right quadrant groups basic and transversal themes that are important for the field but are not yet fully developed. Notably, the absence of themes in the lower-right quadrant indicates a mature research field in which central topics are no longer underdeveloped or in an early or exploratory stage. However, the prominence of ML and deep learning highlights increasing reliance on black-box models, raising concerns about interpretability, transparency, and regulatory compliance in actuarial practice. This structure reflects the continuing trade-off between predictive accuracy and explainability in modern actuarial science. The empty lower-right quadrant, together with the rise of ML and deep learning, indicates that the field is moving toward complex “black-box” models, highlighting that future actuarial practice will increasingly rely on powerful, less interpretable systems and become more closely intertwined with IT and data-driven technologies.

5. Conclusions

This study consolidates the dispersed body of literature on ML applications within the vehicle insurance domain. By analysing 358 publications from 1990 to November 2025, the research highlights the growing integration of data-driven methods within traditional actuarial frameworks and identifies the most influential authors, journals, and research trends. The findings indicate a clear historical evolution in actuarial modelling within vehicle insurance. Traditionally, actuarial practice relied on classical statistical methods, particularly GLM. Research has shifted from traditional methods to advanced ML techniques, which have become core to actuarial practice in vehicle insurance, improving accuracy and efficiency.

The analysis addressed all seven research questions. The study shows that publication volume in ML-based actuarial methods for vehicle insurance has grown steadily over the past decades, with a highly collaborative and multidisciplinary research community, reflecting increasing international interest. Shengkun Xie and Montserrat Guillén emerge as the most prolific authors, while publications from 2018 demonstrate the greatest scholarly impact, coinciding with the adoption of advanced ML and telematics approaches. Leading journals such as Risks, Astin Bulletin, and IEEE Access serve as primary outlets for this research, disseminating studies on both foundational and emerging topics. Trend topics in ML applications within actuarial methods for vehicle insurance literature showed that research has gradually shifted focus: earlier studies emphasized the methodological development of ML techniques and their integration with traditional models, while more recent work prioritizes practical performance in predictive accuracy, fraud detection, and risk management. Keyword co-occurrence analysis identified four thematic clusters: ML as the central analytical framework, telematics and usage-based insurance enabling data-driven pricing, classical actuarial models as a methodological

foundation, and advanced ML techniques offering enhanced performance while raising concerns related to interpretability, governance, and regulation. These results suggest that future actuarial practice will rely on hybrid approaches combining traditional and data-driven methods. Thematic mapping further confirms the transition toward predictive analytics and personalized pricing, with ML and deep learning dominating high-impact research themes. This evolution highlights a growing trade-off between predictive accuracy and model interpretability, emphasizing the need for XAI. Future developments indicate that actuarial practice will become increasingly integrated with IT and data science, requiring closer collaboration with technical experts. In vehicle insurance, this trend points toward fully personalized, data-driven pricing models based on real-time behavioural data, alongside increasingly automated and proactive fraud detection systems, ultimately leading to a more comprehensive and analytics-driven approach to risk management.

Despite these contributions, the study has some limitations. First, only publications indexed in the Scopus database were included, potentially overlooking relevant research in other databases. Second, the analysis focused primarily on English-language publications, which may exclude important regional studies. Third, the selection of keywords and search strings defined the dataset and may have omitted studies using alternative or newly emerging ML methods, given the rapidly evolving nature of ML in vehicle insurance.

Future research could incorporate the emerging paradigm of XAI in bibliometric analyses to examine how it intersects with existing ML trends in vehicle insurance and to trace its emergence and development over time. Such analyses could also identify emerging clusters and explore XAI's role in interpretability, transparency, and decision-making in actuarial practice within vehicle insurance. In addition, further studies are needed to assess the long-term impact of ML-driven approaches based on real-time collected data on pricing fairness, risk management practices, and overall insurance market dynamics. Future research should examine trends in smaller or less developed insurance markets, which often face unique challenges such as limited data availability, lower technological infrastructure, and different regulatory environments. Additional concerns include difficulties in applying complex ML models due to small sample sizes, the need for highly interpretable models given limited local expertise, challenges in model validation and regulatory compliance, and constraints on technological, human resources and field experts. Understanding the current state of these markets and the implications of adopting ML methods in vehicle insurance can provide insights into their readiness and challenges associated with the transition to data-driven actuarial practices.

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A scientific paper

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EDUCATIONAL AND SOCIODEMOGRAPHIC BACKGROUND AS A PREDICTOR OF STUDENTS' SOCIAL CAPITAL

ABSTRACT

Students' social capital has emerged as an important yet underexplored resource within business education, shaping students' academic engagement, well-being, and career prospects. Although previous research has highlighted the importance of networks, trust, and shared norms in educational contexts, much less is known about the specific attributes shaping social capital among university students. This paper examines educational and sociodemographic determinants of students' social capital in Croatia, with a particular focus on the role of early contextual and structural factors. Drawing on classical and contemporary theoretical approaches, the study conceptualizes social capital as a multidimensional construct encompassing structural and cognitive components, including social networks, social support, trust, reciprocity, and institutional confidence. Using a quantitative cross-sectional design, data were collected from a sample of 611 university students across several higher education institutions. Bivariate and hierarchical regression analyses were conducted to examine the predictive value of selected background variables. The results indicate that the place of residence during upbringing represents the most robust predictor of students' social capital, with students from larger urban centres exhibiting significantly higher levels of social capital. In addition, field of study and student allowance also impacted the level of social capital. These findings suggest that students' social capital is strongly rooted in early-life contextual conditions.

Key words: *social capital; education; relationship-building; urban-rural difference; university students.*

1. Introduction

In recent decades, there has been an increasing interest in concepts that enable a broader understanding of economic behavior, beyond exclusively material and monetary determinants. Within this context, social capital has attracted growing attention as a concept that captures the economic relevance of social relationships, social networks, and norms of trust and cooperation. Although intangible in nature, social capital is increasingly recognized as a resource that

produces measurable economic effects and operates alongside other forms of capital (Cho et al., 2025). The growing interest in social capital reflects the recognition that economic activity does not take place in isolation but is embedded in concrete social structures and relationships (Postelnicu & Hermes, 2018).

Social interactions, patterns of cooperation, and levels of trust among economic actors influence coordination, exchange, and collective action, thereby shaping economic outcomes. From this perspective, social capital represents a mechanism through which social relations acquire economic significance (Postelnicu & Hermes, 2018; Cho et al., 2025). Despite the absence of a single, universally accepted definition, most approaches to social capital emphasize its foundation in social relationships and shared norms that facilitate cooperation and reduce the costs of economic interaction (Granovetter, 1973). These characteristics make social capital particularly relevant for the analysis of economic processes that depend on trust, reciprocity, and long-term interaction. Yet, social capital is not relevant only for firm performance, but in the context of academia, might be relevant for students' academic performance (Plagens, 2011; Oranye et al., 2017), or in the broad sense, general higher education outcomes. Due to its importance for academic performance and future career outcomes, further attention needs to be paid to understanding the processes of social capital creation. This paper considers the determinants of students' social capital, specifically focusing on deeper exploration of the role of educational and early-life sociodemographic factors in shaping social capital. As most contributions on social capital come from developed countries (Carradore, 2022), it is particularly interesting to investigate students' social capital in a country with a highly collectivistic culture such as Croatia. As such, social capital provides an analytical framework that complements standard economic models by incorporating the social context with standard economic behavior theories. Paper contributes to the literature by providing both theoretical and empirical insights into the concept of social capital, with a focus on formation of students' social capital.

2. Literature review

2.1. Social capital

In the scientific literature, there is a growing interest in concepts that explain economic behavior beyond purely material frameworks, with social capital emerging as a key link between sociological and economic approaches (Postelnicu & Hermes, 2018). Interdisciplinary research increasingly treats social capital as an intangible resource with measurable economic effects, operating alongside human, physical, and cultural capital (Coleman, 1988; Putnam, 2000; Halpern, 2005).

Although no single definition of social capital exists, most authors agree that it refers to resources embedded in social relationships, networks, and norms of trust and reciprocity. Early interpretations already emphasized that individuals accumulate social capital through mutual contacts in ways that benefit both individuals and communities (Hanifan, 1916). Later sociological contributions further clarified the economic relevance of social capital. Bourdieu conceptualizes social capital as resources derived from durable networks and views it as a private good contributing to the reproduction of social inequality (Bourdieu, 1986). Coleman, by contrast, defines social capital through its function as a feature of social structure that facilitates goal attainment and conceptualizes it as a public good (Coleman, 1988; Coleman, 1990). Granovetter's theory of embeddedness challenges neoclassical assumptions of atomized

economic actors by emphasizing that economic action is embedded in concrete social networks, positioning social capital as a mechanism shaping trust, exchange, and cooperation (Granovetter, 1973). From this perspective, social capital can be understood as an investment in social relationships that generates returns such as access to information, social support, and influence, with direct implications for economic behavior (Postelnicu & Hermes, 2018; Lin, 2000). Trust plays a central role by reducing transaction costs and enabling stable economic relationships (Coleman, 1988; Fukuyama, 1999). Putnam further emphasizes that social capital consists of networks, norms, and trust that promote cooperation and social efficiency, extending its relevance to economic development, democratic performance, and quality of life (Putnam, 1993; Putnam, 2000).

Overall, social capital represents a key link between social relations and economic outcomes, complementing economic models focused solely on individual utility maximization (Woolcock, 2001). Despite extensive literature, its micro-level economic interpretation remains insufficiently explored when contextual, institutional, and economic factors are examined simultaneously within a single empirical framework (Carradore, 2022).

2.2. Living environment as a determinant of social capital

Various studies have explored determinants which could influence the level of social capital. One of these predictors can be viewed as the living environment, which can roughly be divided between individuals living in rural areas and those living in urban communities. Since there is no clear answer whether the living environment has a positive or negative impact on the development of social capital, this paper aims to examine in which direction the rural or urban environment will affect the social capital of the observed respondents. Starting from classical social theories and first relevant papers in the field of social capital (Durkheim, 1997), it was considered that the rural environment enables a closer social network and greater connectivity, while the urban environment is characterized by less frequent and less intense opportunity to broaden social capital. Some past studies examined very specific resources, such as financial resources, which influence the social network differently. Specifically, families living in rural areas have more bonding social capital and stronger social ties because they are more likely to receive financial support from their relatives than urban families (Hofferth & Iceland, 1998; Sørensen, 2016). Other research examined the expectations of elderly persons for receiving help from their children and again the results showed that the support was more evident in rural regions than in urban areas (Lee et al., 1994). However, support was not only limited to financial issues, as the rural environment was more beneficial for job seeking and people felt more comfortable to use their social networks (Matthews et al., 2009). Overall, classical research over many years indicated that rural environment has higher level of social integration than the urban area, explaining it by higher care of its inhabitants for each other. One study showed that in rural areas more than 95% of the participants regularly communicate and thereby develop their social capital while in urban areas around 75% citizens communicate enough (Eriksson et al., 2021), which is in case of large cities even surprisingly high percentage.

Given these close personal connections and the relationships which can provide significant social support, some authors emphasize limited mobility from rural areas (Tobiasz-Adamczyk & Zawisza, 2017). On the other hand, some authors argue that due to effective communication and the increasing presence of new technologies, urban-rural differences in social capital are increasingly disappearing (e.g. Friedland, 1982) or non-existent (Nieminen et al., 2008). Sørensen (2016) suggested that people from rural areas may build up social capital for social reasons, while urban inhabitants may do so more for economic reasons.

While some authors show that the urban-rural difference is fading, other research indicates that there are significant social capital differences of different social groups in the urban area (Wesselow, 2023). Urban environment offers a freedom of creating new supportive networks which enable the strengthening of social capital. Through the adequate social environment which stimulates the development of social capital, some studies found the relationship with the quality of life showing that social cohesion was higher among urban dwellers than among rural residents (Ward et al., 2021). Since the focus of this research is on the student population, the intention was to find comparable research among young people worldwide. Some research show that young adults in urban areas tend to have better prerequisites of accessing sources of support than their peers in rural environment (Amato, 1993). The opportunity to meet people and expand the volume and quality of different networks in urban area enables the strengthening of social capital. One very comparable research was conducted among Belgian students which showed that students who grew up in an urban environment stimulated the creation of social capital and consequently possessed higher social capital opportunities than those who were raised in a rural environment (Lannoo et al., 2012). Other research makes a difference in social capital regarding the point of contacts to whom the individual addresses. Considering that, individuals in rural areas have higher level of social capital when they are closely related to family contacts, while individuals in urban locations enhance their social capital through intensive contacts with close friends (Glatz & Bodi-Fernandez, 2020). Based on previous research findings, the following hypothesis was set:

Hypothesis 1 (H1): Place of residence (urban vs. rural) significantly predicts students' levels of social capital, with students from urban areas expected to have higher social capital.

2.3. Educational background as a determinant of social capital

As social capital encompasses the value derived from membership in social groups, social networks, or institutions, scholars broadly agree that social networks themselves constitute important social assets. Education enhances knowledge and skills, but also may strengthen an individual's network position, which ultimately affects the likelihood of engaging in political or civic activities (Apfeld et al., 2022). Therefore, the university stage represents a particularly critical period for the accumulation of social capital as students have a wide range of opportunities to build new social capital through class relationships, participation in clubs and associations, participation in extracurricular activities, shared living arrangements, friendships, and institutional connections (Li, 2020; Huang & Gao, 2025). These networks generate bonding capital, which consists of strong and supportive ties, as well as bridging capital, which provides broader connections and new opportunities. The uniqueness of social capital among university students has also been recognized by scholars who have developed instruments specifically designed to measure students' social capital (see Huang & Gao, 2025 for a review).

A substantial body of research empirically demonstrates that education plays a crucial role in the generation of social capital. A meta-analysis by Huang et al. (2009) showed that one standard deviation increase in years of schooling accounts for 12–17 percent of the standard deviation in social trust and social participation. University education significantly increases social capital, particularly in terms of voting participation and interpersonal trust, with potentially stronger effects for individuals from disadvantaged backgrounds (Apfeld et al., 2022). In addition to attending university per se (Apfeld et al., 2022), other education-related variables associated with social capital include years of schooling and educational groups (Nieminen et al., 2008), the educational level of people in one's social environment (Nie et al., 1996), mother's education (Lannoo et al., 2012), first-generation student status (Martin et al.,

2014), and the status of being an international student (Teng & Takemoto, 2022). These findings indicate that both individual educational attainment and the surrounding educational context shape social capital formation.

At the same time, some scholars suggest that the effect of education on social capital may change over time and that its impact today may not be as strong as in previous decades (Apfeld et al., 2022). This is namely as due to greater access to education more people can now build networks and skills through education, reducing the relative advantage once held by the educated. Furthermore, critics argue that educational attainment may partly proxy for underlying characteristics unrelated to education itself, such as genetic or personality traits, early childhood socialization, or peer group influences, which may simultaneously encourage individuals to pursue education and to engage in civic activities (Apfeld et al., 2022). Nevertheless, Imandoust (2011) contends that any type of education, including distance education, can influence the level of social capital within a country and makes education an important determinant of social capital.

Students' social capital holds particular relevance, given its demonstrated impact on both individual achievement and institutional effectiveness. Social capital has been positively associated with higher levels of student academic achievement and improved school performance (Plagens, 2011; Oranye et al., 2017). As explained by Plagens (2011), basic skills such as reading, writing, and arithmetic enable individuals to access social groups that provide long-term advantages; without these competencies, individuals may become excluded from networks that foster socioeconomic advancement.

In the context of access to education, another relevant variable is students' financial situation. For example, it has been found that scholarship recipients are more likely to engage with peers on school work outside of class (Boatman & Long, 2016), which has a positive effect on peer social interactions and contributes to growth of bonding social capital. Students being less satisfied with their finances or with fewer parental financial support are less likely to engage in social activities at university because such activities often require financial resources, which may impact social capital as well (Brooks et al., 2011; Rubin & Wright, 2017).

Although research has attempted to demonstrate that social capital differs among student groups (Martin et al., 2014), there has been limited systematic effort to distinguish social capital levels according to area of study. Students gain access to social capital from multiple sources, and deficits in one source may be compensated by strengths in another, potentially reducing observable differences between groups (Martin et al., 2014). However, evidence suggests that in the Croatian context field of study may matter. Research by Puzić et al. (2021) found that STEM students choose their faculties largely based on prior academic performance rather than cultural capital, suggesting potential differences in social capital dynamics across fields. Moreover, Gvozdanović (2014) reported statistically significant differences in social trust between students of technical and social sciences, with social science students exhibiting lower levels of trust. This finding may be related to disciplinary training that emphasizes structural inequality and institutional critique, which can foster greater skepticism toward social institutions and generalized trust in others. Nonetheless, this issue remains insufficiently explored and seeks for further empirical investigation. Therefore, the following hypothesis is set:

Hypothesis 2 (H2): Area of study significantly predicts students' levels of social capital.

3. Methodology of research

3.1. Research sample and instrument

The study adopts a quantitative research approach in order to examine students' social capital and its association with selected sociodemographic characteristics. A cross-sectional research design is employed, allowing for the observation of social capital indicators at a specific point in time and enabling comparisons across different sociodemographic groups. Data were collected using a structured questionnaire administered to university students in Zagreb, Croatia. The research was conducted on a sample of 611 students enrolled in undergraduate, graduate, and integrated study programs at several universities located in Zagreb (University of Zagreb, Catholic University of Croatia, Libertas, and VERN) where the majority of respondents (64%) were from the largest public university in Croatia and the rest (36%) were from the three private universities (Catholic University of Croatia, Libertas, and VERN). Data collection was carried out during the academic year 2022/2023. The sample included students from different years of study and various scientific fields, ensuring heterogeneity in terms of educational background and institutional context.

A non-probabilistic quota sampling method was used, with quotas defined according to the year of study and scientific field, in order to approximate the structure of the student population. Participation in the research was voluntary and anonymous. Table 1 presents respondents' sociodemographic characteristics.

Table 1: Profile of respondents

Variable	**Category**
Gender	Female 66.3%, Male 33.7%
Field of study	Social sciences & humanities 58.6%, STEM & related fields 41.4%
Year of study	1st–3rd year 66.9%, 4th–5th year 33.1%
Place of residence	Up to 10,000 inhabitants 29.6%, 10,001–50,000 inhabitants 22.7%, 50,001–100,000 inhabitants 10.8%, 100,001–500,000 inhabitants 5.7%, More than 500,000 inhabitants 31.1%
Student allowance	Yes 64%
Financial independence	Yes 31.1%

Source: Authors´calculation

Sociodemographic characteristics included standard background variables commonly used in social science research, such as gender, age, year of study, field of study, and selected indicators of socioeconomic background (Šubić et al., 2019). Sample was dominated by female students (66.3%), social sciences and humanities students (58.6%) and undergraduate students (66.9%). A total of 64% of respondents regularly received student allowance from their parents and 31.1% of respondents reported to have financial independence. Place of residence was originally measured as a five-category variable based on settlement size (up to 10,000 inhabitants; 10,001–50,000; 50,001–100,000; 100,001–500,000; more than 500,000 inhabitants). For regression modelling, alternative binary operationalizations were examined in

order to assess the robustness and interpretability of the effect. The threshold of 100,000 inhabitants was retained, as it meaningfully distinguishes large urban centers from smaller settlements within the Croatian context and yielded stable explanatory power across model specifications. In the Croatian context, settlements with more than 100,000 inhabitants correspond to major urban centers characterized by higher institutional density, broader civic infrastructure, and greater opportunities for social participation.

Social capital was conceptualized and operationalized as a multidimensional construct, in line with established theoretical and empirical approaches. It was measured through indicators reflecting both structural and cognitive dimensions of social capital. The structural dimension included variables related to the frequency of social contact with close persons and participation in social activities, capturing aspects of bonding and bridging social capital. The cognitive dimension encompassed perceived social support, generalized trust, trust in institutions, perceived fairness, and generalized reciprocity. These variables reflect norms of trust, cooperation, and mutual support embedded in social relationships. All items used to measure social capital were based on the European social survey round 6 questionnaire (European social survey round 6, 2012a; European Social Survey (ESS), 2012b). To examine the latent structure of these indicators, factor analysis was conducted. Based on the results, a single latent factor representing overall social capital was identified and subsequently used in further analyses. The analysis was conducted using Python, statistical software for data processing and analysis. Descriptive statistics were employed to provide an overview of social capital indicators, while inferential statistical methods were used to examine associations between social capital and sociodemographic characteristics.

3.2. Research results

Factor analysis confirmed the existence of a single latent factor underlying the observed indicators of social capital, with all items loading positively on the extracted factor (standardized factor loadings ranged from 0.33 to 0.81). To assess the suitability of the data for factor analysis, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were examined. The results confirmed the appropriateness of factor analysis (KMO = 0.80; Bartlett's test $p < 0.05$). This supports the conceptualization of social capital as a coherent multidimensional construct. Based on the established one-factor structure, social capital was operationalized as a composite index encompassing interpersonal, normative, and institutional dimensions of social relations. The individual components of the index (social relations, generalized trust, perceptions of fairness, willingness to help others, institutional trust, and social support) were standardized using z-transformation and subsequently aggregated into a single measure. Standardization was applied to ensure comparability of components that differ in their distributions and variances, thereby preventing any single indicator from disproportionately influencing the overall value of the index. This procedure is consistent with methodological recommendations for the construction of composite indicators, according to which standardization should precede aggregation to preserve the internal coherence and interpretability of the measure (Ward et al., 2009). The resulting standardized value of social capital was additionally transformed into a T-score (M=50, SD=10), which allows for a more straightforward interpretation of regression coefficients and facilitates the comparison of effects across variables (N=611).

