ANALYSIS OF SMART MOBILITY SOLUTIONS IN SELECTED URBAN CENTERS IN POLAND

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Abstract

With the dynamic expansion of urban areas, the effective development of cities is becoming a priority both for technologically advanced countries and for countries that are not among the world leaders. Sustainable and modern in terms of infrastructure and management, ecological urban centers are seen as key foundations of the future. It should be noted that traditional transport systems may become insufficient in the near future, given the growing demand for mobility. Smart urban mobility solutions are aimed at implementing the assumptions of sustainable transport, intelligent traffic management systems, minimizing traffic jams and travel time, and optimal use of transport infrastructure. Polish cities are also starting to take part in the process of transforming urban mobility towards intelligent solutions. This article will present the results of analyzes of smart urban mobility solutions in selected Polish cities participating in the Intelligent Cities Challenge initiative, these are: Poznań and Gdańsk (ICC, 2023). The aim of the article was to analyze smart urban mobility solutions in selected Polish cities (Poznań and Gdańsk). The research methods used were desk research and focus expert interview. Analysis of the level of development of smart urban mobility (at the national level) showed that Poznań ranks higher than Gdańsk in the categories of electric transport, bicycle transport, facilities for electromobility and clean air. Moreover, based on the expert research conducted, it can be indicated that both cities are characterized by similar development factors (e.g., focus on introducing new technologies) as well as development threats (e.g. residents' fears of changing the scope of transport solutions used, such as giving up private transport). Based on the analyzes performed, it can be indicated that both Poznań and Gdańsk are taking active steps to develop solutions related to intelligent mobility, although there are some differences in transport infrastructure and achievements in individual areas. Both urban centers show potential for further

development in the field of urban mobility, which may bring benefits for both residents and the natural environment.

Keywords: smart urban mobility, urban mobility, mobility innovation, smart city, urban mobility solutions, smart mobility solutions

1. INTRODUCTION

In the modern world, the role of cities as the main centers of life, concentrating an increasing part of society, is growing dynamically. It is estimated that the urban population in the world is 3.5 billion and is systematically increasing. According to the United Nations forecast, approximately 60% of the world's population will live in cities in 2030 (BI, 2023). Technological development, combined with a significant increase in the world's population, brings very dynamic changes in the way societies function. The main place of interaction of these two basic factors are rapidly changing cities and their character (Ryba, 2007; Gądecki, 2013).

It should be noted, however, that cities evolve and adapt to the changing needs of their inhabitants, which is why they have often begun to become centers of innovation supporting the development of countries (Florida, 2023). Demographic growth and dynamic urbanization, reinforced by globalization processes and unprecedented flows of population, capital and information, cause cities to face unprecedented challenges, requiring new operational concepts, technologies, technical solutions and development strategies (Neirotti et. al., 2014). Currently, significant socio-economic and technological changes are taking place, in which cities play a key role. That is why the concept of the so-called smart cities (Ryba, 2007). Intelligent solutions implemented in cities can use their advanced infrastructure to support transport operation and management (Stawasz et al., 2012; Pichlak, 2018).

It can be argued that smart urban mobility plays a key role in urban centers by providing efficient, sustainable and connected transport solutions. It uses advanced technologies (e.g., Internet of Things IoT, artificial intelligence AI, analysis of large data sets) to improve the way people move and the flow of goods (through intelligent road traffic management, optimization of routes and schedules and adaptation of transport services to needs in real time, intelligent traffic lights, parking management systems, smart bus stops or mobile applications integrating various means of transport). On this basis, it can be indicated that developing intelligent urban mobility is important from the point of view of the efficiency of urban centers and improving the quality of life of their inhabitants.

The aim of the article was to analyze smart urban mobility solutions in selected Polish cities participating in the Intelligent Cities Challenge initiative (these are: Gdańsk and Poznań).

The study consists of several parts: introduction, analysis of the literature on the subject (in relation to the location of smart urban mobility in the broader concept of smart city, as well as the scope of the concept of smart urban mobility), materials and methods, results, discussion and conclusive remarks.

2. SMART MOBILITY CONCEPT – LITERATURE REVIEW

Modern urbanized urban areas constantly strive to ensure coherence between social, economic and environmental phenomena. Continuous improvement of processes and increasing mobility through the sharing economy are priority issues in the era of rapidly developing urbanization. Cities of the future must adapt to changing environmental conditions in order to quickly respond to: climate change, population size, ongoing globalization of the economy and demography, technology development, geopolitical threats and changes, urban mobility, population aging, conflicts and social inequality (Caragliu, 2016 ; Czupich et al., 2016; Makieła et. al., 2022).

City authorities, in order to take care of urbanized urban areas and their users, are increasingly implementing the smart city concept, which is now becoming a strategic plan of many agglomerations both in Poland, Europe and around the world (Bachanek, 2019).

According to the definition of the Massachusetts Institute of Technology, a smart city is: intelligence contained in the combination of increasingly effective digital telecommunications networks communication (compared to nerves), ubiquitous, continuous intelligence processes (compared to brains), sensors and receptors (compared to sense organs), and software (compared to knowledge and cognitive competences) (Mitchell, 2007).

In turn, Mohanty et. al. (2016) considers a smart city to be: a place where traditional networks and services are more flexible, efficient and sustainable. They are based on the use of information, digital and telecommunications technologies to improve the functioning of cities and for the benefit of residents. Therefore, smart cities are greener, safer, faster and friendlier. It is assumed that a smart city is one that is characterized by (Giffinger et. al., 2007; Manville et. al., 2014):

- a smart economy, i.e. a highly efficient and technologically advanced economy thanks to the use of ICT technology;
- smart transport networks, i.e. integrated transport and logistics systems using mainly clean energy;
- sustainable use of resources (smart environment); i.e. striving for economical management of natural resources;
- high-quality social capital (smart people), the creation of which is possible in conditions of social diversity, tolerance, creativity and commitment;
- high quality of life (smart living), which means safe and healthy living in a city with a rich cultural and residential offer, providing wide access to ICT infrastructure enabling the creation of lifestyle, behavior and consumption;
- smart public management, i.e. one in which social participation in decision-making, including strategic decisions, transparency of operations, quality and availability of public services play an important role.

A smart city is a creative, sustainable city in which the quality of life improves, the environment becomes friendlier, and the prospects for economic development are stronger (Lee et al., 2014). Its distinguishing feature is "intelligence", which can be

understood as the sum of various improvements regarding the functioning of urban infrastructure and city resources, as well as public services related to the sphere of mobility (Gontar et al., 2013; Angelidou, 2014; Jong et. al., 2015; Trinidade et. al., 2017).

It is in this field that intelligent mobility becomes an important area of research and an important research gap that is worth filling. Improving the functioning of the broadly understood sphere of logistics in the city is one of the city's development priorities. Since its inception, the concept of intelligent mobility has been used in transport networks, both in the area of urban planning and transport planning due to innovation (Łabędzki, 2022). At the same time, it is one of the main factors of the attractiveness of cities and determines the level and quality of life of residents (Bielińska-Dusza et. al., 2021).

It should be noted that there are many definitions of the concept of smart mobility. This is because this idea is evolving. Gabrys (2014) indicates that intelligent mobility is an approach that helps reduce the emission of toxic exhaust gases emitted into the atmosphere by vehicles, encouraging residents to use environmentally friendly means of transport. In turn, Allam and Newman (2018) point out that smart mobility is not only about integrating technology into urban infrastructure, but also calling on citizens to use the urban environment in an intelligent and rational way and derive benefits from it. Giffinger (2020) defines smart mobility as the use of creativity or advanced technologies to manage transport and communication (including digital). The indicators are: transport efficiency, the use of sustainable solutions, the use of public transport, local and global transport availability and technological infrastructure, e.g. access to smart city cards.

Smart mobility aims to improve mobility while reducing the impact of transport on the environment and society, as well as managing traffic congestion, reducing independent travel, encouraging people to change modes of transport, reducing the length of trips and increasing the efficiency of the transport system (Papa & Lauwers 2015).

Benevolo et al. (2016) define the following fundamental goals relating to the implementation of smart mobility assumptions: reducing transport costs, reducing air pollution, reducing the nuisance of emitted noise, reducing traffic congestion, increasing safety and shortening the time of movement of goods and movement of people .