Prior to estimating regression models, a comprehensive bivariate screening was conducted to examine correlations between the constructed social capital index and all sociodemographic and study-related variables included in the study. The tested variables comprised of gender,

age, year of study, employment status, financial independence, living arrangements, place of residence, field of study, and parental student allowance. Differences in social capital across binary variables were assessed using independent-samples t-tests, while multi-category variables were examined using one-way analysis of variance (ANOVA). Correlations involving continuous variables were tested using Pearson's correlation coefficient.

The results of the initial screening indicated that the majority of sociodemographic characteristics were not significantly associated with social capital. Specifically, gender, age, year of study, employment status, financial independence, and living arrangements did not demonstrate statistically significant relationships with the social capital index (all p-values > 0.05). These variables were therefore excluded from further modelling to ensure model parsimony and avoid over-specification. In contrast, three variables demonstrated statistically significant correlation at the bivariate level and were consequently identified as potential predictors of social capital. First, place of residence showed a statistically significant relationship with social capital, indicating systematic differences in social capital across settlement-size categories (ANOVA, $p<0.001$). Second, field of study was significantly associated with social capital, with students enrolled in social sciences and humanities exhibiting higher levels of social capital compared to students in STEM and related fields (independent-samples t-test, $p=0.002$). Third, allowance in youth also showed a statistically significant association with social capital (independent-samples t-test, $p<0.001$). On the basis of these results, place of residence, field of study, and allowance were retained for subsequent univariate and multivariate regression analyses. This stepwise analytical procedure ensured that only empirically relevant predictors identified during the initial bivariate screening were included in regression models.

Further analysis tested the two hypotheses, and it examined the relationships between social capital and three key variables: place of residence, field of study, and allowance from parents. As mentioned earlier, place of residence was for regression analysis purposes dichotomized and the final operationalization distinguishes between students who grew up in settlements with ≤100,000 inhabitants and those from settlements with >100,000 inhabitants. Field of study was operationalized as a binary variable (0/1), distinguishing between social sciences and humanities on the one hand and other scientific fields on the other. Social sciences and humanities differ in terms of curricular content, normative frameworks, and more frequent exposure to topics related to social relations, institutions, and social cohesion.

To facilitate interpretation of the regression results and to clearly specify the relationships between variables, the model is presented in its general mathematical form:

$$SC_{\mathrm{i}} = \beta_0 + \beta_1 \, Residence_{\mathrm{i}} + \beta_2 \, Field_{\mathrm{i}} + \beta_3 \, Allowance_{\mathrm{i}} + \varepsilon_{\mathrm{i}}$$

where SC_i represents the social capital score of individual i, $Residence_i$ is a binary variable indicating whether the student grew up in a settlement with more than 100,000 inhabitants (1) or not (0), $Field_i$ denotes the field of study (1=Social sciences & humanities; 0=other), and $Allowance_i$ indicates whether the student received parental financial allowance (1=yes; 0=no). The term ε_i represents the error term capturing unobserved influences on social capital.

The results of univariate regression analyses indicate that all three variables are statistically significantly associated with social capital (Table 2). According to Hypothesis 1 (H1), larger places of residence are associated with higher levels of social capital; and according to Hypothesis 2 (H2) is expected that students enrolled in social sciences and humanities achieve, on average, higher levels of social capital compared to students from other fields of study. Table

2 also showed that higher levels of allowance show a positive and statistically significant relationship with social capital.

Table 2: Univariate regression models

Independent variable	B	SE	t	p	R^2
Place of residence (1 = >100,000; 0 = ≤100,000)	7.134	0.561	12.717	< 0.001	0.210
Field of study (1 = SocSci & Hum; 0 = other)	1.703	0.615	2.771	0.0058	0.012
Allowance in youth (1 = yes; 0 = no)	3.795	0.618	6.125	< 0.001	0.059

B = regression coefficient; SE = standard error; t = t-statistic; p = p-value; R^2 = coefficient of determination

Source: Authors´ calculation

In the next step, hierarchical multiple regression analysis was conducted in order to examine whether the observed predictors retained their statistical significance when entered simultaneously. Predictors were introduced sequentially in three steps: (Model 1) place of residence, (Model 2) field of study, and (Model 3) allowance in youth. This hierarchical specification allows for the assessment of incremental explained variance (ΔR^2) and the stability of regression coefficients across models.

Model 1 included only place of residence (coded 1=>100,000 inhabitants; 0=≤100,000 inhabitants). The model explained 21.0% of the variance in social capital ($R^2 = 0.210$). Students who grew up in larger urban settings exhibited significantly higher levels of social capital (B=7.134, SE=0.561, t=12.717, p<0.001), providing empirical support for Hypothesis 1 (H1).

In Model 2, field of study (1=social sciences and humanities; 0=other fields) was added. The increase in explained variance was modest (ΔR^2=0.003), after controlling for place of residence, field of study was no longer statistically significant (B=0.898, SE=0.553, t=1.624, p=0.105), while place of residence remained a strong and significant predictor (B=7.027, SE=0.564, t=12.461, p< 0.001).

Model 3 additionally introduced parental financial allowance (1=yes; 0=no). This step resulted in a statistically significant increase in explained variance (ΔR^2=0.023, p<0.001), bringing the total explained variance to 23.6% (R^2=0.236). In the final model, place of residence remained the strongest predictor in terms of explained variance and standardized effect magnitude (B=6.591, p<0.001), and allowance in youth was also statistically significant (B=2.419, p<0.001). Field of study did not retain statistical significance in the full model (B=0.638, p=0.245).

Table 3: Hierarchical multiple regression analysis

Predictor	**Model 1 B (SE)**	**p**	**Model 2 B (SE)**	**p**	**Model 3 B (SE)**	**p**
Place of residence	7.134 (0.561)	<0.001	7.027 (0.564)	<0.001	6.591 (0.566)	<0.001
Field of study	—	—	0.898 (0.553)	0.105	0.638 (0.549)	0.245
Allowance in youth	—	—	—	—	2.419 (0.571)	<0.001
Constant	47.496	—	47.008	—	45.767	—
R^2	0.210		0.214		0.236	
ΔR^2	—		0.003		0.023	

Source: Authors´ calculation

Results shown in Table 3, combined with results from initial screening that included a larger set of variables, indicate that the contextual factor of early urban environment represents the most robust predictor of students' social capital confirming H1, while the effect of field of study observed in the univariate model is largely accounted for by differences in place of residence. Parental allowance in youth contributes independently, suggesting that early economic socialization has a lasting association with social capital formation.

4. Discussion

Research findings indicate that students' social capital is shaped primarily by contextual and early-life structural factors rather than by characteristics related to university studies (e.g. year of study, living arrangement or financial independence). Given that previous empirical evidence suggests that social capital positively correlates with years of education (Huang et al., 2009), it is surprising that this was not confirmed for student sample in Croatia, which calls for further examination. The lack of a significant independent effect of field of study may imply that social capital is largely formed prior to university entry. Univariate regression analyses show that all three variables are significantly related to social capital: place of residence, field of study, and parental financial allowance. More precisely, students from larger towns, those studying in the field of social sciences and humanities, and those receiving higher allowances tend to exhibit higher levels of social capital. Therefore, this study contributes to social capital theory by demonstrating that, at the micro level, students' social capital is more strongly associated with early-life contextual conditions than with educational environments.

The research further analyzed the effect of these determinants when observed simultaneously. The most robust and consistent predictor across all models was the size of settlement during upbringing, in line with H1. Students who grew up in larger urban environments (>100,000 inhabitants) exhibited significantly higher levels of social capital, even after controlling for field of study and allowance during youth, consistent with previous research on students' social capital (e.g. Lannoo et al., 2012). This suggests that early exposure to denser institutional settings, broader civic infrastructure, and more diverse opportunities for social interaction may

have long-term implications for the development of bridging social capital and related social trust, institutional orientation, and social connectedness among students. However, such finding contrasts Sørensen's (2016) analysis of a generalized Danish sample, which reports significantly higher levels of bonding social capital in rural areas and only marginally higher levels of bridging social capital in urban contexts. These findings contribute to the debate on rural versus urban social capital by suggesting a shift from bonding-dominated to bridging-dominated mechanisms. While earlier sociological perspectives (e.g., Durkheim, 1997) emphasized cohesion in rural settings, the present results indicate that urban environments may provide more favorable conditions for the accumulation of bridging social capital, which is particularly relevant for students aiming to integrate into complex institutional and professional environments.

Although field of study was significantly associated with social capital at the bivariate level, this effect did not remain statistically significant once contextual and economic factors were taken into account. This indicates that the initially observed differences between students in social sciences and humanities and those in other fields are largely explained by background characteristics, particularly settlement size during upbringing. In other words, educational context alone does not appear to exert an independent effect on social capital once other structural factors are considered.

Parental allowance retained statistical significance in the final model, although its explanatory contribution was notably smaller than that of settlement size. This suggests that early economic socialization and access to discretionary resources may facilitate participation in social activities and the maintenance of social ties, but its effect is secondary compared to broader contextual conditions. Rather than representing a decisive determinant, allowance appears to partially contribute to social capital formation. Nevertheless, this finding is still consistent with previous research findings (Brooks et al., 2011; Rubin & Wright, 2017) indicating that financial deficit has a negative effect on social capital development.

Importantly, no significant effects were found for gender, age, year of study, employment status, financial independence, or living arrangements. This indicates that social capital does not simply accumulate with time spent in higher education, nor does it primarily reflect short-term sociodemographic characteristics. Instead, it appears to be rooted in structural conditions established prior to university entry. Overall, the results support an understanding of social capital as a resource embedded in early social environments and shaped by long-term contextual exposure. The predominance of settlement size over institutional or short-term demographic variables underscores the importance of broader structural settings in explaining variations in students' social capital.

5. Conclusion

Higher education institutions provide an important platform for the expansion of students' social capital. Previous empirical research demonstrates that prolonged education increases students' social capital. However, research on other determinants of students' social capital remain scarce. This paper addressed the research gap by focusing on sociodemographic and educational backgrounds as primary determinants of social capital among university students in Croatia. The results of primary research indicate that three variables impact social capital levels: place of residence, field of study and parental allowance. Higher levels of social capital were observed among students coming from densely populated urban areas, those enrolled in

social sciences and humanities, compared to other fields including STEM, and those receiving allowance. Among these, the contextual factor of early urban environment emerged as the most robust predictor of students' social capital (R^2=0.210).

From a theoretical perspective, the findings confirm Coleman's (1990) view demonstrating that students' social capital is not shaped solely within higher education institutions, but is strongly rooted in other social networks and structural conditions. In practical terms, the findings suggest that universities and policymakers should pay particular attention to students from smaller settlements, as they may enter universities with comparatively lower levels of social capital and potentially fewer network-based resources. Furthermore, the results of this research can be an incentive for more targeted public investments in the development of local communities which would enhance the level of social capital in general. Further analysis of local budget expenditures might reveal opportunities for practitioners to adjust future budgetary planning with the ultimate goal of ensuring equal opportunities regardless of settlement size. Moreover, certain amount of local budget investments will certainly boost the evolution and growth of social capital by citizens enabling them to use it in their future activities.

Finally, several study limitations should be acknowledged. Firstly, the use of a non-probabilistic quota sample limits the generality of the findings for the broader study population in Croatia. Secondly, the reliance on self-reported measures of social capital may introduce response bias and provide socially acceptable responses. Future studies on this topic could address these limitations through longitudinal designs and multi-institutional probability samples. Finally, this study could benefit from a mixed-method approach in order to provide deeper multilevel insight into the topic of social capital.

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A scientific paper

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DO COMPANIES MANIPULATE EARNINGS TO AVOID EXTERNAL AUDIT OBLIGATION? EVIDENCE FROM CROATIA

ABSTRACT

Besides responsibility for objective presentation of clients' financial statements, external auditors are also guided by the professional auditing standards to pay attention to the earnings management techniques. Determining the criteria for audit exemption based on the values of accounting items provides the opportunity for companies to avoid the additional financial oversight. Thus, if the values of company's financial statement items are near the limits relevant for determining the audit exemption, company could resort to earnings management to ensure that it remains under a threshold. Therefore, the main aim of this paper was to determine if there is evidence in favour of notion that companies manage earnings downward to avoid the audit obligation. The modified Jones model was applied to estimate the level of discretionary accruals as a proxy of earnings management and the regression analysis was used to test the established hypothesis on the sample of companies whose audit exemption indicators were near the thresholds. Research results show no evidence indicating that companies conduct income-decreasing activities to avoid audit exemption thresholds. On the one side, this could indicate that Croatian audit environment is not sufficiently stringent and that companies are not motivated to avoid audit obligation because of sufficient manoeuvring space for circumventing strict external oversight even if they are not exempt of audit, but it could also signify that companies avoid greater public scrutiny. To the authors' knowledge, this is the first research to analyse the audit exemption from a standpoint of audit evasion and establish the measure of proximity of a company to the audit exemption threshold. These results should motivate further scientific research and they have the practical implications for institutions actively involved in shaping the audit environment in the Republic of Croatia.

Key words: *Audit Exemption, Audit Obligation, Earnings Management, Financial Manipulation, Financial Reporting Quality.*

1. Introduction

There is an information asymmetry that works in favour of corporate management with a detrimental effect on owners of a company (Jensen & Meckling, 1976, in Kamarudin, Abidin & Smith, 2012) which can be monitored through the financial statements (Goddard and Masters, 2000, in Kamarudin, Abidin & Smith, 2012). Corporate management, pressured by the stakeholders' expectations in highly competitive and unpredictable contemporary business

environment, is often in temptation to manipulate items in financial statements to achieve certain financial result and undermine financial reporting quality (Ježovita & Tušek, 2025). "The most important motives that push companies to engage in earnings management practices are tax evasion, achieving personal gains and incentives, keeping up with competing companies, legal requirements, strengthening the financial position to attract investors, obtaining high ratings from international institutions, pressure from major shareholders and creditors, and obtaining bank loans" (Siekelova et al., 2020; Alfadhael & Jarraya, 2021; Boachie & Mensah, 2022; Athanasakou et al., 2009; Baskaran et al., 2020; International Auditing and Assurance Standards Board, 2022, in Shbeilat, 2024, p. 48 and 49).

The financial accounting in the member countries of the European Union is organized by complex "patchwork of regulations" which includes sources such as regulations, directives, and member states' laws and "applies to different sets of firms" and, besides the financial accounting regulation, also includes other types of regulation (e.g. taxation and stock market) and the process of auditing (Labro & Pierk, 2025, p. 3178). Among the mechanisms crucial for financial stability and stakeholders' trust, significant role in curbing earnings management belongs to the external audit (Ježovita & Tušek, 2025). It is an important oversight mechanism which "provides reasonable assurance that the reports are prepared in compliance with the accounting standards and ensures the credibility of its information" (Kamarudin, Abidin & Smith, 2012, p. 153). According to the International Standards on Auditing they should consider the indications of earnings management (International Auditing and Assurance Standards Board, 2009). More precisely, the International Standard on Auditing 240 prescribes that, within the discussion between the members of audit engagement team, the "circumstances that might be indicative of earnings management and the practices that might be followed by management to manage earnings that could lead to fraudulent financial reporting" should be considered (International Auditing and Assurance Standards Board, 2009, A12).

The companies could be motivated to avoid external audit if they are manipulating their earnings because of the reduced space to accomplish their objectives. Companies near the audit exemption threshold do not have incentives regarding the stock market, but they could be motivated to present better image to the creditors, or reduce their tax obligations. Three conditions are considered in order to determine if a company is obliged to appoint external auditor – net income, total assets and average number of employees (Official Gazette, 2024). According to the Accounting Act in force in the Republic of Croatia (Official Gazette, 2024), the legal obligation for external audit is incorporated in the paragraph 20 and it implies that public interest entities, large enterprises and medium-sized enterprises, parent companies of medium-sized, large groups, companies which sought approval to have their shares listed in the stock market and companies which changed their legal status through mergers or splits are subject to statutory audit (Official Gazette, 2024). Mandatory audits are considered as a guarantee that the minimum accounting quality will be achieved (Ruiz & Gómez, 2008, in Huguet & Gandía, 2016). On the other side, the audit could only be performed as a form of passive compliance with a lenient auditor (Huguet & Gandía, 2016) which do not contribute to the quality of an audit.

The main objective of this research was to determine if there is evidence in favour of notion that companies manage earnings downward to avoid the audit obligation, which is also the scientific contribution of this research, as well as the fact that the Republic of Croatia was used as research environment, given that there are indications of external audit ineffectiveness in detecting earnings management (Ježovita & Tušek, 2025). To the authors' knowledge,

previous research did not analyse the audit exemption from a standpoint of audit evasion and did not establish the measure of proximity of a company to the audit exemption threshold. Also, it mostly considered developed European countries in the context of audit exemption. The scientific paper is divided in several sections. First section contains introductory thoughts on the issue of earnings management as a means of achieving exemption from audit obligation. Second section includes literature review on small private unaudited companies in the context of earnings management. Third section comprises the specifics of mandatory audit regulation in the Republic of Croatia and European countries and its evolution from 2015 to present. Fourth section includes the details on methodology used in the research, such as the specifics of research sample, calculation of the dependent variable used in the research model, as well as the research model equation with the variables included in the research model. Fifth section contains the results of the research, including descriptive statistics, correlation matrix and regression analysis with their pertaining explanations. Finally, sixth section combines the thoughts from previous sections in concluding remarks on earnings management in the context of audit exemption.

2. Literature Review

Previous literature regarding the audit exemptions is limited, especially in transition economies. Research was predominately conducted in more developed European countries, such as Norway, Spain and Italy. The increase of audit exemption thresholds raises concerns of decreased financial reporting quality in unaudited financial statements of the companies which are not obliged to conduct external audit (Vanstraelen & Schelleman, 2017, in Höglund & Sundvik, 2018). Starting from the assumption of external audit as a deterring mechanism for the manipulation in financial statements and considering the results of their research which indicate "less accrual earnings management in audited companies within a subsample that on average could anticipate the effects of the tax reform the most", Höglund and Sundvik (2018) concluded that "the audit exemption programmes can be detrimental to the quality of financial reporting and that auditors provide value to the tax authorities" (p. 20).

Reduction of costs is stated as the one of the advantages of audit exemption, but audit fees represent negligible amount of a company's profits (Kamarudin, Abidin & Smith, 2012). Exemption can result in repercussions in the other areas (Collis, 2003, in Kamarudin, Abidin & Smith, 2012), such as reduced credit worthiness which can increase borrowing costs of a company and limit potential for expansion of a business (Kamarudin, Abidin & Smith, 2012). On the other side, small companies in which the role of shareholders and directors is combined in one or more persons have the least utility of audit obligation (Davies, 2004, in Kamarudin, Abidin & Smith, 2012). In this case external audit is rendered irrelevant because shareholders have the same knowledge on company's financial statements as directors because the roles of directors and shareholders are unified (Kamarudin, Abidin & Smith, 2012).

Several reasons can be mentioned as a reason for lower quality of private companies' financial reporting in comparison to public companies (Valentincic, Novak & Kosi, 2017), such as less pronounced agency problems (Jensen & Meckling, 1976; Ang, Cole & Lin, 2000; Ball & Shivakumar, 2005, in Valentincic, Novak & Kosi, 2017) and a less prominent role of financial reporting in resolving information asymmetries with external interest groups (Beatty & Harris, 1999; Ball & Shivakumar, 2005; Garrod, Kosi & Valentincic, 2008, in Valentincic, Novak & Kosi, 2017). There are potentially negative sides of small and medium enterprises

external audit exemption, such as decreased quality of financial statements which has repercussions on tax collection (Accountancy Europe, 2018, in Mohamed & Gan, 2024).
The findings of research Downing and Langli (2018) conducted on the legal exemption of audit requirement for small Norwegian companies are in line with this notion. They have found lower accounting and tax regulation compliance in the financial statements of companies which decided to be exempt from audit. On the other side, they also acknowledged that, besides costs which policy-makers have to consider before their implementation and decisions on audit obligation thresholds, audit exemptions can have advantages, such as reduced administrative burden for smaller companies. Bisogno and de Luca (2015) confirmed the tendency of the Italian small companies to conduct earnings manipulation. They have attributed it to the fewer information disclosure requirements and higher information asymmetry (Bhattacharya, 2001, in Bisogno & de Luca, 2015).
Similar conclusions are derived from the research conducted by Huguet and Gandía (2016), who have examined the differences between mandatorily audited Spanish companies and companies exempt from audit. They have found that absolute discretionary accruals are lower in the case of audited companies, but in higher extent when audits are mandatory. They have also found that upward earnings management is curbed more efficiently, attributing it to the conservatism of auditors. Considering the notions made in this section, the research hypothesis was established as follows:

There is a statistically significant relationship between the closeness of company's revenues to the audit exemption threshold and the level of earnings management.

3. Mandatory Audit Regulation in the Republic of Croatia and European Countries

Mandatory audit obligation in the Republic of Croatia is defined by the size and importance of a company. Accordingly, public interest entities, large enterprises, medium-sized enterprises, parent companies of medium-sized and large groups, companies which sought approval to have their shares listed in the stock market and companies which changed their legal status through mergers or splits are subject to statutory audit (Official Gazette, 2024). Other companies also fall under this obligation if they exceed at least two thresholds regarding (1) the value of total assets, (2) the value of total income and (3) the average number of employees during the financial year (Official Gazette, 2024).

Table 1: Mandatory Audit Thresholds in the Republic of Croatia from 2015 to 2026

	Accounting Act	
Criteria	Official Gazette (2024)	Official Gazette (2015)
Assets	2.500.000,00 €	1.990.842,13 € (15.000.000,00 HRK)
Income	5.000.000,00 €	3.981.684,25 € (30.000.000,00 HRK)
Average number of employees during a financial year	25	25

Source: Created according to the provisions of Official Gazette (2024). Accounting Act, Official Gazette no. 85/24, 145/24 and Official Gazette (2015). Accounting Act, Official Gazette no. 78/15, 134/15, 120/16, 116/18, 42/20, 47/20, 114/22, 82/23.

The evolution of regulation for audit obligations was presented in Table 1. Given that on 1st January 2023 the Republic of Croatia adopted the euro as its official currency according to the *Act on introducing the euro as the official currency in the Republic of Croatia* (Official Gazette, 2022a), the changes of the *Accounting Act* have followed these provisions and the values, until then, expressed in Croatian kuna (HRK) were converted in euro (€) (Official Gazette, 2022b).

It is evident that the thresholds for given criteria were increased in 2024. This is in accordance with an increase of thresholds that affect statutory audit obligation in *Commission delegated Directive (EU) 2023/2775 of 17 October 2023 amending Directive 2013/34/EU of the European Parliament and of the Council as regards the adjustments of the size criteria for micro, small, medium-sized and large undertakings or groups* in comparison to the *Directive 2013/34/EU of the European Parliament and of the Council of 26 June 2013 on the annual financial statements, consolidated financial statements and related reports of certain types of undertakings, amending Directive 2006/43/EC of the European Parliament and of the Council and repealing Council Directives 78/660/EEC and 83/349/EEC*. "The new delegated directive increased the EU size criteria by 25% to reflect accumulated inflation, and countries responded differently – 10 countries chose not to change their thresholds, 12 countries applied the full 25% increase, and 9 countries increased their thresholds by more than 25%. One jurisdiction continues to have no audit exemption thresholds; however, it introduced a review option for very small entities as an alternative to statutory audit" (Accountancy Europe, 2026). Among the European countries, which include the members of European Union, United Kingdom, Switzerland, Norway, Iceland and Turkey, arguably highest thresholds are in Switzerland, which amount to 21.324.000,00 € for balance sheet total and 42.685.000,00 € for net turnover in 2026 (Accountancy Europe, 2026). This can be considered as a manner to disburden their small companies from additional administrative costs.

The Directive's harmonizing effect on the classification of companies across the European Union "facilitates comparability and consistency in financial reporting and auditing requirements" which "has been particularly important for cross-border business operations, international investors, and supervisory authorities, as it enhances transparency and reduces the complexity that previously arose from divergent national regulations" (Füredi-Fülöp, Murányi & Bárkonyiné Juhász, 2026, p. 48). Besides stimulating the harmonization in the legislation of European Union, national economic specificities must also be taken into account – "the ongoing evolution of thresholds and audit requirements also reflects the dynamic balance between two policy goals. On one hand, reducing unnecessary administrative costs for smaller undertakings, and on the other, safeguarding the reliability of financial information and the protection of stakeholders" (Füredi-Fülöp, Murányi & Bárkonyiné Juhász, 2026, p. 48).

4. Research Methodology

4.1. Research Sample

The research sample consists of companies which had surpassed the threshold for audit obligation regarding total assets in the financial year 2022 that amounted to 1.990.842,13 €, but have not reached total income threshold value of 3.981.684,25 € the financial year 2022. These thresholds were in force until they were changed in 2024. More precisely, all companies which have fulfilled only one criterion for the audit obligation – the value of total

assets – and whose total income was lower 10 % or less from the threshold value were included in the sample. Among these companies, those which conducted upward earnings management were excluded, starting from the presumption that they do not have incentives to avoid audit obligation or did not act upon it. After the mentioned exclusions, the final sample included 51 companies. Financial data and the data on the average number of employees needed to determine companies with audit obligation was gathered from the Croatian Financial Agency's (Fina) *Info.BIZ* database which provides the data on financial position and financial performance of all business entities on the area of the Republic of Croatia.

4.2. Dependent Variable Measurement

There are two types of earnings manipulations regarding their impact on the financial result – upward and downward earnings management. Only downward earnings management was considered in this research as a manner of avoiding audit obligation and it was measured by the modified Jones model based on the Jones model developed in 1991, which was the result of the evolution of methods used to determine the presence of earnings management in financial statement of a company, commencing with the Healy model developed in 1985 and continuing with the DeAngelo model developed in 1986 (Jones, 1991, in Denich, 2021).

The Jones model incorporated the change made by DeFond and Jiambalvo which implied estimating regression coefficients for every business activity separately (DeFond & Jiambalvo, 1994, in Denich, 2021), as well as the change made by Dechow et al. which included the revenue modifications because of the lower degree of discretion associated to the cash sales in comparison to the credit sales, making them much more susceptible to accounting manipulation (Dechow et al., 1995, in Denich, 2021). Equation used for its calculation is as follows (Dechow et al., 1995, in Denich, 2021):

$$TA_{it}/A_{it-1} = \alpha_1 (1/A_{it-1}) + \beta_{1i} [(\Delta REV_{it} - \Delta REC_{it})/A_{it-1}] + \beta_{2i} (PPE_{it}/A_{it-1}) + \varepsilon_{it} \qquad (1)$$

where "TA_{it} = total accruals in year t for firm i
ΔREV_{it} = revenues in year t less revenues in year t-1 for firm i
ΔREC_{it} = receivables in year t less receivables in year t-1 for firm i
PPE_{it} = gross property, plant, and equipment in year t for firm i
A_{it-1} = total assets in year t-1 for firm i
ε_{it} = error term in year t for firm i
i = firm index
t = year index for the years included in the estimation period for firm i
α, β = firm specific parameters" (Dechow et al., 1995, in Denich, 2021, p. 203).

5. Research Model

To test the research hypothesis, the following research model was developed and estimated using regression analysis:

$$dwDACC_i = \beta_0 + \beta_1 * REVbT_i + \beta_2 * CS_i + \beta_3 * PROF_i + \beta_4 * LEV_i + e_i \qquad (1)$$

where the dependent variable is $dwDACC_i$ which represents downward earnings management measured with the discretionary accruals calculated using the modified Jones model for a

company i, and $REVbT_i$ as the test variable which represents the percentage of revenue company i needs to reach the threshold for the audit obligation.

Several control variables were included to ensure higher precision of the regression model – CS_i represents the size of a company i estimated as a natural logarithm of total assets, $PROF_i$ represents the profitability of a company i measured with return on assets (ROA) calculated as a ratio of net profit and total assets for a company i, LEV_i represents the level of leverage of a company i calculated as a ratio of total liabilities (which are computed as a total of short-term liabilities and long-term liabilities) and total assets, and e_i represents the error of the regression model for a company i.

Exclusively income-decreasing discretionary accruals were included in the research considering that companies with upward earnings management did not have the incentives to avoid external audit obligation or, in case if they had the mentioned incentive, they did not act upon it or did not have the possibility to act upon it (e.g. if they used they earnings management manoeuvring space in the previous financial year and are faced with the accrual reversals).

6. Research Results

This subsection comprises the results of research and include the descriptive statistics, correlation matrix and regression analysis. Firstly, the descriptive statistics regarding the research variables included in the regression model were presented in Table 1. Measures such as minimum, maximum, mean, standard deviation, median and 25th and 75th percentile were included.

Table 2: Review of the descriptive statistics measures

Measure/Variable	dwDACC	REVbT	CS	PROF	LVG
N	51	51	51	51	51
Minimum	-0,5657	-0,0999	14,52	-0,1423	0,0993
Maximum	-0,0054	-0,00001	17,06	0,6891	5,4371
Mean	-0,1237	-0,0474	15,05	0,0927	0,6348
Standard Deviation	0,126	0,0332	0,606	0,1376	0,755
Median	-0,0849	-0,0462	14,79	0,0694	0,5542
25th percentile	-0,1632	-0,0782	14,64	0,0149	0,2533
75th percentile	-0,035	-0,0154	15,24	0,1299	0,7522

*Note: Thresholds used to determine statistical significance are as follows: * $p < 0,1$; ** $p < 0,05$; *** $p < 0,01$. dwDACC = downward discretionary accruals (the proxy variable for downward earnings management calculated as income-decreasing discretionary accruals using the modified Jones model), REVbT = revenue below threshold (the percentage of revenue company needs to reach the threshold for the audit obligation, calculated as the difference between the value of revenues that company achieved and the revenue threshold used to determine audit obligation of a company divided by the revenue threshold used to determine audit obligation of a company), CS = company size (calculated as a natural logarithm of total assets), PROF = profitability (return on assets calculated as the ratio between net profit and total assets), LVG = leverage (calculated as a ratio of total liabilities and total assets).*

Source: Authors' calculation.

The average value of dependent variable which included measure of discretionary accruals has negative value of approximately -0,1237 given that only downward earnings management

was considered. The average company was rather profitable and indebted, with average return on assets of 9,3 % and average leverage level of 63,5 %.

Table 3: Matrix of correlation coefficients

Variable	dwDACC	REVbT	CS	PROF	LVG
dwDACC	1				
REVbT	-0,0977	1			
CS	0,2129	0,0434	1		
PROF	0,1563	-0,08	-0,1796	1	
LVG	0,0043	-0,183	0,03025	-0,2727*	1

*Note: Thresholds used to determine statistical significance are as follows: * p < 0,1; ** p < 0,05; *** p < 0,01. dwDACC = downward discretionary accruals (the proxy variable for downward earnings management calculated as income-decreasing discretionary accruals using the modified Jones model), REVbT = revenue below threshold (the percentage of revenue company needs to reach the threshold for the audit obligation, calculated as the difference between the value of revenues that company achieved and the revenue threshold used to determine audit obligation of a company divided by the revenue threshold used to determine audit obligation of a company), CS = company size (calculated as a natural logarithm of total assets), PROF = profitability (return on assets calculated as the ratio between net profit and total assets), LVG = leverage (calculated as a ratio of total liabilities and total assets).*

Source: Authors' calculation.

The correlations of variables included in the research model and presented in the correlation matrix in Table 2 were calculated to ensure that there is no multicollinearity problem. Given that the correlation values were rather low, it is evident that there is no multicollinearity problem in this research. Below the diagonal line filled with the perfectly strong correlation coefficients are the remaining correlation coefficients.

Table 4: Regression analysis of the research model

Variable	Coefficient	Standard Error	T	P
Constant	-0,9496	0,4509	-2,11	0,0407
REVbT	-0,3246	0,5468	-0,59	0,5557
CS	0,0525	0,0297	1,77	0,0837
PROF	0,1875	0,1369	1,37	0,1774
LVG	0,0061	0,0249	0,25	0,8063

*Note: Thresholds used to determine statistical significance are as follows: * p < 0,1; ** p < 0,05; *** p < 0,01. dwDACC = downward discretionary accruals (the proxy variable for downward earnings management calculated as income-decreasing discretionary accruals using the modified Jones model), REVbT = revenue below threshold (the percentage of revenue company needs to reach the threshold for the audit obligation, calculated as the difference between the value of revenues that company achieved and the revenue threshold used to determine audit obligation of a company divided by the revenue threshold used to determine audit obligation of a company), CS = company size (calculated as a natural logarithm of total assets), PROF = profitability (return on assets calculated as the ratio between net profit and total assets), LVG = leverage (calculated as a ratio of total liabilities and total assets).*

Source: Authors' calculation.

The research hypothesis was tested using the multiple linear regression model presented in Table 3. The test variable was not statistically significant indicating that there is no relationship between the closeness of a company to audit obligation threshold and earnings management. Among control variables, only company size was statistically significant and positively related to downward earnings management at a threshold of 10 percent.

7. Conclusion

External audit serves as an important external mechanism for ensuring that the financial statements are composed according to the financial reporting standards and other relevant corporate regulation. Given that costs of audit can surpass its utility, lawmakers usually exempt smaller companies with lower number of stakeholders from audit obligation. To this category of companies, exemptions ensure wider opportunities for manipulating the items of financial statements. If a company manipulates financial result, it has an incentive to avoid external audit obligation, given that statutory auditors have the knowledge and means to restrict their earnings management behaviour. In this context, companies which are near the threshold that affects the audit obligation could use earnings management techniques to lower the value of relevant items and avoid the external audit obligation. Thus, the relationship between the closeness of company's revenues to the audit exemption threshold and the level of earnings management was hypothesized.

The research hypothesis was not confirmed, indicating that closeness to the income threshold for audit obligation is not statistically related to the measure of earnings management. This indicates the absence of evidence that companies manage earnings to avoid audit obligation. Possible explanation is that the external audit is not efficient mechanism in the Republic of Croatia. This presumption is in line with the findings of the research conducted by Ježovita and Tušek (2025) which indicate ineffectiveness of external auditors in detecting earnings management in Croatian business environment, including the time period used for the analysis in this research. If financial statements of a company indicate the audit obligation, more lenient auditor could be appointed to ensure that their accounting objectives are not disrupted. On the other side, companies could have abstained of earnings management to avoid closer public scrutiny. More precisely, companies near the threshold could be monitored by the public in expectation that they will manage earnings, so their managements could avoid additional attention. To the authors' knowledge, there is no previous research on audit exemption from a standpoint of audit evasion and proximity to audit obligation thresholds.

This research also has limitations which should be acknowledged. Firstly, the research sample is rather small, so the future research should include larger number of companies in the sample and include more financial years into consideration. Also, in terms of the generalization of research results, research could be done in other countries, especially in ones with higher legal protection than in the Republic of Croatia which ensures more rigorous external audit approach. Given that the results of the research are not favourable in the context of audit efficiency, they have practical implications and deserve a closer analysis by the relevant institutions actively involved in shaping the audit environment in the Republic of Croatia.

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A scientific paper

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DEVELOPING MOTIVATIONAL LEADERSHIP IN PRESCHOOL EDUCATION INSTITUTIONS: CHALLENGES AND OPPORTUNITIES

ABSTRACT

This paper aims to examine the concept of motivational leadership in the system of early and preschool education, with a particular focus on the possibilities and limitations of its application in the Croatian context. The study seeks to identify dominant leadership characteristics in preschool institutions, analyse the perceptions of principals and educators regarding the effectiveness of motivational leadership, and provide recommendations for the improvement of leadership practices in early and preschool education. The research was conducted in August 2025 in Zadar County using a qualitative research approach. Data were collected through semi-structured individual and group interviews and analysed using descriptive qualitative analysis. The sample comprised five preschool principals and sixteen educators, representing both private and public kindergartens. The findings reveal that both principals and educators acknowledge the importance of motivational leadership in preschool institutions. Educators emphasized the need for increased support, recognition, professional development, and active involvement in decision-making processes. Principals identified legal and financial constraints as significant challenges but also recognized opportunities for strengthening motivational leadership through professional training, mentoring, and enhanced cooperation with founders. Overall, motivational leadership emerges as a crucial factor for the effective functioning of preschool institutions, as it directly affects educator motivation and job satisfaction and indirectly contributes to the quality of educational practice and the well-being of children.

Key words: *leadership styles, motivational leadership, early and preschool education, Croatia, Zadar County.*

1. Introduction

Institutions that provide early childhood education and care (ECEC) represent an essential and integral component of the education system. Contemporary social changes, characterized by increasing dynamics, complexity, and heightened expectations regarding educational quality, significantly affect the functioning of preschool institutions (Atha, 2025). In this context, leadership has received growing attention as one of the key determinants of the effective functioning and development of educational organizations (Leithwood et al., 2004, 2021; Mincu, 2022). Leadership is commonly defined as the ability to influence employees to achieve assigned tasks and organizational goals (Ćuprudija et al., 2019). In educational

settings, leadership is understood as a process of aligning and directing human resources toward the attainment of shared objectives, with particular emphasis on professional responsibility and leaders' self-regulation (Staničić, 2006; Russo, 2021). Beyond organizing people and work processes, leadership also involves initiating change and monitoring and managing its consequences (Seme Stojanović and Hitrec, 2014). Empirical research indicates that leadership is crucial for organizational success and plays a significant role in enhancing the quality of practice in the ECEC system (Douglass, 2019; Leithwood et al., 2021; Wang, 2024). However, scholars also highlight a lack of research addressing the specific characteristics and effects of different leadership models in preschool institutions, particularly within national contexts. The development of leadership theory has been shaped by the distinction between transactional and transformational leadership, introduced by Burns (1978). Transactional leadership is based on the exchange of benefits between leaders and employees, whereas transformational leadership focuses on motivation, inspiration, and the development of shared values (Northouse, 2015). In preschool institutions, increasing emphasis is placed on motivational leadership, which encompasses two-way communication, employee participation, timely feedback, support for professional development, and self-evaluation (Leithwood et al., 1999; Widyastuti et al., 2024). Motivation is defined as the internal energy that initiates and directs an individual's behaviour toward goal attainment (Russo, 2021). In organizational contexts, motivation is a responsibility of management and implies aligning employees' needs and goals with institutional objectives (Ćuprudija et al., 2019). Given that opportunities for material rewards in non-profit organizations such as preschool institutions are limited, non-material forms of motivation (support, recognition, and opportunities for professional development) are particularly important (Obradović et al., 2015). In this context, it is essential to establish a clear conceptual distinction between motivational leadership and both transformational and pedagogical leadership. Although these approaches frequently overlap in practice, they differ with regard to their primary focus and level of analytical orientation. Transformational leadership operates predominantly at the level of vision, values, and organizational change (Bass and Riggio, 2006), whereas pedagogical leadership concentrates on the enhancement of teaching and learning processes and the improvement of educational quality (Male and Palaiologou, 2015). By contrast, motivational leadership is primarily oriented toward the operational management of employee motivation within everyday professional practice. From an analytical perspective, transformational leadership addresses the strategic questions of "why" and "where" an organization is developing, emphasizing long-term direction and value alignment. Pedagogical leadership, in turn, focuses on "how" to improve teaching and learning processes within educational contexts. Motivational leadership, however, centres on the question of "how to engage employees" in these processes, with particular attention to daily professional interactions and motivational dynamics. Recent empirical studies further substantiate this conceptual differentiation. Porras-Garcia and Duche-Perez (2023) underscore the interrelationship between transformational and pedagogical leadership in advancing educational practice, while Cheng and Zhu (2025) demonstrate that different leadership approaches exert distinct effects on employee motivation. Moreover, Kaya (2024) argues that transformational leadership may be interpreted as a specific operational dimension that links organizational objectives with employees' individual needs. Taken together, these perspectives enable a more precise conceptual positioning of motivational leadership within contemporary leadership frameworks. Specifically, motivational leadership can be distinguished from transformational and pedagogical leadership by its primary emphasis on motivational processes and everyday professional engagement, rather than on strategic direction or instructional improvement alone.

Based on the above, motivational leadership can be considered a key prerequisite for the quality of educational practice, educators' professional satisfaction, and the effective functioning of preschool institutions. Exploring the characteristics and role of motivational leadership in the context of early and preschool education provides a foundation for further research and the advancement of leadership practices in this field. Accordingly, this study examines the attitudes of principals and educators in preschool institutions with the aim of identifying the possibilities and limitations of implementing motivational leadership. Qualitative research was conducted using individual and group interviews with these groups of employees. The findings indicate certain legal and financial constraints, as well as opportunities related to stronger support from founders and the introduction of structured professional development and mentoring for employees.