To achieve maximum effects when introducing individual elements of smart mobility, a balanced approach is necessary, combining innovative technologies and the needs of city residents. Smart mobility should integrate technologies, systems, infrastructure and capabilities where innovation is a means, not just an end. Intelligent mobility systems include public transport systems as well as individual mobility systems, including ridesharing, bicycle sharing, car sharing and on-demand ride services (Boichuk, 2020).

In individual urban centers, there can be significant differences and levels of advancement in the implementation of solutions or technologies related to intelligent mobility. Differences occur both at the global level, but also at the national and regional level.

The following points will present the methodological assumptions of the authors' own research, and then the research results relating to the comparison of the activities of municipal authorities of selected Polish cities (Poznań and Gdańsk) in the development of the idea of smart mobility.

3. MATERIALS AND METHODS

The main aim of the study was to analyze smart mobility solutions in selected Polish cities: Gdańsk and Poznań. The identified urban centers were selected for the study based on their participation in the Intelligent Cities Challenge (ICC) initiative. This is a project supported by the European Commission, the aim of which is ecological and digital transformation in accordance with the assumptions of the Local Green Deals (for local economies - e.g. within the city). ICC is intended to support the use of innovative technologies while improving economic competitiveness, strengthening civil society and improving the lives of residents. Mobility is one of the dimensions of the indicated transformation (ICC 2023).

The following specific objectives were formulated:

- P1: Determining the level of smart mobility of selected Polish cities.
- P2: Determining the development factors of smart mobility in selected Polish cities.
- P3: Identification of challenges in the field of smart mobility of selected Polish cities.

The main research problem is the question: what smart mobility solutions operate in selected Polish cities: Poznań and Gdańsk?

The main research problem was decomposed into the following detailed questions:

- RQ1: What is the level of smart mobility in selected Polish cities?
- RQ2: What are the development factors of smart mobility in selected Polish cities?
- RQ3: What are the challenges in the development of smart mobility in selected Polish cities?

The study was carried out in three stages (preparation, implementation, results analysis). In each of these phases, specific tools, techniques and research methods were used.

3.1 Preparation phase

At this stage of the research, the desk research method was used, which involves the analysis of records of available data sources, including in particular their compilation, mutual verification and processing. Such an analysis constitutes the basis for developing conclusions about the examined problem (Bednarowska, 2015).

It was used to select smart mobility indicators and related data. Due to the availability of data and the possibility of their comparison, the following groups of measures were selected:

- public roads with hard surface [km];
- bicycle paths per 100 km2 of total area;
- bus lines [km];
- tram lines [km];
- trolleybus lines [km];
- buses [pcs.];
- trams [pcs.];
- trolleybuses [pcs.];
- passenger transport per year [million people];
- based on the report on the Ranking of Electromobile Cities (Piznal et. al., 2021), aspects relating to electric transport, bicycle transport, facilities for electromobility, public transport and clean air.

3.2 Realization phase

The research method in this step was a focus expert interview, which is a special type of methodological research because it draws on the knowledge and creativity of people who are experts in a given field. It involves obtaining data by asking questions based on a specially prepared questionnaire - obtaining answers by the interviewer from respondents selected on the basis of appropriately selected research samples (Magruk, 2005). It is assumed that respondents with extensive professional achievements and professional knowledge on a given topic can present interesting analytical proposals. Thanks to professional knowledge and "imagination rooted in reality", they can also create valuable (realistic) forecasts of the development of the situation in a given fragment of economic and social reality (Churchill, 2002).

The authors' own research was conducted between August and September 2023. The technique of purposeful selection of experts was used. The selection criteria for the study were significant practical experience in the implementation and functioning of intelligent mobility technology solutions. A total of 40 experts participated in the study (two groups of 20 people from each of the analyzed cities).

The interview questionnaire consisted of two parts:

- specifications (defining the profile of experts);
- core containing development factors and threats to smart mobility in selected cities based on the STEEP analysis, containing sociological, technological, economic, ecological (environmental) and political factors, selected on the basis of the modified research approach of Kachniewska (2020) referring to medium-sized cities in Poland.

3.3 Developing research results phase

The development of research results was based on the use of elements of descriptive statistics, such as the arithmetic mean and median (Ręklewski, 2020). This concerned both the analysis of smart mobility indicators and the results of the expert interview.

The analysis of the research results is presented in the next section.