2. Leadership styles and motivational leadership

Leadership styles refer to relatively stable patterns of behaviour through which leaders influence employees and guide organizations toward the achievement of their goals. Classical leadership theories distinguish between autocratic, democratic, and liberal leadership styles, primarily based on decision-making methods and the level of employee involvement (Buble, 2006). Although these styles remain present in practice, contemporary approaches to leadership emphasize the need for flexibility and adaptation to the specific work context. A significant contribution to the development of modern leadership theories was made by Burns (1978), who differentiated between transactional and transformational leadership. Transactional leadership is based on exchanges between leaders and employees and is primarily oriented toward achieving short-term goals. In contrast, transformational leadership focuses on inspiration, the development of shared values, and the long-term professional commitment of employees (Yukl, 2006; Northouse, 2015). In the educational context, transformational leadership is often linked to pedagogical leadership, which emphasizes improving the quality of the educational process, curriculum development, and the professional learning of employees (Slunjski, 2018). Pedagogical leadership aims to create a stimulating environment in which the principal acts as a support, mentor, and initiator of change. Motivational leadership integrates elements of transformational and pedagogical leadership, with a particular emphasis on fostering employees' intrinsic motivation. Motivation is considered one of the key instruments of effective management because it directly influences employee behaviour, job satisfaction, and work performance (Bahtijarević-Šiber, 1999; Buble, 2006). Although motivational leadership is often presented in the literature as an integral component of transformational or pedagogical approaches, its specificity lies in its focus on concrete motivational processes and employee's behaviour in every day practice. In contrast to transformational leadership, which operates at the level of inspiration, vision and organizational changes, motivational leadership involves the implementation of practical strategies such as recognition, support and employee participation in decision making. Furthermore, while pedagogical leadership primarily concentrates on improving curriculum quality and teaching and learning processes, motivational leadership focuses on employees psychological and professional needs as a key determinant of work quality and organizational effectiveness. In this sense, motivational leadership represents a distinct operational layer of leadership that directly shapes employee's engagement, satisfaction and performance (Kaya, 2024; Cheng and Zhu, 2025). Motivational leadership includes recognizing individual employee needs, providing support, acknowledging achievements, and involving employees in decision-making processes (Carless et al., 2000). Given the limited opportunities for material rewards in preschool institutions, motivational

leadership primarily focuses on non-material forms of motivation and recognition. These include providing employees with opportunities to shape and organize their work, autonomy, teamwork, flexible working arrangements, and opportunities for learning and professional development (Pan et al., 2024). In this context, motivational leadership is not viewed solely as an individual leadership style, but as part of a broader organizational culture based on shared values, collaboration, and employee trust (Seme Stojanović and Hitrec, 2014). Taken together, these distinctions enable a more precise conceptual understanding of motivational leadership as a distinct and practice-oriented approach within contemporary leadership frameworks in early childhood education (Kaya, 2024; Cheng and Zhu, 2025).

3. Leadership and early and preschool education

Leadership in early childhood and preschool education institutions is one of the key factors influencing the quality of the educational process, employees' professional development, and the overall functioning of the institution (Douglass, 2019; Bučević and Borovac, 2025). Preschool institutions are characterized by specific features, such as a high level of emotional labour, team-based work organization, professional autonomy of educators, and strong responsibility toward children, parents, and the wider community. In this context, leadership extends beyond administrative tasks and encompasses pedagogical, developmental, and motivational dimensions. Contemporary research emphasizes that the effectiveness of educational institutions does not depend solely on organizational structure and available resources, but largely on the quality of leadership and human resource management (Bahtijarević-Šiber, 1999; Buble, 2006; Douglass, 2019). Particular attention is given to leadership styles oriented toward employees, their competencies, and professional potential, based on the assumption that motivated and satisfied employees significantly contribute to the quality of educational practice. In the field of early childhood and preschool education, leadership is increasingly associated with transformational and pedagogical approaches that emphasize a shared vision, professional collaboration, continuous learning, and the development of organizational culture (Northouse, 2015; Slunjski, 2018). Principals and other leaders play a crucial role in shaping the work environment, encouraging educators' professional development, and creating conditions for high-quality pedagogical practice (Staničić, 2006; Russo, 2021). At the same time, leadership is exercised within institutional and normative constraints that often affect the possibilities of implementing motivational approaches (Barbir, 2020). Consequently, motivational leadership is increasingly recognized as an approach that, despite such limitations, enables the strengthening of professional motivation and employee engagement.

Leadership in preschool institutions takes place within a specific organizational and social context that significantly influences the possibilities of its implementation. Preschool institutions are characterized by the professional autonomy of educators, teamwork, and a strong focus on children's well-being. The role of the principal encompasses administrative, organizational, and pedagogical leadership responsibilities (Staničić, 2006). Research indicates that leadership in preschool institutions is situated at the intersection of administrative and pedagogical functions, which often represents a practical challenge (Heikka and Waniganayake, 2011). In this context, principals frequently face financial and legal constraints and limited decision-making authority, which requires them to balance pedagogical leadership with administrative demands (Russo, 2021). Differences in leadership practices are also observed between public and private preschool institutions. Public institutions generally benefit from more stable institutional support, enabling more systematic

planning of professional development and the implementation of motivational leadership. In private institutions, leadership is more often shaped by financial and market conditions; consequently, motivational leadership frequently depends on the individual initiatives of principals or founders (Barbir, 2020). Despite these limitations, research confirms that motivational leadership has a significant impact on employees' professional development, team stability, and the quality of educational practice (OECD, 2019; Wang, 2024). Motivational leadership in preschool institutions includes two-way communication, employee participation, feedback, opportunities for professional development, and self-evaluation (Leithwood et al., 1999; Widyastuti et al., 2024). Furthermore, clear communication, systematic support, and recognition of professional achievements contribute to strengthening an organizational culture based on trust and collaboration (Slunjski, 2018; Seme Stojanović and Hitrec, 2014). In this sense, motivational leadership represents a strategic approach that enables sustainable quality in the functioning of preschool institutions.

4. Research methodology and results

In this section, the research area is emphasized, followed by the methodology and research results.

4.1. Research area

Early and preschool education (EPE) in the Republic of Croatia is regulated by the Preschool Education Act, which defines it as an integral part of the education system and a public service of special social interest (Croatian Parliament, 2022). EPE activities are implemented in kindergartens and other legal entities that provide early and preschool education programmes, while organizational, personnel, and spatial conditions for their operation are prescribed by the State Pedagogical Standard for Preschool Education (Croatian Parliament, 2008, 2010). At the level of local self-government units, an important planning instrument is the Kindergarten Network, which aims to ensure the availability of preschool programmes in accordance with the demographic and developmental needs of the local community. According to data from the Croatian Bureau of Statistics, in 2024, there were a total of 1,637 kindergartens and 133 other legal entities implementing EPE programmes in Croatia, and the system covered 157,076 children (CBS, 2025). The structure of founders is dominated by public kindergartens established by local governments, which enrol the majority of children. In addition to public institutions, private kindergartens and those founded by religious communities also play a significant role in the system, contributing to increased capacity and accessibility of preschool education, particularly in urban areas (CBS, 2025).

Table 1: Early and preschool education system at the level of the Republic of Croatia in 2024

Founder	Preschools in Croatia	Children in preschools in Croatia	Educators in preschools in Croatia
Public (local government)	1,353	128,545	13,702
Private	351	24,623	2,447
Religious communities	60	3,908	559

Source: Authors' processing according to the CBS, 2025

Data by founder clearly indicate the dominant role of public kindergartens in the early and preschool education system at the level of the Republic of Croatia. The early and preschool education system of Zadar County is organized in accordance with the national legislative framework, taking into account the specific demographic and spatial characteristics of the county. At the beginning of the 2024/2025 academic year, 94 kindergartens and 2 other legal entities implementing early childhood education programs operated in Zadar County, and the programs covered a total of 6,302 children (CBS, 2025). The structure of founders shows the dominant role of public kindergartens, whose founders are cities and municipalities, while private kindergartens and kindergartens of religious communities make up a smaller but significant part of the network of preschool institutions in the county. In Zadar County, a total of 1,211 employees are employed in the early childhood education system, of which 736 are educators, which further confirms the organizational complexity of preschool institutions and the importance of effective human resources management (CBS, 2025). The diversity of founding models and sizes of institutions creates a specific management context in which preschool education activities are carried out, thus emphasizing the importance of managing preschool institutions as a key factor in ensuring the quality, stability and accessibility of early and preschool education.

Table 2: Early and preschool education system at the level of Zadar County in 2024

Founder	Preschools in Zadar County	Children in preschools in Zadar County	Educators in preschools in Zadar County
Public (local government)	68	4,898	586
Private	22	1,231	129
Religious communities	4	173	21

Source: Authors' processing according to the CBS, 2025

At the regional level, data for Zadar County clearly indicate the dominant role of public kindergartens within the EPE system. Public preschool institutions constitute the largest proportion of kindergartens, enrol the greatest number of children, and employ the highest number of educators, thereby forming the foundation of the organization and functioning of the system. Although numerically less represented, private kindergartens play a significant complementary role. Their share of children and educators is more pronounced in Zadar County than at the national level, highlighting their importance in ensuring the availability of preschool programmes and their adaptation to local needs. This structure further underscores the differences in organizational and management models between public and private institutions. Kindergartens operated by religious communities represent the smallest segment of the system across all observed indicators. Despite their relatively low share in terms of total kindergartens, children, and educators, they contribute to the plurality of founding models and the diversity of the institutional framework of early and preschool education. Overall, variations in the number of kindergartens, children, and educators by type of founder point to a complex and heterogeneous organizational context in which EPE activities are conducted. Such a context has direct implications for the management and leadership of preschool institutions, particularly in the areas of human resource planning, work organization, and the motivational leadership of employees.

4.2. Research methodology

The research was conducted in the Zadar County area in August 2025 with the aim of exploring the attitudes of principals and educators regarding leadership styles, with particular emphasis on the role and effects of motivational leadership in early childhood and preschool education institutions. The total sample comprised 21 participants and was selected purposively. Five principals participated, including three from private institutions and two from public early childhood and preschool education institutions. Individual semi-structured interviews were conducted with these principals. Additionally, two group semi-structured interviews were conducted with preschool educators. The first group included eight educators employed in private institutions, while the second consisted of eight educators employed in public preschool institutions. In social research, individual and group interviews are frequently employed as qualitative methods because they enable an in-depth understanding of participants' experiences, attitudes, and the meanings they ascribe to social phenomena (Gill et al., 2018). Individual interviews are particularly suitable for exploring personal experiences and sensitive topics, whereas focus groups provide insight into group norms and dynamics (Almutrafi, 2019). The combination of these methods supports methodological triangulation and enhances the validity of research findings (Maksimović and Macanović, 2017). An interview protocol was used for both individual and group interviews, containing the same set of questions to capture different perspectives on leadership. The questions were formulated to be comprehensible to both principals and educators. The protocol included a total of nine grouped questions related to knowledge and application of leadership styles, perception and effectiveness of motivational leadership, and perceived opportunities, limitations, and suggestions for its improvement within preschool institutions. The collected data were analyzed using qualitative content analysis, with an emphasis on identifying common patterns, as well as similarities and differences in the responses of principals and educators employed in private and public preschool institutions. The results are presented descriptively and interpreted comparatively to provide a deeper understanding of the research problem.

4.3. Research results

Based on certain demographic characteristics, it can be inferred that the respondents possess experience working in preschool institutions. An overview of the respondents according to these characteristics is presented in Table 3.

Table 3: Sample of surveyed principals and educators in preschool institutions

Demographic characteristics		Principals	Educators in private preschool institutions	Educators in public preschool institutions
Gender	Female	5	8	8
Age	31-40	/	3	4
	41-50	2	5	3
	51-60	3	/	1
Work experience	1-10	/	2	1
	11-20	4	5	5
	21-30	1	1	2
Workplace experience	1-10	2	2	1
	11-20	2	5	5
	21-30	1	1	2

Demographic characteristics		Principals	Educators in private preschool institutions	Educators in public preschool institutions
Education level	Bachelor	/	3	3
	Higher education	5	5	5

Source: Authors

It can be observed from the table that all surveyed principals were female. They are experienced leaders, as indicated by their years of work within the system and in principal positions. All principals hold a university degree in their professional field. Regarding the preschool educators who participated in the group interviews, all were also female. These educators are similarly experienced, with many years of service within the system and at their respective workplaces. The educators have completed undergraduate or graduate studies in teacher and educator education. This sample structure provides insight into the attitudes of experienced principals and educators with diverse professional backgrounds, all of whom possess extensive experience working with children and collaborating with colleagues.

The research conducted offered a systematic understanding of the experiences and attitudes of principals and educators in private and public preschool institutions regarding leadership. The analytical dimensions presented in Table 4 were developed using qualitative content analysis, following the procedural principles outlined by Mayring (2014) and Schreier (2012). A hybrid deductive-inductive coding strategy was applied. Deductively, the initial coding frame was derived from established leadership theories, including transformational leadership (Burns, 1978; Bass, 1985), pedagogical and instructional leadership (Sergiovanni, 1998; Hallinger, 2005), and distributed leadership in early childhood education (Heikka and Waniganayake, 2011). These frameworks informed the preliminary analytical dimensions. Inductively, categories were refined through iterative engagement with the empirical material, allowing sector-specific themes, such as resource-related concerns in private institutions and collaborative pedagogical practices in public institutions, to emerge from participants' accounts. Continuous comparison between theory-driven categories and data-driven insights ensured both conceptual coherence and contextual sensitivity. This combined approach enhances analytical rigor, transparency, and interpretative validity.

Analysis of the collected data revealed significant differences between the surveyed groups, as well as certain common patterns that may be interpreted as characteristic of the educational system in the Republic of Croatia. Table 4 presents a comparison of principals' attitudes toward educators in private and public preschool institutions.

Table 4: Comparative analysis of the attitudes of principals and educators towards leadership

Category	Principals	Educators in private preschool institutions	Educators in public preschool institutions
Conceptual familiarity with leadership styles	High (comprehensive understanding; ability to articulate institutional impact)	Low-moderate (limited theoretical knowledge; partial recognition after clarification)	Moderate-high (ability to identify and explain key styles, especially transformational and democratic)
Dominant leadership model in practice	Integrative and situational (pedagogical and transformational and democratic)	Laissez-faire tendencies; low structural leadership presence	Democratic and pedagogical, with distributed/transformational elements

Category	Principals	Educators in private preschool institutions	Educators in public preschool institutions
Perceived effectiveness of motivational leadership	Strong positive impact on climate, loyalty, and institutional development	Limited visibility and inconsistent implementation	Positive when linked to recognition, teamwork, and professional development
Primary motivational mechanisms	Mentoring, professional development, team culture building, strategic communication	Material security and formal recognition	Training, collaborative activities, recognition practices, flexible work conditions
Structural constraints	Financial-administrative limitations; regulatory framework; time constraints	Resource scarcity; weak professional support; uneven staff motivation	Resource limitations; administrative burden; resistance to change
Improvement priorities	Systematic mentoring, expanded education, participatory governance	Fair workload distribution, material incentives, structured support	Continuous education, supervision, individualized motivation strategies
Sectoral differentiation pattern	Leadership perceived as strategic, multidimensional, and development-oriented	Leadership perceived as structurally weak and predominantly resource-dependent	Leadership perceived as collaborative but administratively constrained

Source: Authors

The analysis of the results reveals significant differences in the perception, understanding, and application of leadership styles among principals and educators in private and public preschool institutions. The following thematic analysis provides a detailed overview.

Conceptual familiarity with leadership styles

Principals demonstrate a high level of familiarity with leadership styles, with all respondents able to identify the basic styles, and some able to explain in detail their effects on work organization and employee motivation. Educators in public preschool institutions also exhibit moderate to strong knowledge of leadership styles, most frequently emphasizing transformational, democratic, and pedagogical leadership. In contrast, educators in private preschool institutions display a lower level of familiarity, with the majority possessing only general knowledge or recognizing leadership styles only after additional explanation. This finding suggests relatively weaker institutional support for professional development and leadership training in private settings.

Dominant leadership model in practice

Principals report employing a combined approach to leadership, most frequently integrating pedagogical, transformational, and democratic styles, with flexible adaptation to the situational and contextual demands of the workplace. In public preschools, democratic and pedagogical leadership is particularly emphasized, often combined with elements of distributed and transformational leadership, reflecting a tendency toward participative management and active employee involvement. In contrast, educators in private preschools often perceive leadership as laissez-faire or minimal, reporting a lack of structure and involvement, which may negatively affect employee motivation and the overall organizational climate.

Perceived effectiveness of motivational leadership

Principals rate motivational leadership as highly effective, linking it to a positive organizational climate, increased employee loyalty, and institutional development. Educators in public preschools also recognize and value motivational leadership, highlighting praise,

training opportunities, and teamwork as key motivational factors. By contrast, educators in private preschool institutions report that motivational guidance is largely absent or limited, noting insufficient recognition and praise, which underscores the need to strengthen motivational strategies in the private sector.

Primary motivational mechanisms
Principals identify opportunities for motivational leadership in mentoring, professional training, fostering team culture, and improving communication with founders. Educators in public preschools emphasize professional development, team activities, recognition, and more flexible working conditions as important incentives. Conversely, educators in private preschools primarily associate motivational opportunities with securing basic material rights and recognition of their work, highlighting unmet fundamental work needs.

Structural constraints
Principals cite financial and administrative constraints, legal frameworks, and a lack of time for individualized approaches to employees. Educators in public preschools additionally highlight resource limitations, administrative obstacles, resistance to change, and work overload. Educators in private institutions report insufficient resources, weak professional support, and uneven employee motivation, suggesting structural and organizational deficiencies in private preschools.

Improvement priorities
Principals propose education, mentoring, public recognition of work, flexible working arrangements, and greater employee involvement in decision-making. Educators in public preschools suggest education, team workshops, supervision, more flexible schedules, and individualized motivational strategies. Educators in private preschools emphasize the need for fairer work distribution, public recognition, material incentives, and improved professional support, reflecting a focus on basic working conditions as a prerequisite for motivation.

Sectoral differentiation pattern
The findings reveal a clear sectoral differentiation in leadership perceptions across preschool institutions. Public institutions demonstrate a predominantly collaborative and pedagogically oriented leadership pattern, consistent with instructional and distributed leadership frameworks. In contrast, private institutions display a more structurally constrained pattern, where leadership is perceived as less visible and more strongly conditioned by material and organizational stability factors. Motivational processes in the private sector are closely linked to resource security, whereas public institutions emphasize professional recognition and teamwork. Overall, leadership enactment appears institutionally mediated, suggesting that contextual and structural conditions significantly shape the realization of transformational and pedagogical leadership principles.

4.4. Discussion of research results

This study provides comprehensive insights into leadership practices in early childhood education, highlighting the interplay between transformational, pedagogical, and motivational leadership across public and private institutional contexts. The principals' emphasis on mentoring, professional development, and fostering a positive organizational climate reflects core dimensions of transformational leadership, particularly inspirational motivation and individualized consideration (Burns, 1978; Bass, 1985). Burns (1978) notes that transformational leadership elevates followers' values and commitment, while Bass (1985)

emphasizes its role in fostering institutional development beyond transactional exchanges. The principals' practices observed in this study strongly align with these assumptions, confirming that transformational leadership is central to inspiring educators and aligning individual and institutional objectives. In public preschool institutions, leadership patterns correspond closely with pedagogical and instructional frameworks. Sergiovanni (1998) describes educational leadership as a moral and pedagogical practice grounded in shared values and professional community, while Hallinger (2005) highlights the importance of instructional processes, professional collaboration, and capacity-building. The prominence of teamwork, recognition, mentoring, and structured professional learning reflects a pedagogically oriented paradigm, indicating that leadership is embedded not only in vision and motivation but also in teaching quality and collaborative practices. These findings suggest that transformational and pedagogical leadership are mutually reinforcing, with motivational influence operationalized through pedagogical structures. Leadership in early childhood education also emerged as relational and context-dependent. Rodd (2013) and Waniganayake et al. (2017) emphasize that effective leadership is inherently collaborative and shaped by institutional culture. The present findings confirm this, showing that leadership is enacted through professional relationships and embedded practices rather than solely through formal authority. In private preschools, resource dependence and weaker structural leadership visibility constrained principals' influence, making leadership outcomes more contingent on individual initiative (Heikka and Waniganayake, 2011). Motivational leadership emerged as a crucial factor for successful management and quality development in both public and private settings (Douglass, 2019; Bučević and Borovac, 2025). Principals demonstrated awareness of different leadership styles and frequently combined pedagogical, transformational, and democratic approaches. This aligns with Yukl (2006) and Northouse (2007, 2015), who identify transformational leadership as particularly effective in educational contexts due to its capacity to inspire employees, foster shared vision, and strengthen professional commitment. In Croatia, pedagogical leadership is emphasized for guiding curriculum improvement and enhancing educational quality (Slunjski, 2018), though principals reported limitations related to financial resources, legal regulations, and founder authority, consistent with Russo (2021). These findings illustrate that principals often balance pedagogical leadership goals with administrative requirements. Educators' experiences further underscore sectoral differences in motivational leadership. In private institutions, leadership largely depends on individual initiatives, with limited systematic support, material incentives, and principal presence (Barbir, 2020). Educators emphasized the importance of fair workload distribution, basic material rights, and public recognition, highlighting leadership's critical role in fostering engagement and satisfaction (Leithwood et al., 2004, 2021; Mincu, 2022). In public institutions, educators demonstrated higher theoretical understanding of leadership styles and more frequent recognition of motivational leadership in daily practice. Positive outcomes included team stability, professional satisfaction, and improved relationships with children and parents (Whalley, 2011; Male and Palaiologou, 2015; Slavić et al., 2018), suggesting that motivational leadership is more effectively embedded within public institutional structures. Despite these positive practices, common challenges persist across sectors, including limited financial resources, administrative and legal constraints, employee overload, and resistance to change (Staničić, 2006; Fung Tam, 2018; Wang, 2024). Consistent with previous research (Seme Stojanović and Hitrec, 2014), systematic support and a clear leadership strategy are essential for implementing motivational approaches successfully. The study confirms that motivational leadership is not merely a personal style but a function of building an organizational culture based on trust, cooperation, and mutual respect (Northouse, 2015; Slunjski, 2018). Effective leadership practices directly impact the quality of education, parental satisfaction, children's well-being, and broader societal outcomes (Russo, 2021). In

conclusion, leadership in early childhood education is multidimensional, integrating transformational, pedagogical, and motivational elements. Its enactment is contextually mediated by sector-specific structures, resources, and institutional culture. Public institutions benefit from greater systemic support, enabling more consistent implementation of leadership practices, while private institutions rely heavily on individual initiative. The findings underscore the importance of integrating motivational, pedagogical, and transformational approaches to foster professional development, enhance educational quality, and ensure sustainable leadership practices across diverse early childhood contexts.

5. Conclusion

The analysis of theoretical and empirical approaches to leadership in early childhood and preschool education institutions indicates the key role of leadership structures in shaping organizational efficiency, professional development of employees, and the quality of educational practice. Contemporary concepts of leadership indicate a shift from traditional administrative-hierarchical models toward transformational, pedagogical, and motivational approaches. Emphasis is placed on participatory decision-making, building a shared vision, and encouraging professional learning. Motivational leadership has been identified as an integrative concept that combines elements of transformational and pedagogical leadership, with a focus on strengthening employees' intrinsic motivation, professional commitment, and an organizational culture based on trust, cooperation, and shared values. The specificities of preschool institutions, including team-based work organization, a high level of professional autonomy for educators, and a strong focus on the well-being of children and cooperation with parents and the community, require leadership that goes beyond administrative functions and includes developmental, supportive, and reflective dimensions. The existing literature also indicates the significant influence of the institutional, legal, and financial framework on the possibilities of implementing motivational leadership. The limited formal powers of the principal, normative regulations and insufficient material resources often represent obstacles to the systematic application of motivational strategies. Despite the aforementioned limitations, non-material forms of motivation, such as professional support, mentoring, recognition, autonomy in work and opportunities for professional development, have been recognized as particularly relevant and effective in the preschool context. Overall, motivational leadership can be viewed as a strategic and cultural element of the organization that contributes to the sustainable quality of the educational process and the strengthening of the professional identity of employees. Systematic support from the founders, the development of leadership competencies of the principal and the integration of motivational approaches into organizational practice have been identified as key prerequisites for further improving the quality of early and preschool education.

This study was limited to Zadar County and a small, purposively selected sample of 21 participants, which may restrict generalizability. Findings rely solely on qualitative interviews, making them subject to participants' self-reporting and potential biases. Additionally, the focus on motivational leadership in early childhood education and data collected during a single month may limit applicability to other contexts or periods. However, this study advances early childhood leadership research by offering a comparative analysis of private and public preschool institutions. It demonstrates how transformational and pedagogical leadership models are differently perceived and enacted across institutional roles, while emphasizing the mediating influence of structural and material conditions. In doing so, the study extends relational leadership perspectives by integrating an institutional-contextual

dimension. Accordingly, certain conclusions can be drawn. Effectiveness of preschool institutions largely depends on the quality of leadership and motivational practices, while the organizational structure and available resources themselves, although important, are not sufficient to achieve high pedagogical and organizational quality. Principals demonstrate a high level of familiarity with leadership styles and apply a combined approach that includes pedagogical, transformational and democratic leadership, while educators in public and private kindergartens show different levels of knowledge and application of motivational strategies, with the private sector often not implementing systematic motivational leadership. Based on the results obtained, continuous improvement of professional knowledge about leadership through regular training and mentoring for principals and educators, with a focus on transformational and motivational leadership and participatory management models, is recommended. At the same time, it is important to systematically strengthen motivational practices by recognizing employee achievements, providing individualized support, including them in decision-making and encouraging autonomy in work organization. The development of organizational culture and a collaborative environment, through team workshops, supervision and peer mentoring, also contributes to increasing motivation, professional development and cohesion in institutions. Flexibility in working conditions, including flexible schedules and working conditions, contributes to the use of limited resources, and consequently reducing overload and increasing employee satisfaction. Prevention of constraints and institutional support through resolving administrative obstacles, securing financial and infrastructural resources, and continuous feedback and evaluation of leadership further enable quality motivational leadership and strengthening organizational efficiency. The implementation of these measures contributes to the systematic improvement of motivational leadership and human resources management, thereby ensuring better quality of the educational process and work of preschool institutions.

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A scientific paper

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FINANCING AND SOCIAL BENEFITS OF „MINOR SPORTS "- CASE STUDY OF ZAGREB FENCING FEDERATION

ABSTRACT

The aim of this paper is to examine the structure of sports' financing in Republic of Croatia with the special emphasis on financing and social impact of those sports that receive limited media coverage and public recognition (so called "minor sports"). As it is well known, among other useful social impacts, sport contributes to social cohesion and public health. First part of this paper will deal with the economic, social, and health impact of sport on the society, which will be followed by a very brief introduction of the evolution of sport in order to provide contextual background for the analysis. In the second part of the paper, we will focus on the financing framework of sports organizations in Croatia, analysing the legal structure of sports entities and the role of public funding in accordance with the new Croatian Sports Act, establishing the legal foundation and framework that aimed at improving transparency, accountability, and long-term stability within the sports system. Finally, we will use The Zagreb Fencing Federation as an example of financing sport clubs in those not-for-profit sports which nonetheless have important and beneficial social functions. We will be using historical and comparative analysis that include its revenues and expenses, as well as the challenges faced by the Federation. The results of the analysis will probably highlight the need for strategic management and the necessity of diversifying funding sources through self-generated revenues and private sector involvement. This paper will hopefully contribute to the understanding of the sports financing system in the Republic of Croatia, particularly from public sources, which fund the majority of legal entities within non-profit sports system.

***Key words*:** *fencing, sport, Sports Act, sports' financing.*

1. Introduction

The Political Economy of sport is fundamentally bifurcated along a transatlantic axis. Professional sports are primarily thought of in the US as businesses that are part of a thriving market ecology (Szymanski, 2010). The European model, on the other hand, has long included sport into a social-democratic framework, highlighting its function as a medium for public

health, education, and collective identity—a "public good" deserving of government assistance. This latter viewpoint is explicitly codified by the Croatian legal system, specifically through the 2022 Sports Act (ZOS, Official Gazette 141/22), which declares sport to be an activity of "public interest" (Article 3). As a result of that regulation, the state is legally and financially obligated to promote the growth of sports. However, a hierarchy is created by the practical distribution of limited public resources, which invariably favours high-profile sports, professional leagues, and Olympic medal potential. Consequently, disciplines with limited spectator appeal and media coverage—termed “minor sports”—operate within a precarious financial niche, despite demonstrably contributing to very important social objectives.

Using the Zagreb Fencing Federation (ZFF) as a significant case study, this paper investigates the structural dynamics of finance and the associated social benefits within this underappreciated industry. In Croatia, fencing is the epitome of the “minor sport”: with a rich, if sporadic, history that dates back to an Olympic medal in 1900, but today maintained by a small group of about 1,000 registered athletes nationwide.

In the first part of analysis the theoretical groundwork is presented by examining the multifaceted effects of sport, going beyond simple economic measurements to include social capital building and public health benefits. Physical activity offers important cognitive and psychosocial benefits, as confirmed by Biddle et al. (2015), and community sports clubs are a direct manifestation of Putnam's (2000) concept of "bonding" and "bridging" social capital. Public investment in non-commercial sports is primarily justified by these positive externalities, which range from decreased public health costs to improved social cohesion.

The second part outlines legal and financial framework that characterizes Croatian sports. By requiring state and municipal budgetary support, actively encouraging private sponsorship through tax deductions, and allocating a percentage of national lottery proceeds, the ZOS establishes a hybrid financing mechanism. Importantly, it encourages strategic planning, enforces strict openness and reporting requirements, and links public co-finance to the adoption of multi-year development initiatives. In order to highlight the ZOS's unique emphasis on procedural rigor and accountability, this framework is briefly compared to the more state-centric Hungarian model, the partnership-based Polish system, and the federally delegated Austrian method.

I the last part of the paper empirical examination of the ZFF is also presented. It tracks the federation's revenue composition and spending trends from 2017 to 2024 using financial data, strategy documents, and a SWOT analysis. In contrast to a notable increase in self-generated revenue, mainly from hosting international competitions like the European Cup and Vladimir Mažuranić Memorial, the investigation shows a continued, albeit gradually declining, reliance on municipal grants from the Zagreb Sports Association. However, growing fixed expenses, especially for specialized training facilities, and systemic weaknesses brought on by a small talent pool and amateur athletic status offset this revenue diversification.

This study aims to contribute a nuanced, evidence-based perspective to the ongoing policy discourse on sport financing in Central and Eastern Europe, arguing for a more refined understanding of “impact” that recognizes the indispensable role played by „minor “sports like fencing in the fabric of society.

2. Brief history of sport fencing in Croatia

At the 2nd Olympic Games (1900), the Croatian fencer Milan Neralić won a bronze medal in the sabre event for Austro-Hungary.

Until the Second World War, fencing was widespread in all major Croatian cities. In Zagreb, Franjo Bučar incorporated fencing into the Course for Physical Education Teachers. As a result, fencing was introduced into Zagreb schools, and fencing clubs began to be established. The first fencing club in Zagreb was founded in 1902, followed by the formation of numerous others. In Karlovac, fencing was also highly popular, especially until the outbreak of the First World War, as well as in Split, Zadar and Dubrovnik. Rijeka and Istria prior to World War II were influenced by Italian school of fencing Subsequently, its popularity declined, and fencing activity gradually disappeared, only to be revitalized in 2008. Osijek is notable as the first city in which women were instructed in fencing (Kovačić & Kovačić, 2022).

The period following the Second World War was characterized by state investment in mass forms of physical activity, such as running, combined events, mass gymnastics displays, and similar activities (Popovčić, 2015).

After the Second World War, fencing in Croatia survived primarily due to the activities of Zagreb-based clubs.

This challenging period persisted until 1990 and was marked by a lack of both administrative leadership and professional coaching staff. Professional expertise relied largely on informal mentorship, whereby older athletes guided younger participants. The Croatian Fencing Federation (CFF) was officially recognized by the Croatian Olympic Committee (HOO) in 1992. The years that followed have been characterized by positive developments in Croatian fencing, including the organization of numerous tournaments, participation in various international championships, and a succession of competitive successes.

At present, 14 fencing clubs operate in Croatia (Strategija 2020 – 2032, 2020). The most prevalent weapon is the épée, which is practiced in nine clubs, followed by the foil in six clubs and the sabre in two clubs.

Fencing is practised in Zagreb, Zaprešić, Karlovac, Poreč, Split, Osijek and Zadar.
Currently, there are 42 licensed fencing coaches in Croatia (23 are active). Of these, 16 hold a higher education degree. The gender structure comprises 15 male and 8 female coaches. The total number of registered athletes is approximately 1,000, of whom around 450 are based in Zagreb (ibid, 14).

3. Economic Impact(S) of Sport

The economics of physical culture and sport can be defined “as a scientific discipline concerned with the criteria and methods for the optimal allocation of funds and resources from the economy and society to physical culture; with the economic activities and functioning of physical culture; and with the assessment of outcomes in physical culture“(Bartoluci,2003). Bartoluci divides the effects of sport in macroeconomic effects (the sports goods industry, the trade of sporting goods, the construction of sports facilities, tourism, increased labour productivity, reduction in sick-leave costs, extension of working life and life expectancy) and

microeconomic effects (within sports organizations, within sports enterprises, the context of major sporting events) (ibid, 33, similar in El Mehdi Falloul, 2016; Gouget &Barget in Andreff&Szymanski ed, 2006). Sport can have a profound economic impact especially when there are professional teams in the city/region and as Rudy Perpich, the former governor of Minnesota, once joked "Without professional sports, Minneapolis would just be a cold Omaha" (Mathieson in Andreff&Szymanski, 2006). In USA there is more willingness to live and work in the cities with professional clubs in one of the major sporting leagues (NFL, NBA, MLB, NHL). Some economists believe that local economic growth has been generated from the presence of a professional sports teams in multiple ways: the creation of new jobs, increased consumer spending, multiplayer effect, increased sales in certain market segments, and increased tax revenue (Kuznitz, 2011). Three main types of employment in sports are sports technician jobs: administrative, management and commercial jobs; and maintenance, caretaking and reception jobs (Primault, in Andreff&Szymanski ed, 2006). We already mentioned positive externalites which sport causes, namely reduction in sick-leave costs, extension of working life and life expectancy, while the negative ones would be: "hooliganism – along with the loss of credibility due to underground deviations (doping, cheating and so on)" (Gouget and Barget in Andreff&Szymanski ed, 2006). Negative externalities connected with territorial dynamics usually come into three forms: "the crowding-out effects due to fears about the area being saturated during major sports events; the debt which ensues for those areas hosting sporting events when the investment which has been made does not later lead to real economic development; and the spatial separation between rich and poor engendered by major urban redevelopment operations involved in hosting major events" (ibid).

Coats&Humphries point out that "attracting a professional sports franchise to a city and building that franchise a new stadium or arena will have no effect on the growth rate of real per capita income and may reduce the level of real per capita income in that city" (Coates, Humphries, 2000). They actually identify four areas in which this will have a negative impact on the income and quality of life in metropolitan area: "substitutions in public spending, compensating differentials in income and negative effects on productivity" (ibid, 19-20). The authors conclude that the overall effect of the sports environment was to reduce personal income per capita by a small amount. Coates claims that "if the local government is looking for a policy to foster economic growth, far better candidate policies exist than those subsidizing a professional sports franchise" (Coates, 2015).

4. Physical Activity and Health

The impact of physical activity on fitness, mental health, and general health has been the object of discussion and study from the ancient times. *Mens sana in corpore sano* (a healthy mind in a healthy body) principle is still as valid or as discussed as it was in antiquity. Ratey & Sattelmair point out that "Regular physical activity represents a critical component to improving physical fitness and preventing juvenile obesity, early-onset diabetes, and the like. Physical activity also offers equally compelling benefits to the brain, attention and focus, mood and self-efficacy, and thus to learning and memory" (Ratey& Sattelmair in Meyer& Gullotta eds, 2012). Biddle et al. emphasise the impact of physical activity on "children's school learning and for older adults' mental function and independence. These are powerful arguments in support of the role of physical activity in the promotion of good and prevention of poor mental health" (Biddle et al, 2015). American heart association for example recommends "at least 150 minutes per week of moderate-intensity aerobic activity or 75 minutes per week of vigorous aerobic activity, moderate- to high-intensity muscle-strengthening activity (such as

resistance or weights) on at least 2 days per week" and connects this with better mental and physical health, ageing more gracefully and generally enjoying the better quality of life[1] (similar in Rodriguez et al, 2011) .

5. Social Impact of Sport

The impact of sport on social cohesion and social capital is not to be neglected. Putnam for example distinguishes between two types of social capital: "bonding (inclusive) and bridging (exclusive). Bonding capital occurs among similar people (age, race, gender, educational level, etc), while bridging capital involves same activities among dissimilar people" (Putnam 2000). Sport is good for both of these types of social capital since it makes stronger connections between similar people (local football teams and their fans) and also allows for making connections between dissimilar people (dissimilar people who exercise together in their sport club or local gym). Balfour & Kaplan (2002) emphasize that older adults living in a poor neighbourhood environment have been shown to have greater risk of functional loss over time. People who live in socioeconomically disadvantaged neighbourhoods are faced with a higher likelihood of being obese (Glass, Rasmussen, & Schwartz, 2006; Grafova, Freedman, Kumar, & Rogowski, 2008).

6. The Legal Framework for the Financing of Sport in Croatia

The financing of sport represents a critical public policy where legal frameworks define the balance between state responsibility, market participation, and civic initiative, directly impacting its development, competitiveness, and accessibility to citizens. In Croatia, this is regulated by ZOS. This law represents the legal document that comprehensively defines the organization, promotion, and financing of sports activities in Croatia by establishing a modern, multi-layered legal framework. It successfully intertwines the state's role as a guarantor of sport as a public good and interest with mechanisms that encourage financial autonomy and private sector participation by establishing a multifaceted system for financing sport, moving beyond mere state budget allocations. Sport is "a public interest" of the Republic of Croatia, according to Article 3 of the ZOS. This proclamation is more than just symbolic; it creates a state duty to foster the growth of sport and provides legal justification for the distribution of public funds. This gives substantial governmental action and budgetary allocations constitutional-legal validity.

The Hungarian model, however, is overtly state-centric. The Hungarian Sports Act of 2004's preamble declares that "the State has a key role in the development of sports." This is further supported by Section 1(2), which states that "the promotion of sports... is a priority mission of the State." In contrast to the Polish system, which emphasizes the independence of the sports movement in addition to official backing, this establishes a robust top-down framework where funding is directly linked to national strategic goals defined by the government. "The main type of sports activity is the activity of sports clubs," whose autonomy is recognized, according to Article 3(1) of the Polish Sports Act. Public authorities must, nevertheless, "promote the growth of sport" in collaboration with sports groups, according to Article 5. This results in a model that is more partnership-based than Hungary's. The traditional federal corporatist paradigm is used

[1] American Heart Association Recommendations for Physical Activity in Adults and Kids https://www.heart.org/en/healthy-living/fitness/fitness-basics/aha-recs-for-physical-activity-in-adults (accessed 2 February 2026).

in Austria. The goal of the Federal Sports Promotion Act (BSportFG §1) is "to promote sport as an essential part of Austrian society." The system is built on a strong partnership between the federal government, the Austrian Olympic Committee, and the umbrella organization Sport Austria. Funding flows through these recognized, self-governing peak bodies, respecting their autonomy.

ZOS article 76 lists the main sources of funding for sports in Croatia. It states that public budgets (central and local government), the own earnings of legal and natural persons involved in sports activities, donations, sponsorships, and other forms of aid, earnings from games of chance, and other sources in compliance with the law are all used to fund sport in Croatia. It is a hybrid model; The law actively promotes financial diversity through self-sustainability (own income), private sector involvement (sponsorships), and a designated stream from gaming earnings, which is a popular approach in European sport finance, even though public funding plays a major role. In Hungary, funding is centralized; the Parliament is required by Section 11/A of Act I of 2004 to approve a "central sports subsidy" in the state budget. Similar to Croatia, Poland has a multi-level system: According to Article 30 of the Polish Sports Act, the state budget is used to fund public administration activities in sports, whereas the budgets of territorial self-government units are used to fund local sports activities. Additionally, there is a special-purpose extra-budgetary fund called the Sport Fund which is funded by a variety of sources (Article 34a). In Austria, the federal government provides a so-called block grant. BSportFG §3 mandates an annual federal contribution to Sport Austria for the promotion of top-level sport and general sports development. The specific amount is determined by the federal budget law. Crucially, the distribution of these funds among specific sports and projects is largely delegated to Sport Austria and its member federations.

Croatian ZOS regulates the allocation of funds from various levels of government, adhering to the principle of subsidiarity; The state budget, managed by the central government, is a crucial source for high-priority and national-level sports functions. The highest political and financial significance is given to elite international sports achievements and representation through HOO that holds a special position. Article 77(4) stipulates that the HOO is financed from the state budget for the implementation of its statutory activities related to the preparation and participation of Croatian athletes in the Olympic Games and other Olympic events. Article 77 details the purposes for which funds from the state budget are allocated.

Additionally, there is a decentralized approach to financing. Local and regional self-government entities are clearly required by ZOS article 78 to include money in their budgets for the following purposes: building, maintaining, and equipping public sports facilities; organizing sports and leisure activities for children, youth, and citizens; co-financing programs for elite athletes from their territory; and other activities in compliance with their statutes and the law. By addressing particular regional requirements and encouraging grassroots involvement, this clause guarantees that sport development is rooted in local communities.

According to ZOS, a national sports federation must approve both an annual program and a multi-year program (for four years) in order to be eligible for public subsidy, according to Article 79. The National Sports Program be in line with these initiatives. The required content of these programs is outlined in Article 79(3) and includes plans for athlete development, coaching, officiating, and contests, as well as development plans and financial plans with accurate forecasts of required finances. These programs are approved by the Ministry of Tourism and Sport after receiving a favourable evaluation from the HOO. The state budget may only co-finance authorized programs (Article 79(4) ZOS). This fosters strategic thinking and

responsibility by establishing a contractual-like relationship between the state and the federations, where funding is subject to the submission and approval of a defined development plan. According to Hungary's centralized, strategy-driven distribution methodology, the Ministry distributes the monies in accordance with yearly calls for proposals and the National Sports Strategy. National federations and the Hungarian Olympic Committee (MOB) submit applications for certain initiatives. Strong discretionary power is retained by the state. Poland uses a combination of fund allocations and direct grants. According to Article 33 of Polish Sports Act, the Ministry of Sport may award targeted grants for particular projects. The independent at the same time. Based on bids reviewed by its Council, the Sport Fund provides funding for development projects. As a result, two streams are created: a more technocratic fund distribution system and politically directed ministerial grants. Austria, meanwhile, has a federal delegation arrangement. Sport Austria receives a worldwide support from the federal government (BSportFG §3). Based on its own regulations and internal assessment standards, Sport Austria then allocates these monies to its member federations and for particular initiatives. Respecting the "subsidiarity principle," the state refrains from directly influencing how money is distributed.