4. RESULTS

Two selected urban centers in Poland - Poznań and Gdańsk - will be subject to comparative analysis in relation to smart mobility solutions. When characterizing these cities, it can be indicated that Poznań is located in the western part of the country - in the Greater Poland Voivodeship, on the Warta River. The area of Poznań is 261.9 km2. The number of inhabitants in 2022 was 541,316 people. Gdańsk, in turn, is a port city on the Polish Baltic coast - in the Pomeranian Voivodeship, located at the mouth of the Motława River and the Vistula River on the Bay of Gdańsk. The area is 265.9 km2. In 2022, the number of inhabitants was 486,345 people. Therefore, we can point to a comparable area and number of inhabitants, which is important from the point of view of selecting these centers for research. Additionally, both cities participate in the Intelligent Cities Challenge, which shows that they intend to develop and implement solutions, technologies and concepts regarding smart city solutions, including in relation to broadly understood mobility.

Considering the elements of the transport network, the length of public roads in Poznań (31.23 thousand km) is much longer than in Gdańsk (12.23 thousand km). Moreover, both bus and tram lines are longer in Poznań. The existing fleet of buses and trams is also larger in Poznań. Public transport in Poznań carried 11.59% more passengers. Only in the case of saturation with bicycle paths, a better result was obtained in Gdańsk - table 1.

Table 1 Selected parameters of the transport network of Poznań and Gdańsk in 2021

Element oceny lub wskaźnik	Poznań	Gdańsk
Public roads with a hard surface	31230,7	15233,6
Bicycle paths per 100 km2 of total area	7,84	8,5
Bus lines in km	6237,5	3248
Tram lines in km	207,5	156
Trolleybus lines in km	-	211
Buses in pcs.	988	719
Trams in pcs.	228	141
Trolleybuses in pcs.	-	108
Passenger transport in public transport per year in millions	213	207

Source: own work based on (USG, 2021; USP, 2021)

The analysis of the level of development (at the national level) of smart urban mobility in the surveyed cities will be based on the Ranking of electromobile cities developed by Polityka Insigh (Piznal et. al., 2021). The list was prepared on the basis of numerical data regarding various types of quantifiable aspects of local government activities in the 50 largest Polish cities with county rights in terms of population, compiled in a total of 27 indicators, in five categories: electric transport, bicycle transport, facilities for electromobility, public transport and clean air (Piznal et. al., 2021). It should be noted that the city of Poznań achieved a higher position than Gdańsk in four of the five indicated categories: in the field of electric transport, bicycle transport, facilities for electromobility and clean air. However, in terms of public transport, both cities were ranked in the same place - table 2.

Table 2 The level of smart urban mobility in Poznań and Gdańsk in relation to the largest cities in Poland

Group of indicators	**Poznań**	**Gdańsk**
Electric transport: 1. City hall car fleet 2. Electric public transport 3. New registrations of electric cars 4. Electric vehicle charging stations 5. Analysis of the benefits of using zero-emission vehicles	5	9
Bicycle transport: 1. Number of city bikes 2. Number of city bike stations 3. Length of bicycle paths 4. Expansion of the bicycle path network 5. Electric scooters	5	26
Facilities for electromobility: 1. Planned expenditure on transport and communications 2. Index of changes in transport and communications expenditure 3. Electromobility development strategy 4. Charging station location plan 5. Support for commercial charging stations	1	4
Public transport: 1. Length of bus lanes 2. Operation of public transport vehicles 3. Change in the number of vehicle kilometers traveled 4. Expenditures on public transport 5. Type of fuel in buses 6. Tram and bicycle infrastructure	7	7
Clean Air:	2	12

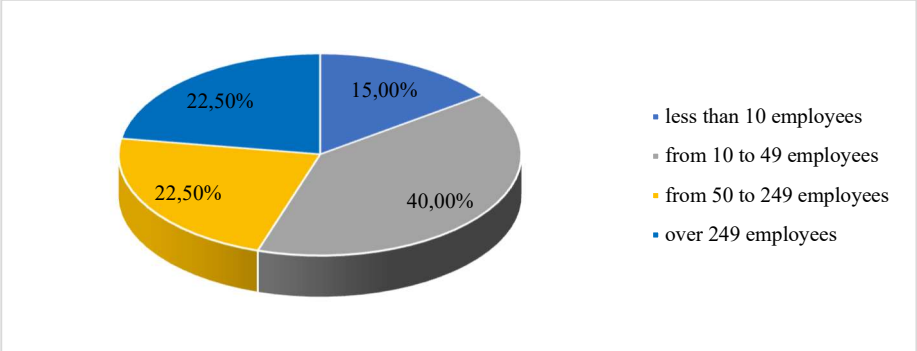
Group of indicators	Poznań	Gdańsk
1. Street green areas 2. The amount of funding for the replacement of furnaces 3. Subsidies for heating replacement 4. Clean air campaigns 5. Co-financing for renewable energy 6. Number of smog alerts		

Source: own work based on (Piznal et. al., 2021)

The next analyzed aspects will refer to development factors and threats in the development of intelligent mobility in Poznań and Gdańsk. The results were developed based on focus group interviews with experts.

A total of 40 deliberate selected experts took part in the study. The largest percentage of experts (40%) were employed in small organizations (employing from 10 to 49 employees). Then experts employed in large enterprises (employing at least 249 people), as well as in medium-sized enterprises (employing from 50 to 249 employees) - both 22.5%. The remaining 15% were experts employed in micro-enterprises (employing up to 10 employees) – figure 1.

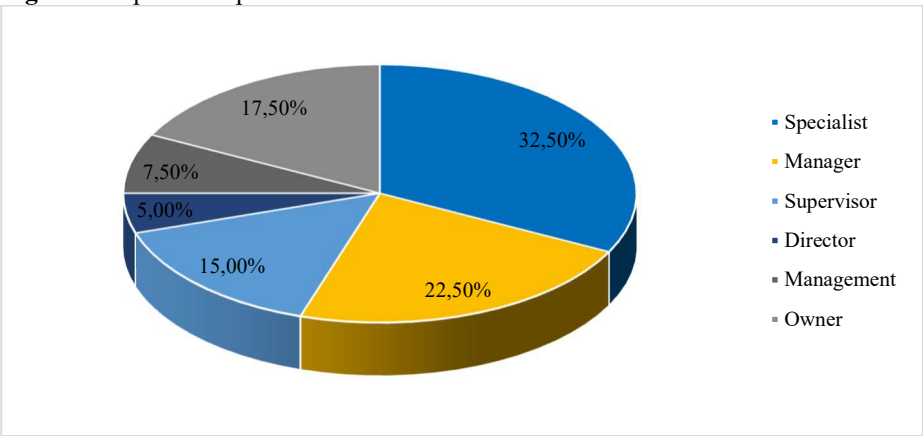
Figure 1 The size of the company employing the expert



Source: own work

The largest percentage of experts (32.50%) were employed as specialists, 22.50 as managers, 17.50% as owners, 15% as supervisors, 7.50% as management and 5% as directors (figure 2).

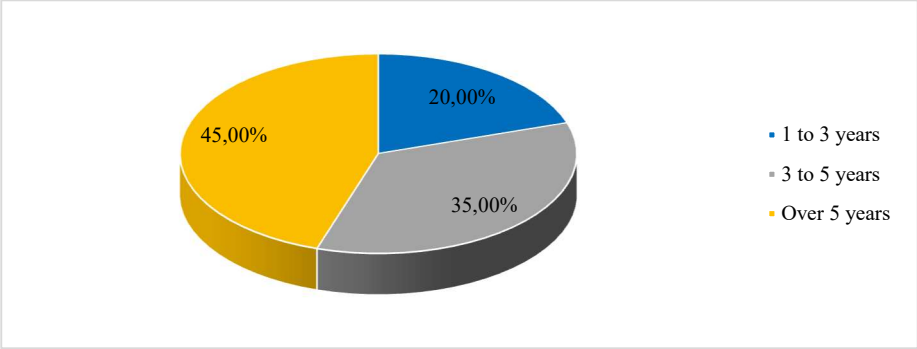
Figure 2 Expert workplace



Source: own work

Referring to the professional experience of experts in the current position, the largest part of experts (45%) were employed for over 5 years, 35% for 3 to 5 years, and 20% for 1 to 3 years (figure 3).