A significant financial source in Croatia, Hungary and Poland is the revenue from games of chance. Article 80 of Croatian ZOS prescribes that part of the concession fees paid by operators of games of chance shall be allocated for financing sport. The specific purposes, criteria, and distribution methods for these funds are determined by a separate regulation—the Ordinance on the Use of Funds from Games of Chance for Sport. This creates a stable and legally mandated inflow of non-budgetary funds dedicated solely to sport. In Austria the Austrian Lotteries also contribute to sports funding, but the mechanism is less prescriptive in the core law. Funding agreements are made between the lottery company and sports bodies like Sport Austria, often linked to sponsorship and marketing rights rather than being a fixed statutory percentage.

Sponsorships, donations, and own revenues are also encouraged by Croatian ZOS article 81 regulates sponsorship in sport, defining it as a form of promotion where a sponsor, in exchange for funds, goods, or services, obtains the right to use the name, logo, or other attributes of a sports entity for commercial promotion. The law mandates that sponsorship agreements must be concluded in writing. Furthermore, to incentivize private investment, Article 82-83 of Croatian ZOS state that funds spent on sponsorship of sports activities, in accordance with the law, are recognized as business expenses for profit tax purposes. Poland provides tax deductions for donations to public benefit organizations, which include many sports clubs and associations. Article 18 of the Personal Income Tax Act and Article 26 of the Corporate Income Tax Act allow taxpayers to deduct donations (up to a limit) from their taxable income. Similar to Poland, in Austria the donations to non-profit sports organizations tax-deductible under the Income Tax Act (EStG §4a). Sponsorship payments are considered fully deductible business expenses if they serve the company's commercial interests. On the other hand, Hungarian companies can deduct 150% of their sponsorship donations to specific, state-recognized sports organizations (e.g., MOB, NSF) from their corporate tax base, as per the Act on Corporate Tax (Art. 7(1). This is a powerful incentive unmatched in the other three countries.

The Croatian ZOS ensures that public monies are handled responsibly by incorporating financial control and transparency procedures. The core idea of "efficient, economical, and effective utilization of funds" allotted for sport from public budgets is introduced in Article 85 of ZOS. It is legally required of recipients of these monies to administer them according to this principle. Mandatory public reporting is one way to enforce transparency. Every legal entity that receives public funding for sports is required under Article 86 ZOS to provide an annual

report on their official website. A report on the execution of the sports program for which the funds were allotted, the yearly financial report audited by an independent auditor, information on all received funds (amount and source), information on all spent funds (purpose and amount), is required by law. Article 87 adds another layer of oversight, granting the Ministry of Tourism and Sport the authority to monitor the legality of the use of public funds allocated for sport. If irregularities are found, the Ministry can initiate procedures to protect the public interest, including potentially suspending further funding until the issues are rectified. Croatia has the most detailed transparency mandates in its core sports law. Similarly, Article 35 of the Polish Sports Act requires entities receiving public funding to keep separate accounting and provide reports on their use. The Chamber of Audit audits the Sport Fund and ministry expenditures. In Hungary the control is exercised through ex-ante and ex-post state audits. Recipients of state subsidies are subject to the general rules of the State Audit Office (ÁSZ) and must provide detailed accounts on the use of funds as stipulated in their funding agreements with the Ministry. Public reporting is not as explicitly mandated in the Sports Act as in Croatia. On the other hand, Austria prefers indirect control and corporate governance. As the main recipient of federal funds, Sport Austria is subject to the Federal Foundation and Fund Act requiring annual financial statements and activity reports. The Court of Audit can audit the use of federal subsidies.

7. Research Methodology

A SWOT analysis of fencing in Zagreb will be conducted through the lens of ZFF, offering an initial assessment of its current state and informing the identification of opportunities and threats for strategic improvement.

Financial documents—including annual income and expenditure reports, balance sheets, and internal financial summaries—will be examined to assess the structure of public and private funding, the share of self-generated revenues from sporting and economic activities, and the allocation of expenditures.

Data will include the allocation of funds for public needs in sport of the City of Zagreb, which provides insights into local government funding levels and allows for temporal comparisons over two Olympic cycles. Governance documents, such as Executive Board decisions and reports from the President and Secretary, will also be reviewed to analyse the allocation of the ZFF own resources toward activities beyond standard municipal funding, thereby supporting the development of sport at both local and national levels.

7.1. SWOT Analysis – Zagreb Fencing Federation

The focus of the SWOT analysis is the financial structure and functional efficiency of the Federation. The SWOT analysis is based on publicly available information and observations, as well as data obtained from the official websites of the Federation and the Croatian Fencing Federation.

Table 1: SWOT analysis of ZFF

Strengths	**Weaknesses**
1.Support from the City of Zagreb and the Zagreb 2. Sports Association: Increased financial support has enabled the Zagreb Fencing Federation to finance programme activities at a higher level than ever before. 3.Internationally recognized competitions: The successful organization of official international competitions ensures international reputation and generates significant financial inflows for the Federation. 4.Long-standing tradition: Over 65 years of continuous legal and organizational existence provide institutional stability and recognition in domestic sport community. 5.Strong competitive results: A noticeable increase in results at cadet, junior, and U23 levels has been recorded over the last two Olympic cycles, while a growing number of senior athletes achieved good results. 6.Human capital and commitment: Despite very low salaries, staff retention remains high, indicating strong motivation, commitment, and organizational loyalty.	1.Dependence on external funding: Despite an increase in self-generated revenues, the Federation remains highly dependent on programme-based funding from the City of Zagreb. 2.Relatively small number of clubs and athletes: A small base of Fencers in Zagreb limits effective talent identification and selection across all age categories. 3. Insufficient number of professional coaches: A very high proportion of coaches operate on a part-time or voluntary basis, slowing long-term athlete development. 4. Insufficient professionalization of athletes: All athletes compete on an amateur basis, placing them at a significant disadvantage compared to fully professionalized international competitors. 5. Limited flexibility of funding mechanisms: Although revenues are increasing, existing funding structures are insufficient to address key structural challenges, necessitating alternative funding sources.
Opportunities	**Threats**
1.Dependence on external funding: Despite an increase in self-generated revenues, the Federation remains highly dependent on programme-based funding from the City of Zagreb. 2.Relatively small number of clubs and athletes: A small base of Fencers in Zagreb limits effective talent identification and selection across all age categories. 3. Insufficient number of professional coaches: A very high proportion of coaches operate on a part-time or voluntary basis, slowing long-term athlete development. 4. Insufficient professionalization of athletes: All athletes compete on an amateur basis, placing them at a significant disadvantage compared to fully professionalized international competitors. 5. Limited flexibility of funding mechanisms: Although revenues are increasing, existing funding structures are insufficient to address key structural challenges, necessitating alternative funding sources.	1.Uncertainty of financial support: Heavy reliance on funding from the Zagreb Sports Association exposes the Federation to risks arising from changes in funding priorities. 2.Funding structure constraints: A system largely based on programme financing limits the ability to build financial reserves for weaker budgetary periods. 3.Rising operational costs: Increasing costs of facilities, equipment, and competition organization threaten long-term financial stability. 4.Insufficient investment in human capital: Limited professionalization and investment in elite athletes and coaches increase the risk of losing highly qualified personnel. 5.Competition from other sports: Increasing sport categorization and performance-based evaluation in Croatia place greater emphasis on medals at major competitions, intensifying competition for funding.

Source: Authors

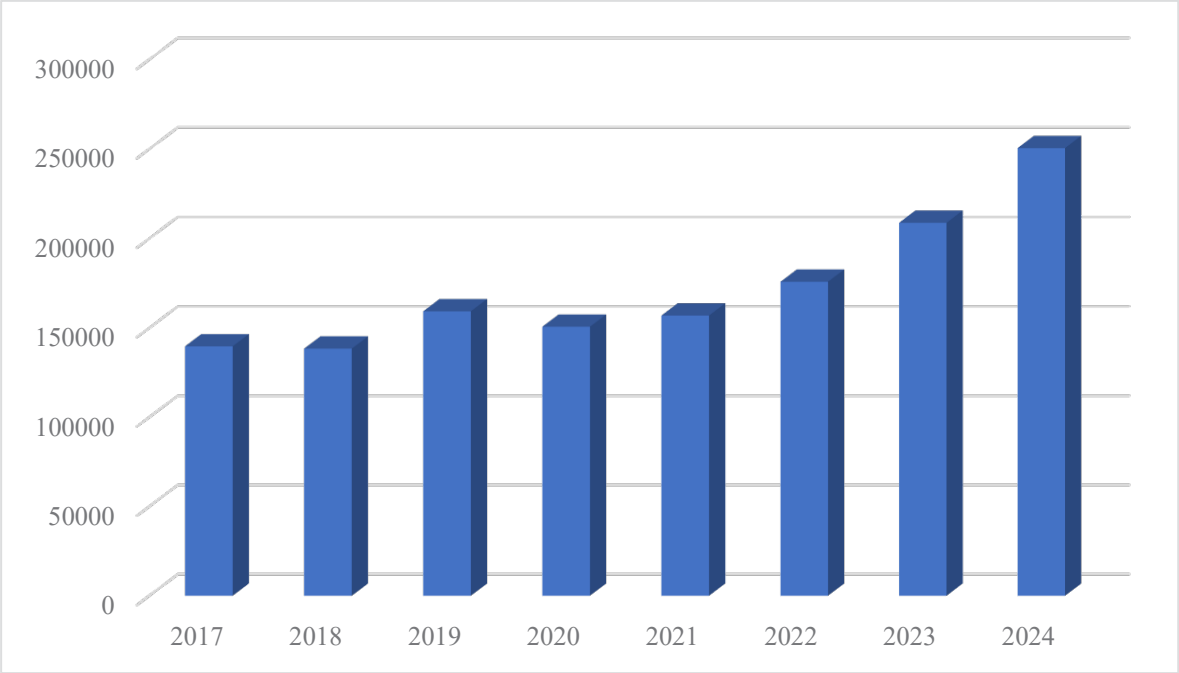
The SWOT analysis shows that while ZFF benefits from strong institutional support, tradition, and improving results, its long-term sustainability is challenged by financial dependence, limited professionalization, and increasing external pressures.

7.2. Structure of the Financial Revenue

ZFF is required by law to submit annual financial statements to the Financial Agency in accordance with law (Zakon o financijskom poslovanju i računovodstvu neprofitnih organizacija, NN 121/14, 114/22). As a non-profit organization, it must submit its financial report within 60 days of the end of the calendar year (Pravilnik o izvještavanju u neprofitnom

računovodstvu i Registru neprofitnih organizacija, NN. 31/2015) These reports are publicly available and can be verified on the official website of the Register of Non-Profit Organizations. In this study, we will analyse the submitted financial statements covering the period from 2017 to 2024. This timeframe corresponds with two Olympic cycles, which we consider sufficient for a thorough analysis and for making informed projections for the future.

Table 2: Revenue trends of ZFF

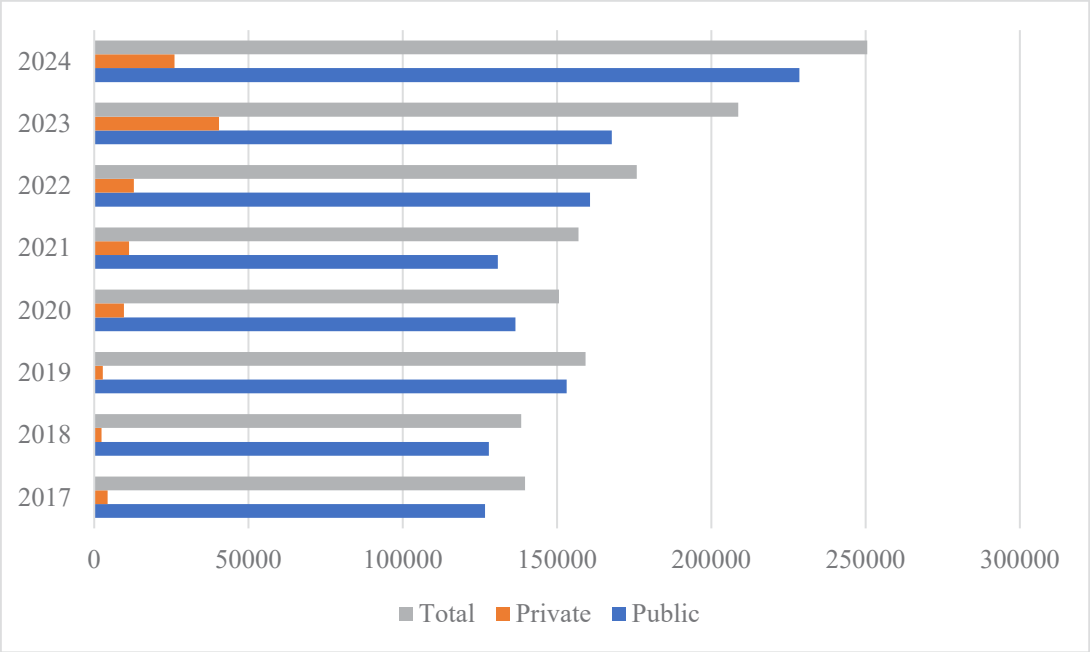


Source: Authors

Data from the financial statements clearly indicate that ZFF remains[2] largely dependent on grants allocated through the Allocation Plan for Public Needs in Sport of the City of Zagreb, administered by the Zagreb Sports Association. This structural reliance on public funding exposes ZFF to potential financial vulnerability, particularly in the event of changes in municipal budget priorities or allocation criteria. However, it is also evident that since 2021, self-generated revenues have become an increasingly significant source of revenue for the Federation. While previously these revenues amounted to only a few thousand euros, from 2021 onwards they have become more stable and reliable, averaging €22,636 per year over the period 2021–2024. With the continued organization of official competitions in 2025, and 2026 revenues are expected to further increase as the number of participants grows.

[2] Financijska izvješća Mačevalačkog saveza Zagreba Ministarstvu financija 2017- 2023 ; Financijsko izvješće Tajnika MSZ-a za 2024. godinu

Table 3: Ratio of public and private revenue sources of ZFF



Source: Authors

According to available financial reports, self-generated revenues are primarily composed of membership fees and so-called household donations, which, in accounting terms, include competition entry fees. This demonstrates that the organization of official international competitions is the main contributor to the structure and level of self-generated revenues. This finding underscores the strategic importance of organizing official competitions, as they serve not only a sporting function but also as a key financial mechanism for ZFF.

Based on the ZFF documentation, there is no evidence of significant donations or sponsorships in the conventional sense during the observed period. The observed increase in self-generated revenues therefore represents not only a positive financial trend, but also a gradual shift toward greater financial autonomy and sustainability. The absence of sponsorship and external donations may indicate there is an underutilized area of revenue diversification, suggesting room for strategic improvement.

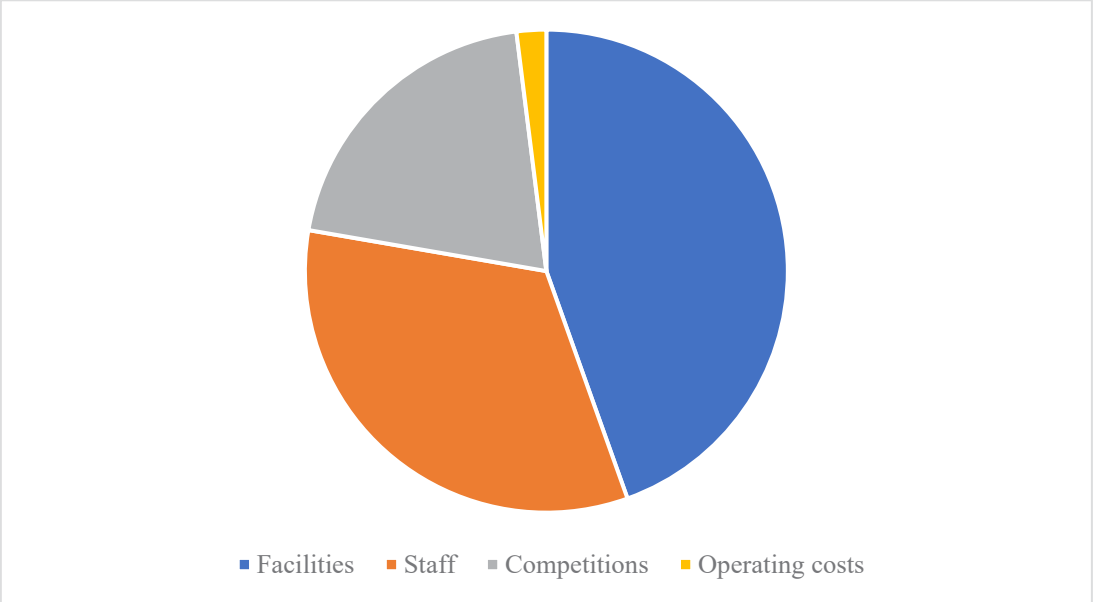
Continued growth in self-generated revenues, in the absence of sponsorships or donations, would facilitate the ZFF ability to implement projects and activities that cannot be financed through public funds, such as marketing initiatives and other strategic activities. This highlights the need for a more proactive financial strategy focused on revenue diversification, particularly through partnerships, sponsorship development, and event commercialization. Ultimately, ZFF`s long-term financial resilience will depend on its ability to balance public funding with internally generated and market-based revenue streams.

7.3. Expenditure structure

In its financial plan, ZFF allocates funding for the following program items: facility usage costs, competition expenses, material expenditures, and staff salaries, including the secretary and coaching staff. For the analysis, we will consider the year 2023, which was preceded by a full year without a COVID-19 pandemic, during which sport revenues and expenditures stabilized

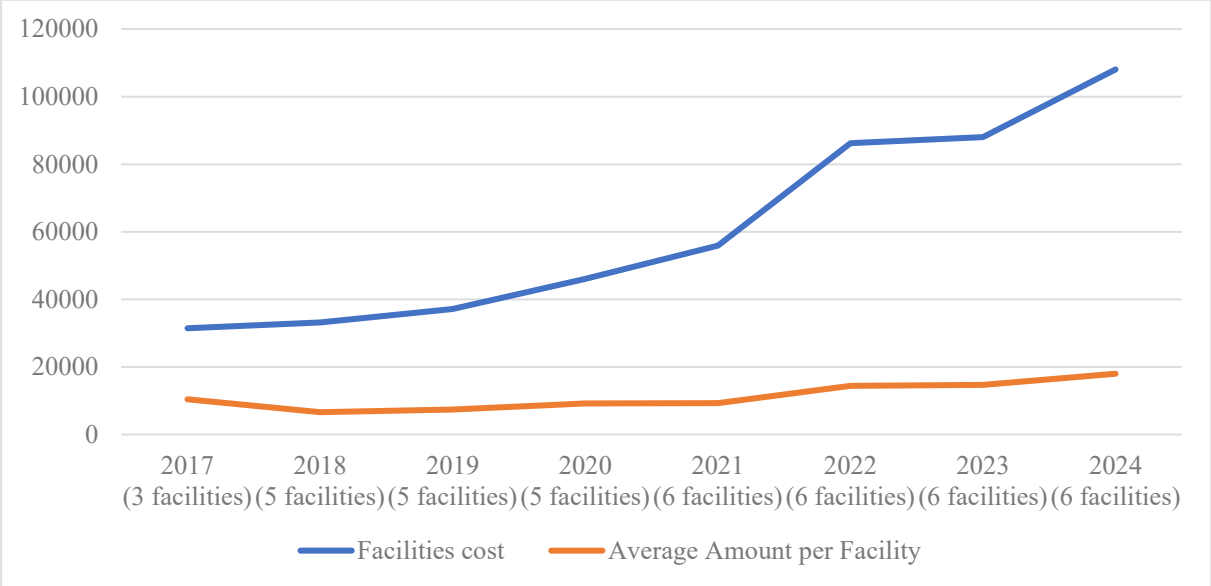
in Zagreb. Therefore, the year 2023 is characterized by budget increases in many sports associations, including fencing.

Chart 1: Expenditure Structure of ZFF in 2023



Source: Authors

Chart 2: Facility usage cost trends of ZFF



Source: Authors

Chart 3: Competitions and training cost (EUR)



Source: Authors

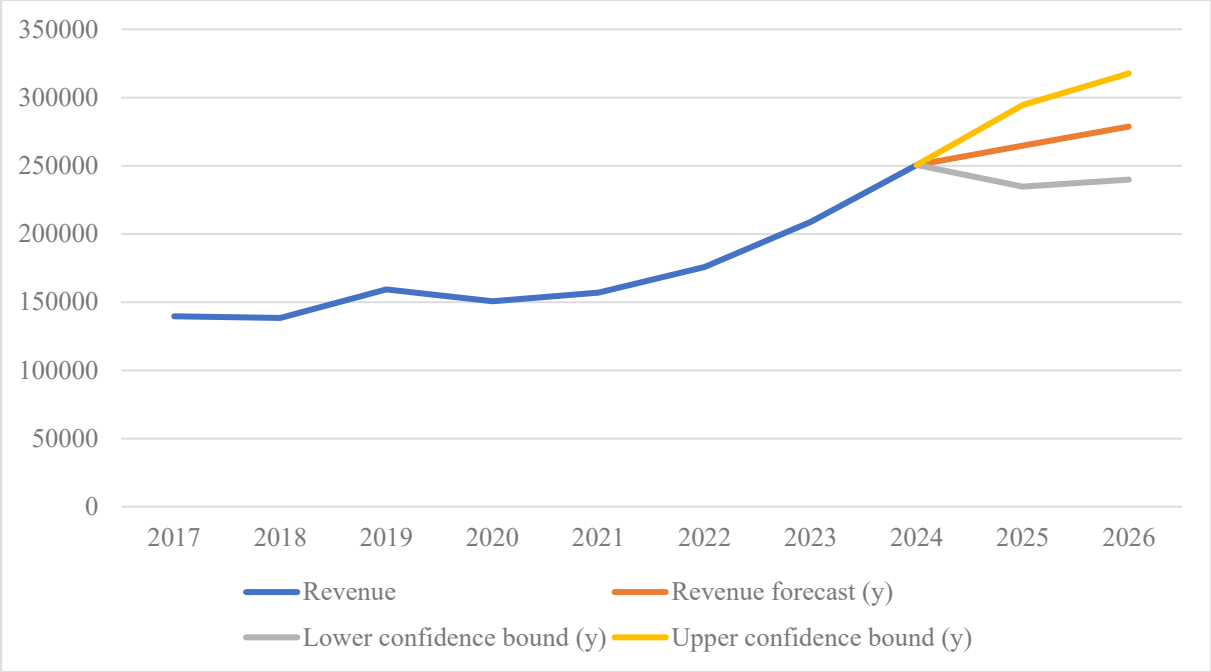
The analysis of the revenue trends of the Federation for the period from 2017 to the present, the following conclusions can be drawn:

1. The data indicate the stability of the Federation's revenues over the course of two Olympic cycles.
2. A continuous growth in revenues is also observed, with revenues increasing by 79% over the eight-year period from 2017 to 2024.
3. The largest share of revenue comes from the Zagreb Sports Association, but a significant increase in the proportion of own-source revenues is also noticeable, particularly over the last three years.
4. Increased investment in Zagreb`s sports sector directly leads to a substantial rise in the ZFF income.
5. Revenue declines were observed in 2018 and 2020. The year 2020 was marked by a significant budget reduction and the cancellation of competitions due to COVID-19.
6. Revenue projections for the ZFF, based on linear regression analysis, indicate expected revenues of €264,592 in 2025 and €278,681 in 2026.

The increase in own-source revenues over the past three years can attributed to several factors:

- Since 2022, the ZFF has independently organized the international Vladimir Mažuranić Memorial competitions, which had previously been co-organized with the CFF for a period of 16 years.
- Since 2022, ZFF has been responsible for hosting the U23 European Cup in the épée and foil disciplines, which has generated additional inflows of own-source funds.
- In 2024, ZFF gained the organization of the Junior World Cup in men’s foil (in addition to the existing organization of the women’s foil event), further increasing and stabilizing its financial revenues.

Chart 4: Projected Revenue trends of the ZFF



Source: Authors

The investment of human and organizational resources in the management of official international competitions has yielded the desired results in the form of increased own-source revenues for ZFF.

The expense structure shows that facility costs constitute a significant portion of the Federation's expenditures. According to data from the City of Zagreb's Public Sports Needs Program, the number of active athletes in ZFF slightly increased between 2017 and 2024, despite the number of training halls rising from three to six. This indicates that investment in facilities alone, where fencing training can take place, is not sufficient; it must be accompanied by an increase in both the number and quality of professional coaching staff.

Not only are facility costs high, but they are also increasing in absolute terms (due to the addition of specialized fencing halls) and in relative terms, as the cost per hall has risen. Interestingly, in 2018 and 2019, there was little increase in facility costs, despite the opening of two new fencing training locations in Zagreb. This is because one of the newly opened halls is a school facility, where costs for three weekly training sessions do not exceed €2,600 annually. This information could serve as a guide for ZFF in planning future expansion, with a focus on school facilities rather than specialized halls used exclusively for fencing, whose cost-effectiveness is higher due to partial subsidies from the City of Zagreb. It should be noted, however, that the increase in the number of halls from three to six did not result in a proportional increase in the number of competitors at competitions. On the other hand, school facilities in Zagreb have long been occupied by other sports, which underscores the importance of timely planning in order to secure hall availability as soon as one of the current users vacates the space. To conclude the ZFF demonstrates stable financial performance, with a gradual shift toward increased revenue diversification. There is continued dominance of public funding, but the growth of self-generated revenues represents a positive trend toward greater financial sustainability. However, the findings point to structural inefficiencies in resource allocation, particularly the disproportion between infrastructure expansion and athlete development (not utilizing the infrastructure fully in number of the athletes who use it). These finding may suggest

that future strategic focus should prioritize human capital and program quality. Ensuring long-term sustainability will require a more balanced approach, combining controlled expenditure growth with further development of independent revenue streams.

8. Conclusion

ZOS of 2022, which codifies Croatia's legal framework for sports financing, is a fair and reasonable approach. Multiple funding sources are defined and prioritized by law in the Croatian system, ranging from required state budgetary appropriations to commercial sponsorship incentives and gambling-related earnings. Planning, accountability, and results-oriented funding are encouraged by the connection set up by Article 79 between state co-finance and the approval of federations' strategic programs. The Ministry's monitoring function (Article 87) and the required public reporting of finances (Article 86) establish a framework intended to guarantee the effective and legal use of public funds. One purposeful legal tool for leveraging private resources for the public good in sports is the tax deduction of sponsorship fees (Article 82). Although Croatia, Hungary, Poland, and Austria all acknowledge the value of public support for sports, the principles and workings of respective legal frameworks for funding them are very different. The strictest, state-oriented structure is created by Hungarian law, where funding is a tool of centralized national policy. characterized by funding closely tied to a national agenda, centralized budgeting, and a powerful, directed state role. One special and aggressive fiscal tool for mobilizing private investments is the 150% tax deduction for sponsorship. By entrusting organized civil society (the sports federations) with resource management within a federal partnership, Austria's law creates the most delegated system. Sport Austria, a strong, independent apex sports organization, receives a block funding from the state and oversees its distribution. While avoiding micromanagement, the state establishes broad objectives. Poland's legislation creates a parallel system in an effort to strike a compromise between secure, insulated funding (via the lottery-fed Sport Fund) and political responsibility (through the ministry). It balances state support with sports autonomy. It features two main channels: ministry grants and an independent Sport Fund (heavily financed by the national lottery). This aims to separate day-to-day political influence from longer-term, merit-based development funding.

In conclusion, ZOS presents itself as a synthesis model of sorts. It integrates the Hungarian emphasis on sport as a clear public interest, adopts the Austrian/Polish respect for federation programming, and then adds exceptionally strict, codified transparency and reporting standards that are not present in the other three countries' basic sports legislation. It is more dependent than Hungary or Austria on the local government financial mandate, which is similar to the decentralised obligation in Poland. In order to guarantee predictability, strategic alignment, and public accountability at every stage of the sports financing system, the Croatian legal framework thus seems to be the most thorough and procedurally detailed. The impact of this legislation is visible in the positive example of the ZFF, and the clubs it coordinates.

Economically, fencing in Zagreb and Croatia generates some microeconomic effects. Between 2010 and 2022, ten major international competitions were organized, including World and European Championships across various age categories. The most recent event, the 2022 World Veterans Championship in Zadar, had a budget of approximately €700,000 and attracted around 950 athletes and their entourages, providing a microeconomic boost in the post-summer season. Annually, three official international competitions are held in Zagreb, with roughly 200 participants and an accompanying entourage of approximately 350 people per event. These

competitions take place outside the peak tourist season (January–March), supporting local accommodations and service providers. Fencing in Zagreb is supported by five specialized training halls, with four funded through ZFF resources, donations, or other means, representing significant investment in sports infrastructure. Nine full-time staff members are employed, with additional temporary staff and referees engaged for event organization. In conclusion, fencing in Zagreb, through the activities of the ZFF, contributes to the athletic development of members and the broader social community. By providing high-quality training and competitive programs, ZFF promotes health, fair play, social inclusion, and ethical values across all age groups. International competitions enhance Zagreb's global profile and generate localized economic benefits by stimulating tourism during off-peak periods. Although fencing does not have a major macroeconomic impact, investment in infrastructure, coaching, refereeing, and event organization contributes to the local economy and strengthens the city's overall sports system. This demonstrates that even smaller sports can generate measurable social and economic effects at the community level.

With only 450 fencers in Zagreb the social impact of fencing could seem negligible. But the ability to form bonding and bridging social capital in this "micro" community is still significant. After all, two of the paper `s co-authors became acquainted through fencing.

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ARTIFICIAL INTELLIGENCE FOR FOOD WASTE PREDICTION - A BIBLIOMETRIC ANALYSIS

ABSTRACT

This paper examines the use of Artificial Intelligence (AI) in predicting food waste and analyzes the field's thematic and intellectual structure through a Socio-Technical Systems (STS) lens. Although research on food systems and food-waste prediction, particularly AI-based approaches, is steadily growing, studies on machine learning, deep learning, optimization, computer vision, and related areas remain scattered and only loosely connected. To address this gap, the PRISMA protocol was used to systematically review and synthesize the relevant literature in the Web of Science Core Collection database. Based on the search string, 477 articles were identified; after screening, the final dataset comprised 135 publications. Bibliometric and network analyses were performed using VOSviewer, covering keyword co-occurrence, co-authorship, and citation networks. Six core thematic clusters emerged from the keyword analysis, reflecting material, organizational, technical and social dimensions of food systems that shape socio-technical dynamics in AI-based food waste prediction. The co-authorship network indicates that the field is still emerging, as it is characterised by a small number of closely connected author groups and many isolated researchers with limited collaboration links. Fragmentation is apparent in the citation network as well, with only four articles forming a connected citation chain. In conclusion, it is evident that the use of AI in predicting food waste is expanding. However, there is no conceptual unity. Moreover, there are no integrated communities of scholars specializing in the research of the use of AI in predicting food waste. Within this context, the paper illustrates the integrated use of the PRISMA flowchart and bibliometric mapping as a step-by-step process. It thereby provides a comprehensive view of the technological, organizational, and human aspects related to the creation, application, and challenges of AI technologies for food waste prediction.

Key words: *Artificial intelligence, Food waste prediction, Food systems, Bibliometric analysis, Socio-technical systems.*

1. Introduction

The problem of food waste represents one of the fundamental challenges to the sustainability of contemporary food systems. Every year, one-third of the food produced and available for consumption is lost or wasted, contributing an estimated 8–10% of total anthropogenic greenhouse gas emissions (FAO, 2023). The magnitude of the problem explains that food

waste is not an inefficiency; it is a systemic failure. Nevertheless, this failure is also multifaceted. It is ecological due to the consumption of resources and greenhouse gas emissions, it is social through food insecurity and inequalities (Kalogiannidis et al., 2025), and it is economic due to the financial losses (Bedoui et al., 2026). Although it is a long-standing problem, its scale must be urgently and systematically addressed. The issue of food waste, the pressures for sustainability, the digitalization of supply chains, and the need for data-driven decision-making are amplifying the urgency of the challenge.

As previously stated, a considerable amount of food is wasted at various stages of the food system. Some of the reasons for these losses include: purchases made on impulse, changes in household needs, and a lack of adequate storage facilities, as reported in Hebrok & Boks (2017) literature review. Coming from a different angle, Filimonau & Gherbin (2017) investigate loss mechanisms in the retail sector, where product quality monitoring remains a technically and organizationally challenging task. The recent surge in AI-driven forecasting has been a response to these challenges; however, Onyeuka et al. (2023) point out that relying on technology glosses over real-life practices, human behavior, workplace problems and household problems. Despite the growing body of research on AI-based food waste prediction, there is no comprehensive overview of the main ideas or the methods employed. Instead of relying solely on traditional literature reviews, researchers increasingly employ bibliometrics - a structured approach to exploring how topics evolve, which concepts occur together, and what themes dominate the field (Zupic & Čater, 2015). Donthu et al. (2021), in their review of bibliometric analysis, elaborate in detail about basic approaches and their advantages for knowledge mapping.

The Socio-Technical Systems (STS) theory is employed in this paper to determine bibliometric trends in AI and food waste prediction. The first establishment of the STS theory occurred with Emery & Trist (1960). Authors have developed an overall conceptual model of how the social aspects of a system interact with the technological aspects. According to Emery & Trist (1960), technology is not simply comprised of separate parts, but rather a collective of artifacts that are interconnected. As such, the artifacts are embedded in a much broader configuration of human relationships, organizational structures, materials, and work processes. When evaluating the various combinations of AI and food waste, a wide range of AI techniques were found. For example, machine learning, deep learning, optimization, computer vision, and a number of other techniques have been studied extensively in the food waste literature within the Web of Science Core Collection database (Clarivate, n.d.). However, there still exists a significant literature-based gap in systematically understanding the socio-technical implications of these techniques. Addressing this gap will provide the necessary information to ensure that such capabilities can be effectively utilized in real-world food waste prediction.

Nevertheless, bibliometric analysis does have limitations as it only studies visible, or in this case, indexed publications in the Web of Science Core Collection database, therefore excluding papers like industry reports or practical knowledge created outside of academia. With this in mind, this particular study attempts to answer the following research questions:

RQ1: What are the main thematic clusters and collaborative structures within the scientific literature that apply AI techniques to food-waste prediction?
RQ2: How can these bibliometric structures and thematic clusters be interpreted through the lens of Socio-Technical Systems (STS) theory, and what do they reveal about the interaction between technological, material, organizational, and social components of food systems?

This paper provides a comprehensive bibliometric analysis of the scientific literature on AI-based food waste prediction. By integrating bibliometric mapping with the STS framework, it gives a systematic explanation of how the technology, the organization, and the social aspects are reflected and connected in this field.

2. Literature review

Over the last ten years, an increasing number of researchers have utilized bibliometric techniques to describe the development of AI-related research in the food industry. For example, Liu et al. (2023) completed a decade-long bibliometric review of AI in food safety using CiteSpace to analyze articles published between 2012 and 2022. The results from this study demonstrate that China and the U.S. were the top two countries in terms of total publications, while journals like PLoS ONE and Computers and Electronics in Agriculture were among the most frequent outlets. In addition, Zhang & Jian (2024) completed a global bibliometric study of food waste in student research papers. The results from this study demonstrated the presence of three developmental phases: the initial phase (2000–2010), the exploratory phase (2011–2015), and the expansion phase (2016–2023).

In a recent review titled "Mapping the AI Landscape in Food Science and Engineering…" (Pennells et al., 2025), the terms "Artificial Intelligence," "Machine Learning," and "Deep Learning" emerge as the most frequently used, reflecting a strong technological orientation within the field. However, several authors note that the application of AI, specifically for food-waste prediction, remains limited. Onyeaka et al. (2023) argue that AI-based solutions for reducing food waste are still emerging and lack systematic classification and evaluation. This suggests that while AI and food-waste research are both growing fields, their intersection, AI for food-waste prediction, is still in its early stages and requires further dedicated assessments. Furthermore, Jia & Qiao (2022) conducted a comprehensive bibliometric analysis of global consumer-level food-waste research. Authors revealed a transition from early work centred on waste-treatment processes, through quantification and environmental-impact studies, to behavior-management and intervention strategies.

In addition to reviewing literature specific to food waste, bibliometric analyses have also examined digitalization processes in food supply chains. For example, Rejeb et al. (2022) analyzed digitalization in food supply chains utilizing a combination of bibliometric review and key-route main-path analysis. The authors have established clusters related to the digitalization of the food supply chain, including ICT applications, blockchain, IoT, and a cluster linking food waste with the circular economy. Their findings demonstrate that AI and big data are becoming part of the overall discussion regarding the digitalization of sustainable food supply chains.

At the same time, several extensive reviews have mapped AI applications across the food industry more generally. Mavani et al. (2022) offer a thorough review of AI methods in the food industry context (including processing and quality control applications). Authors have found key techniques such as expert systems, fuzzy logic, artificial neural networks and other machine-learning approaches. Particular emphasis is given to their uses in modelling, classification, prediction and process-control tasks. Yang et al. (2025) synthesise recent advances in AI applications across the food industry, highlighting developments in food traceability, safety, quality control, supply-chain optimisation and intelligent packaging.

Additionally, authors emphasised ongoing challenges related to data quality, technological integration and ethical considerations.

Furthermore, when it comes to prediction-focused approaches, the existing literature is still rather fragmented and loosely connected. Lakshmi et al. (2025) developed a machine-learning model for food-waste prediction using a dataset containing country-level, per-capita and sector-specific food-waste indicators. The authors have applied a Random Forest regressor to forecast future waste levels. The results show that the Random Forest (and Gradient Boosting) model achieves an accuracy of about 95% in predicting food-waste trends. Other studies, such as Tang et al. (2023), apply machine-learning models to predict food waste in the catering sector using high-resolution operational and POI data, further illustrating the potential of data-driven approaches to anticipate waste in specific settings. Also, Nijloveanu et al. (2024) developed a prediction model concerning food loss and waste in consumer segments of the agrifood chain in Romania. The authors compared a decision-tree approach and a neural-network approach. Based on survey data, the results show that the neural-network model can capture complex non-linear relationships among behavioral, social, and economic factors with food-waste generation, achieving relatively high predictive accuracy. These papers collectively confirm the rapid diffusion of AI across agri-food waste systems.

A detailed examination of these prediction-oriented research articles reveals that they are, for the most part, structurally divided by specific application contexts rather than by a common conceptual or methodological core. One stream of research considers consumer and household behavior where the models are intended to predict waste generation from the socio-demographic, behavioral, and economic variables (Nijloveanu et al., 2024). Another group of studies is dedicated to food service and catering industries, which utilize operational data to forecast overproduction, plate waste, or demand fluctuations (Tang et al., 2023). In the third stream of research, product deterioration, shelf-life estimation, and quality monitoring are discussed, which are mostly dependent on sensor data, image analysis, or computer vision techniques for predicting the spoilage and losses in the supply chain (Rashvand et al., 2025). These contributions highlight the wide range of AI-based methods, which, in essence, are still heavily sector- and problem-specific. Methodological choices, data sources, and performance metrics vary greatly between areas of application. This makes it difficult to compare across domains or to accumulate knowledge. Besides that, most of the studies have mainly focused on predictive accuracy and technical performance; therefore, they generally ignore organizational integration, user adoption and behavioral changes caused by the use of AI-based decision support (Mavani et al., 2022; Pennells et al., 2025). Consequently, the literature contains a lot of technically advanced localized solutions, but no unifying line of research that has systematically addressed food waste prediction as a socio-technical challenge in real-world food systems.

Looking at the research landscape of food waste, there is a substantial body of scattered studies addressing food waste, including household consumption, food waste generated by catering services, biogas production through food waste decomposition and municipal solid waste (MSW) management. However, these contributions have not been synthesized into a single, cohesive stream. Meanwhile, traditional bibliometric analyses have either addressed the general problem of food waste, without considering AI, or examined the application of AI and digital technologies in different stages of food systems, without focusing on food-waste prediction. It is precisely this disconnection that makes a highly targeted bibliometric analysis of AI-based food-waste prediction a worthwhile research undertaking.

3. Methodology and data description

The PRISMA methodology was adopted to ensure that the literature was identified, screened and included in an organized manner (Moher et al., 2009). Although PRISMA is typically applied for systematic reviews, Page et al. (2021) have recently noted a trend towards using this diagram as a way of documenting the decision-making process of search and corpus refinement. The PRISMA flow diagram (Figure 1) outlines each stage of the research process, from the first database search (the search string) to the final selection of relevant studies.

The first stage involved a comprehensive search of the Web of Science Core Collection database, chosen because of its rigorous indexing standards and its suitability for high-quality bibliometric studies (Donthu et al., 2021; Zupic & Čater, 2015). Using a refined search string combining terms related to food waste, prediction and artificial intelligence, a total of 477 initial articles were retrieved (see PRISMA Identification section in Figure 1). The search strategy was designed to capture studies explicitly using computational or machine-learning-based prediction models in food waste. Also, the search was conducted on 19 November 2025, as shown in the PRISMA diagram.

The second phase, as illustrated in the Screening section of the PRISMA diagram (Figure 1), involved the careful selection of the initial dataset against a specific set of inclusion criteria. The analysis was restricted to the 2018–2025 period and to document types classified as articles, review articles and proceedings papers. This disciplined filtering step removed fields such as agriculture, chemistry and environmental studies, areas that address food waste but less frequently apply AI-based predictive modelling. In addition, only publications written in English were included in the final dataset; this decision was made to ensure consistency in the bibliometric analysis and comparability of keywords, abstracts and citation data across the selected publications. After the category-based screening, 135 articles remained.