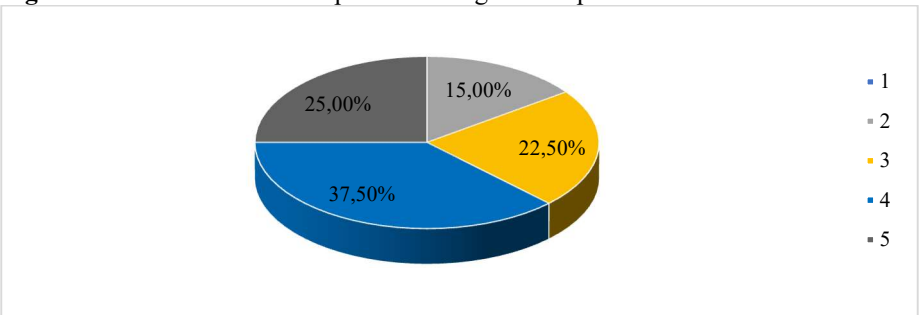
Figure 3 Professional experience in the last position in years



Source: own work

Experts also assessed their own knowledge and experience on a scale of 1 to 5 (where 1 means a low level of knowledge and experience, and 5 a high level of both knowledge and experience). Most largest part of experts (37.50%) made a self-assessment at level 4, 25% at level 5, 22.50% at level 3, and the remaining 15% at level 2. There was no answer regarding the level 1 assessment. The average grade was 3.73 and the median was 4 (figure 4).

Figure 4 Self-assessment of expert knowledge and experience



Source: own work

With regard to the development factors of intelligent mobility, experts indicated the role of individual factors both from the proposed list and based on their own indications. Scales from 1 to 5 were adopted, where 1 meant the factor was of little importance and 5 was very important (no answer meant no importance). For each of the factors (sorted into categories: sociological, technological, economic, ecological and political), the arithmetic mean and median were calculated for both cities.

In the sociological sphere, both places receive similar assessments of individual factors. In both cities, improving safety and quality of life as well as improving mobility solutions received the highest scores. Also in the technology category, Poznań and Gdańsk also received similar ratings. The highest rated development factors were new technologies and the development of ICT. In turn, factors in the ecological sphere received similar ratings. Both towns should focus on reducing the number of vehicles, lower energy consumption and reducing water and air pollution. In Gdańsk, the factor of reducing energy consumption is also important. Moreover, similar assessments were obtained also with regard to economic factors. In both cities, the development of small and medium-sized high-technology enterprises and the reduction of costs related to pollution disposal are important. In the last group - political factors, similar assessments were also obtained. Important development factors include motivating increased financing for technology development and developing a coherent strategy for the development of intelligent mobility (table 3).

Table 3 Assessment of development factors of intelligent mobility in Poznań and Gdańsk

Factors	Poznań		Gdańsk	
	Average	Median	Average	Median
Sociological				
improving mobility solutions	4,21	4	4,23	4
improving safety and quality of life	4,28	5	4,45	5
social interest in solutions known from larger or more developed urban centers	3,83	4	4,03	4
lifestyle	3,68	4	3,84	4

Factors	Poznań		Gdańsk	
	Average	**Median**	**Average**	**Median**
education level and health awareness	3,60	4	3,71	4
demographic trends	3,28	3	3,42	4
promoting a healthy lifestyle	3,68	4	3,87	4
promoting an ecological lifestyle	4,05	4	4,10	4
Technological				
new technologies	4,45	5	4,48	5
ICT development	4,20	4	4,29	4
market niche related to "green technologies"	3,68	4	3,97	4
patents, inventions and intellectual property protection	3,40	3,5	3,65	4
level of digital competences in society	3,48	4	3,74	4
growing acceptance and interest in modern solutions in the field of city bike and scooter systems	3,68	4	3,97	4
growing acceptance and interest in car sharing systems	3,70	4	3,97	4
implementation of multimodal integration systems for passenger traffic and goods transport	3,88	4	4,10	4
renewable energy technologies	3,80	4	3,84	4
Ecological (environmental)				
reducing the number of vehicles	3,88	4	3,94	4
lower energy consumption	4,13	5	4,50	5
reducing water and air pollution	4,15	4	4,45	5
technologies that do not use or process harmful substances (e.g. synthetic fuels)	4,08	4	4,26	4
implementation of the circular economy concept	4,05	4	4,19	4
Economical				
development of (small and medium-sized) high-technology enterprises	3,68	4	3,68	4
reduction of costs related to waste disposal	3,90	4	4,00	4
reducing traffic intensity	3,88	4	3,97	4
reducing the shortage of parking spaces	3,75	4	3,77	4
reducing the number of accidents and the costs of treating the injured	3,78	4	3,90	4