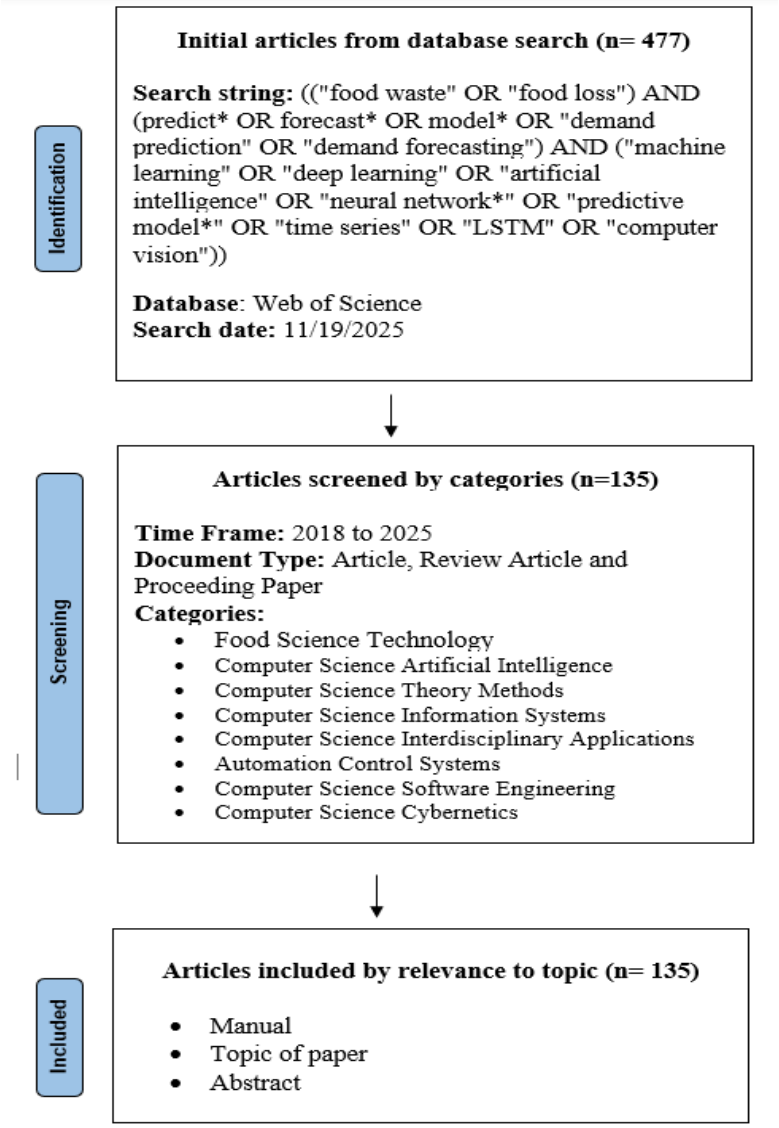
In the Included phase of the PRISMA diagram, each of the 135 papers was briefly scanned by examining the title, abstract and keywords. This step ensured that the selected publications explicitly applied artificial intelligence, machine learning, deep learning, computer vision, or predictive modelling for the purpose of forecasting food waste. In this study, AI-based food waste prediction is understood broadly to cover associated factors like spoilage, estimating shelf-life and loss of quality, as those factors are all directly involved in generating waste.

A total of 135 publications were used for bibliometric and network analyses. Bibliographic data (author names, their institutions, years of publications, keywords, journals, and citation counts) from the Web of Science Core Collection database were exported in plain text format for future processing. Three different bibliometric techniques were combined to reflect various aspects of the research field. On the one hand, keyword co-occurrence analysis was primarily focused on uncovering the central themes of the field, while demonstrating how the fundamental ideas and research topics are connected in the literature. On the other hand, co-authorship analysis was utilized to study collaboration patterns and measure the level of integration and community formation among researchers working in the field. Besides that, citation network analysis was implemented to investigate the intellectual structure of the area and determine whether cumulative knowledge development is taking place.

Data visualization was performed using VOSviewer (version 1.6.10). This software has numerous capabilities in creating large-scale visualizations of bibliographic networks and was primarily selected due to its extensive use within the field of bibliometric research. The

combination of PRISMA corpus selection with bibliometric mapping provided both the analytical reasoning for a methodological approach and a multidimensional view of the thematic and social organization of research on AI-based food waste prediction.

Figure 1: PRISMA flow diagram of the search process



Source: Author's research according to Web of Science Core Collection database, as of November 19th, 2025

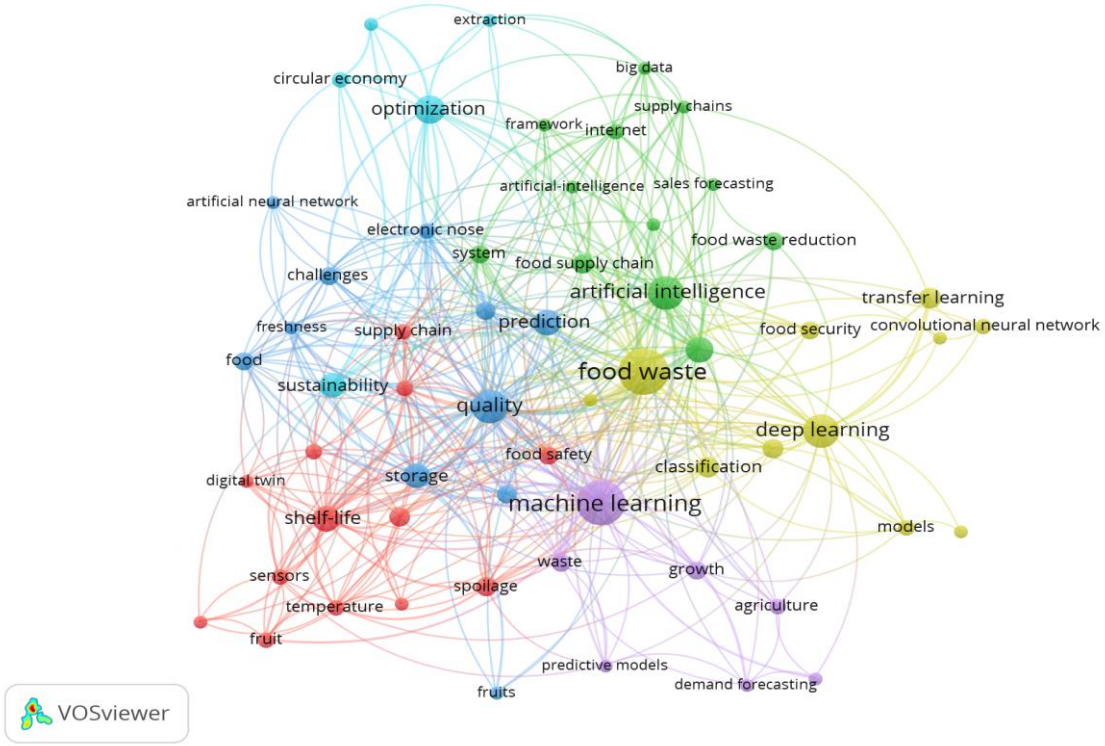
4. Results and Discussion

To investigate the intellectual framework of the domain and reveal how scholarly subjects and academic collectives interrelate, three supplementary bibliometric methods were employed: keyword co-occurrence analysis, co-authorship network analysis and a citation network based on documents with at least two citations. Keyword analysis is often employed in the context of scholarly metrics as it offers researchers a way to explore the dominant themes, investigative trajectories and connections in terms of concepts in a given area (Zupic & Čater, 2015). Co-authorship network, however, helps authors to identify patterns in academic collaborations and therefore the most prominent contributors and thematic groupings. A

citation network illustrates how concepts are disseminated through publications, and thus shows how research builds upon earlier works. It highlights key papers as "anchor" points for the development of knowledge in a particular area (Donthu et al., 2021; Zupic & Čater, 2015).

Through the use of these strategies, authors can identify the fundamental thematic groupings, scholarly communities, and research papers, and in turn, reveal the theoretical foundations and collaborative links that support progress in AI-based food waste prediction research. The visualizations provide a detailed map of the field, focusing not only on the primary elements but also on the intersections of the technological, material, organizational, and social dimensions of food waste prediction and AI.

Figure 2: Visualization map of keyword co-occurrence



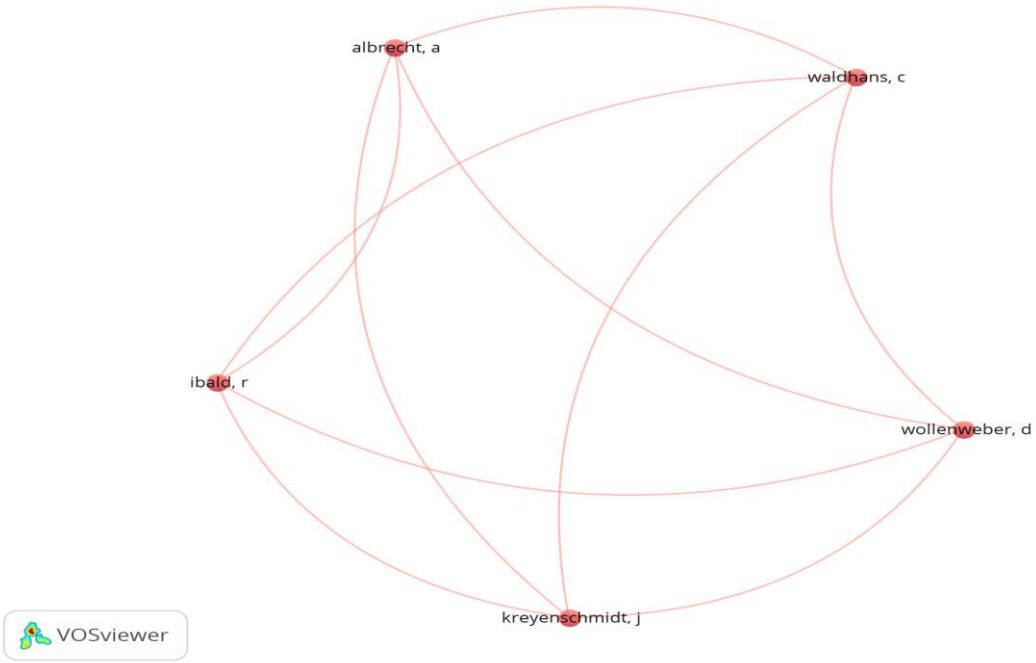
Source: Author's work based on collected data, November 19th, 2025

The six clusters identified through VOSviewer can be interpreted through the Socio-Technical Systems (STS) theory, which conceptualizes complex problems as interactions between technical, material, organizational, and social subsystems (Baxter & Sommerville, 2011). Figure 2 represents a visualization map of keyword co-occurrence. In the authors' network analysis, a minimum occurrence threshold of three keyword appearances (≥ 3 occurrences) was applied, ensuring that only conceptually relevant and recurrent terms formed the final cluster structure. Under this threshold, the machine learning cluster (purple) and the section of yellow cluster with keywords such as deep learning/computer vision appear to correspond to the technical subsystem, as they consist of the core AI methods, neural networks, convolutional models and predictive algorithms that are used for forecasting food waste (Goodfellow et al., 2016; Russell & Norvig, 2021; Sarker et al., 2019). Furthermore, the food waste cluster (yellow-green), where "food waste" appears as a central node, presents the integrated socio-technical core of the system. It links the material characteristics of waste, the technological components needed for prediction and the organizational processes within which waste emerges (Reynolds et al., 2019). The spoilage, shelf-life, sensors and packaging

cluster (red) suggests alignment with the material subsystem, since it includes the physical properties of food degradation and the sensor-generated data that support predictive modelling (Ingram, 2017; Rahman, 2007; Sahin & Sumnu, 2006). The optimization cluster (turquoise) can be interpreted through an organizational subsystem, reflecting operational and analytical procedures, optimization, modelling and system integration, through which AI predictions are embedded into workflows and decision-making structures (Baxter & Sommerville, 2011; Hillier & Lieberman, 2021). The storage, quality, freshness and food system challenges cluster (blue) can be associated with the social subsystem, capturing societal expectations, behavioral practices and sustainability concerns that shape food waste generation (Reynolds et al., 2019). Taken together, these clusters suggest that AI-driven food waste prediction is not purely a technical task but a socio-technical challenge that requires coordinating algorithms, physical food properties, human behavior and supply chain organization within a single integrated system.

It is important to note that this interpretation does not imply an empirical measure of the components of a socio-technical system, but rather a theoretical framework to analyze the structure of a research area.

Figure 3: Co-authorship network of authors

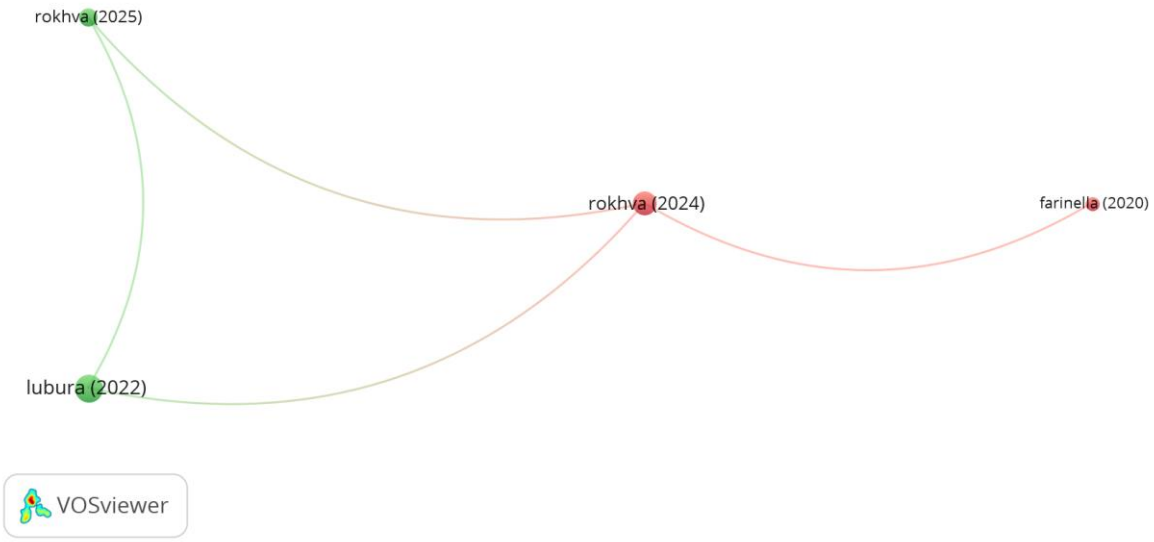


Source: Author's work based on collected data, November 19th, 2025

Furthermore, the co-authorship analysis was also performed in VOSviewer using authors as the unit of analysis and applying the full counting method, which assigns full credit to each co-author of a publication. To avoid distortions from large multi-author papers, documents with more than 25 authors were excluded. A minimum threshold of two publications per author was set. Out of the 613 authors present in the dataset, 33 authors met this requirement. However, when VOSviewer calculated collaboration links between these 33 authors, it became evident that most authors were not connected. Consistent with bibliometric best practice, only the largest connected component, consisting of five authors, was visualized. This ensures a clear and interpretable collaboration map rather than a dispersed network of isolated nodes.

In co-authorship networks, collaborators who frequently co-author articles are positioned closer to each other; this is illustrated in the co-authorship network provided in Figure 3. In this instance, the co-authorship network consists of five closely situated collaborators: Albrecht, A.; Waldhans, C.; Wollenweber, D.; Ibald, R.; and Kreyenschmidt, J. The five authors are linked to each other by having strong indicators of co-authorship spanning over several articles. The five authors have co-authored articles in the connected research areas of artificial intelligence, food quality evaluation, estimation of shelf-life and food systems predictive modelling. The network also reveals that even with 135 publications, the research connected to food waste prediction and AI is still in the early stages of development. It implies that in this field, research is still spread across smaller, more isolated groups and not collected in bigger, more integrated research hubs. This is characteristic of early-stage interdisciplinary domains.

Figure 4: Citation network based on documents with at least two citations



Source: Author's work based on collected data, November 19th, 2025

Finally, citation analysis (Figure 4) was conducted, considering only documents with at least two citations, which yielded 83 publications for further analysis. However, only four of them formed a connected citation network, indicating that there is a highly fragmented intellectual structure in the area of predicting food waste with an AI. The connected cluster includes Farinella (2020), Lubura (2022), Rokhva (2024), and Rokhva (2025), with Rokhva (2024) serving as the central linking node that connects earlier studies with more recent work. Interconnected research, where publications build on each other through citations, is quite rare. Most publications appear to develop relatively independently, without referencing each other. This fragmentation also reflects a characteristic of emerging interdisciplinary fields, where research is dispersed across siloed groups, and comprehensive conceptual frameworks are still developing.

From a socio-technical perspective, it appears that the pace of technological development (i.e., the development of machine learning, deep learning and optimization) has been greater than the pace of conceptual and organizational integration. Consequently, the connection to social context and organizational practice remains relatively underdeveloped. As such, this

can limit the practical application of AI-based solutions. Furthermore, the limited connectivity in the co-authorship and citation networks also shows that knowledge production in this field is still spread across small and loosely connected groups. It is therefore necessary to consolidate cross-domain collaboration and develop integrative research agendas to progress AI-based food waste prediction from a set of isolated technical applications to a mature and impactful socio-technical field.

Concerning RQ1, the data from the bibliometric study shows that the area of scientific knowledge on AI-based food waste prediction can be categorized into several thematic groups (clusters). The found clusters can be interpreted through the theoretical model of Socio-Technical Systems (STS), which consists of four key subsystems. The first subsystem is the Technical subsystem that deals with the use of AI techniques such as machine learning and deep learning. The second subsystem is the Material subsystem, which takes into account the physical properties of foods and their deterioration (spoilage), the sensorial characteristics of products (shelf-life), and also the physical characteristics of packaging. The third subsystem is the Organizational subsystem that represents the different processes of optimization and decision-making applied by the food-related organizations. Finally, the fourth subsystem is the Social subsystem that represents the food system challenges (storage, quality, freshness, etc.) that are of a social nature. Furthermore, the collaborative structures in the scientific literature regarding the use of AI for predicting food waste are still quite fractured. A co-authorship network analysis demonstrates that there is a small number of closely connected research groups and a large number of individual researchers who are disconnected from one another (i.e., they have very few collaboration linkages). There is a small cluster of authors who form a single, cohesive, connected collaboration network, whereas all other authors appear not to be connected. This configuration illustrates that the research area of AI-based food waste prediction is developing, but it has not yet established itself as a large, integrated community of researchers.

With reference to RQ2, the authors interpreted the structural characteristics of the bibliometrics in terms of the Socio-Technical Systems (STS), which describe how technical, physical, organizational, and social elements interact. The data suggest that the effectiveness of AI-based food-waste prediction is influenced by the material characteristics of food, organizational decision-making processes, and the social elements associated with food systems. In this sense, a socio-technical interpretation of the data suggests that for effective solutions to arise, the adoption of AI technologies should be integrated into both current operational practices and food system realities.

5. Limitations and Future Research

Apart from its contributions, this study has several limitations that should be acknowledged. First, the analysis is based on data from the Web of Science Core Collection only. This approach provides high quality and consistency of data. However, it has a drawback of excluding relevant studies that can be found in other databases, as well as grey literature, industry reports, and practitioner-oriented outputs. In addition, only the publications that were written in English were used in the final dataset, potentially excluding relevant studies from other languages. As a result, some applied or practice-oriented knowledge of AI-based food waste prediction may have been left out of the model.

Second, bibliometric methods are based on the use of metadata (titles, abstracts, keywords, citations) rather than the entire text of the articles. Hence, the thematic clusters and the network structures that have been identified in this paper mainly represent patterns in scholarly communication and indexing practices, and not the full conceptual content of individual studies. It also implies that new topics or interdisciplinary contributions that employ different terminologies might be underrepresented.

Third, the research concentrates on a narrow time frame (2018-2025) and selected document types (articles, review articles and proceedings papers), which, although supported by the rapid rise of AI applications, may give a limited historical perspective on the earlier conceptual or methodological roots of the field.

Future researchers could address these issues by broadening the data sources to comprise other bibliographic databases and non-academic outputs, as well as by integrating bibliometric analysis with qualitative systematic reviews or content analysis. Besides that, the next studies might also focus on the socio-technical changes in more depth. For example, by concentrating on particular application domains (such as households, retail, catering or supply chains) or by comparing regional and institutional research patterns in AI-based food waste prediction.

6. Conclusion

This paper aimed to provide a structured overview of the existing research on AI-based systems for predicting food waste using bibliometric methods and Socio-Technical Systems (STS) theory. By applying the PRISMA protocol, in combination with bibliometric mapping methodologies, the study identified, filtered and evaluated a total of 135 articles in the Web of Science Core Collection database. Through this approach, the authors provided a comprehensive overview of the thematic, collaborative, and intellectual structure of this emerging research field.

The results indicate that research on AI-based food waste prediction is increasing; however, there are significant thematic and institutional divisions. The keyword co-occurrence analysis indicates that the field is organized into several clusters related to the technical, material, organizational and social subsystems. These results support the notion that AI-food waste prediction is not merely a technological problem, but rather a socio-technical issue. Meanwhile, the co-authorship and citation networks demonstrated weak integration among research groups and limited cumulative knowledge building, which is typical of a new interdisciplinary domain.

By analyzing these bibliometric structures with the perspective of STS theory, this paper extends the understanding of how AI technologies, organizational practices, material food properties, and social factors interact in the context of food waste prediction. The results indicate that evolution in this area will be increasingly reliant on the development of predictive models, as well as a more profound conceptual integration and a greater interdisciplinary and inter-institutional collaboration. Hence, the paper not only outlines the present research landscape but also lays the groundwork for more integrated, socio-technical research of AI-based solutions to food waste.

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