Factors	Poznań		Gdańsk	
	Average	Median	Average	Median
availability of funds for the development of environmentally friendly technologies	3,80	4	4,03	4
growing rate of implementation and commercialization of innovative technologies	3,53	4	3,71	4
market size	2,95	3	2,97	3
increasing the reuse rate of resources and raw materials	3,75	4	3,87	4
Political				
increasing financing for technology development	4,28	4	4,26	4
developing a coherent strategy for the development of intelligent mobility (indicating priority directions of development) and European guidelines	3,63	4	3,68	4
national scientific and research base	3,55	3	3,65	4

Source: own work

With regard to the threats to the development of intelligent mobility, experts indicated the role of individual factors both from the proposed list and based on their own recommendations. Scales from 1 to 5 were adopted, where 1 meant the factor was of little importance and 5 was very important (no answer meant no importance). For each of the factors (sorted into categories: sociological, technological, economic, ecological and political), the arithmetic mean and median were calculated for both cities.

Regarding development threats of a sociological nature, individual factors received similar ratings in both cities. The residents' fears about changing the scope of transport solutions used, such as giving up private transport, were rated the highest. Poznań has a slightly higher result in the absence of qualified staff, which may suggest a greater challenge related to acquiring specialists to work on the development of smart mobility. In the technological sphere, factors also received similar ratings, especially in terms of high technology competition in the international market and the low technical base of technical universities. In the case of the group of ecological factors, the potential increase in environmental risk and increase in energy consumption related to new needs was rated highly in both cities. In Gdańsk, the generation of harmful waste during the operation of devices was also highly rated. In turn, in the case of economic factors, in both cities the costs of changes in the city's architecture, the costs of new communication solutions and the costs of developing the city bike system were highly rated. In the last, political sphere, both cities received similar ratings in the case of difficulties in financing research in the field of smart

mobility and the lack of units supporting scientists in obtaining/financing patents (table 4).

Table 4 Assessment of development threats of intelligent mobility in Poznań and Gdańsk

Factors	Poznań		Gdańsk	
	Average	**Median**	**Average**	**Median**
Sociological				
fear of changing the scope of transport solutions used (resignation from private transport)	3,65	4	3,77	4
lack of qualified staff (programmers, architects, planners)	3,58	3,5	3,45	3
lack of social trust in modern transport solutions	3,43	3	3,55	3
Technological				
competition of high technologies on the international market (pressure on the costs of the solutions used, low profitability and low scalability of solutions and applications offered by local entrepreneurs)	3,75	4	3,84	4
low technical base/condition of technical universities	3,56	4	3,68	4
lack of readiness to implement "green technologies"	3,45	3,5	3,39	3
Ecological (environmental)				
potentially increasing environmental risk by introducing an unknown solution	3,83	4	3,90	4
increase in energy consumption related to new needs	3,85	4	3,94	4
generation of harmful waste during operation of devices (e.g. electric vehicles)	4,30	5	4,45	5
Economical				
costs of changes in the city's architecture	4,05	4	4,16	4
costs of new communication solutions, new investments, purchase of new vehicles	4,10	4	4,19	4
costs of developing the city bike system	3,20	3,5	3,26	4
cost of experts (smart mobility issues) and programmers	3,65	4	3,77	4

Factors	Poznań		Gdańsk	
	Average	Median	Average	Median
low rate of implementation and commercialization of innovative technologies	3,28	3	3,32	3
Political				
difficulties in financing research in the field of smart mobility	4,07	4	4,29	4
lack of incentives to launch large-scale commercial enterprises, "know-how" contribution	3,33	3	3,45	3
lack of units supporting scientists in obtaining/financing patents	3,45	3	3,58	4
lack of legal regulations allowing for quick implementation of the technology	3,50	4	3,52	4

Source: own work

6. DISCUSSION

It should be noted that both cities - Poznań and Gdańsk take actions and initiatives that are aimed at the development of smart mobility, and there are analyzes in this area in the literature on the subject.

As pointed out by Czupich et al. (2016), the development factors for the implementation of smart mobility in Poland include the creation of transfer hubs, reconstruction of the communication framework, introduction of intelligent street traffic control, and increased interest in sustainable development; reducing energy consumption and CO2 emissions; organizing urban transport more effectively. However, the barriers mentioned by the authors include: a difficult financial situation caused mainly by investment activity in cities in recent years, and the term of office of the authorities, which may negatively affect the continuation of the strategy chosen by the predecessors.

Sikora-Fernandez (2019), in turn, points to slightly different threats to the implementation of the smart city concept (including aspects of smart mobility). This concerns a specific division of decision-making in the selection, location and financing of urban investments. While urban matters are mainly decided by the cities themselves (local level), the decision on spending EU funds is made by marshal offices (regional level). Moreover, investment decisions that are key for the needs of the entire country (e.g. main power lines, transport lines, related to public safety), even if they concern individual urban areas, are undertaken at the central level, and their location often depends on the voting power and importance of the parliamentarian representing a given region. In addition, cities implement selected initiatives selectively, to the extent that overlaps with the smart city concept (especially in areas such as energy, intelligent transport system, e.g. -administration), however, these are

investments involving the so-called single shots, not integrated projects covering the entire city.

Ratti and Townsend (2011) point to innovative technologies that enable fast, unlimited data transfer, availability of databases, creation of effective and easily programmable infrastructure and an expanded network of sensors and controllers as the development factor of smart mobility. The main opportunity in this approach is to improve the quality of services provided to city users and to save money, time and energy from the point of view of the city's operation.

On the other hand, it can be pointed out that there is a need for cooperation between many stakeholders and entities within the city's activities in the context of the effective implementation of smart urban mobility. As Kauf (2016) points out, such intelligent technologies as e.g. intelligent traffic control, modular containers, to improve utilization of vehicle capacity, and alternative means of transport. This helps to reduce the load on the road infrastructure, thus improving the quality of the environment and life in the city. The main trend in sustainable city logistics is cooperation between suppliers, customers and the public administration. Implementation of intelligent logistics requires developing of new business models, enabling to generate benefits not only for the city, but also its operating entities.

7. CONCLUSION

The article discusses the issue of smart mobility, which is a key element of the future of urban transport and is a response to the challenges related to city development and mobility.

The cities of Poznań and Gdańsk were selected for a comparative analysis of smart mobility solutions. Although these centers differ geographically, they have a similar population and urban area, which makes them suitable centers for research on smart city solutions. In addition, both cities actively participate in the Intelligent Cities Challenge, clearly indicating their commitment to developing and implementing innovative mobility technologies and solutions.

In the context of transport infrastructure, Poznań is distinguished by a much greater length of public roads and a more extensive public transport network, including both buses and trams. Also having a larger fleet of public transport vehicles. Poznań transports more passengers in public transport. Gdańsk achieved better results only in terms of bicycle infrastructure.

The analysis of the level of development of smart urban mobility (at the national level), based on the Ranking of Electromobile Cities, showed that Poznań ranks higher than Gdańsk in four of the five analyzed categories: electric transport, bicycle transport, facilities for electromobility and clean air. In terms of public transport, both cities are at the same level.

Based on the expert research conducted, it can be indicated that both cities are characterized by similar development factors. In both urban centers, in the context of the development of smart mobility, there should be a focus on introducing new technologies, promoting an ecological and healthy lifestyle and developing sustainable mobility infrastructure. In turn, with regard to threats, similarities were

found in both towns, such as residents' concerns about changes in the scope of transport solutions used, such as giving up private transport, costs of changes in the city's architecture, or costs of new communication solutions.

To sum up, the comparative analysis indicates that Poznań and Gdańsk are taking active steps towards the development of smart mobility solutions, although they differ slightly in terms of transport infrastructure and achievements in individual categories. Both cities have the potential for further development in the field of urban mobility, which could bring benefits to both residents and the natural environment.

The limitations of the study are related to its qualitative nature - carried out based on focused group interviews. Further detailed analyzes relating to aspects of sustainable transport, greening of transport, and assessment of changes over time should be based on quantitative research. Moreover, as part of future research, residents should be involved in the assessment of smart mobility changes and, preferably, such research should be carried out on a representative sample.

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