THE OPTIMIZATION METHODS IN SUPPLY CHAIN MANAGEMENT – A BIBLIOMETRIC ANALYSIS

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Abstract

To find the most relevant articles applying optimization methods in supply chain management, the Web of Science Core Collection database was searched. 465 papers matching the search query were found. After excluding papers that were not articles and articles that were not in English, 359 articles remained, which were further evaluated using the following bibliometric analyses: Co-authorship analysis (Unit of analysis: Authors and Countries), Citation analysis (Unit of analysis: Documents, Sources and Authors), Co-occurrence analysis (Unit of analysis: Authors keywords). The graphical bibliometric overview was created using the Visualization of Similarities - VoSviewer program. The paper contributes to the understanding of the literature in which optimization methods in supply chain management are applied by showing the main articles, authors, journals, countries where the main articles come from, and the keywords used by the authors when writing the researched articles. To find relevant literature, it is possible to extend the search to the Scopus database and apply the above to future searches. It is also possible to perform other bibliometric analyses in future searches.

Keywords: optimization methods, supply chain management, bibliometric analysis

1. INTRODUCTION

In today's world, a growing population, consumption, and competition in the global marketplace are leading to a reduction in natural resources and an increasing strain on the environment. Current resource use practices are therefore unsustainable. Manufacturing companies need to focus not only on cost-efficient and profitable operations but also on environmentally friendly and sustainable production at the same time to increase their competitiveness. New innovative technologies are needed to improve the efficiency of processes and the optimization of global supply chains (GSC) to achieve sustainability in environmental, social and economic terms (Kovacs & Illes, 2019). Optimizing strategic and tactical decisions related to sustainability and resilience are important because they affect supply chain performance over time

(Saffari, 2023). The supply chain is a complex network from supplier to customer that includes people, technologies, activities, information and resources. Its design and management aim to achieve the best global performance under union operating criteria. A typical supply chain consists of different levels, it is composed of the following elements: Suppliers, manufacturing plants, warehouses, distribution centres (DCs), and customers/final markets (Mastrocinque et al., 2013). Integrating the various processes and actors that make up the supply chain (SC) is essential for better coordination (Roldan, 2017). Vertical and horizontal supply chain collaboration is widespread and has been identified as one of the most important issues for improving competitiveness. However, the implementation of supply chain collaboration faces many obstacles, such as the nature, scope and security of information sharing, equality in benefit sharing, joint decision-making, coordination tasks, etc.

Optimizing a supply chain is the optimal choice of resources to fulfil an objective function. Supply chain models based on the realization of a single objective function usually aim at minimizing total cost. However, supply chain modelling usually involves the realization of multiple objective functions. Some examples of objective functions that can be achieved through supply chain modelling are: Minimizing inventory, maximizing service levels, minimizing delivery times, maximizing environmental impact, etc. Sometimes achieving one desired objective function conflicts with achieving another desired objective function. For example, increasing the level of service companies want to provide to your customers usually increases costs. It is necessary to find a solution that satisfies the conflicting objectives. Thus, in optimization problems with multiple objective functions, one cannot speak of an optimal solution, a dominant solution, i.e., there is no solution in which the improvement of one objective function would not lead to a deterioration of at least one of the other objective functions. A solution that satisfies conflicting objectives is a compromise solution and is called a Pareto-optimal solution (Mastrocinque et al., 2013).

The study aimed to find out in which articles optimization models are used in supply chain management and to answer the following research questions:

RQ1: How many articles have been published over the years that match the researched query, and what is the citation rate of the articles? To test RQ1, the data of all articles and the citation report were downloaded from the Web of Science database;

RQ2: What are the most productive countries in terms of the number of published articles from the studied field, and what is the distribution of the countries in terms of the citation of the articles? To test RQ2, Co-authorship analysis (Unit of analysis: Countries) and Citation analysis (Unit of analysis: Countries) were performed;

RQ3: In which journals are the studied articles mainly published? To test RQ3, a Citation analysis (Unit of analysis: Sources) was performed;

RQ4: Who are the main authors in the studied field in terms of number of published articles and citations? To test RQ4, Co-authorship analysis (Unit of analysis: Authors) and Citation analysis (Unit of analysis: Authors) were performed;

RQ5: What are the most cited articles in the research area? To test RQ5, a Citation analysis (Unit of analysis: Documents) was performed;

RQ6: What keywords did the authors use when writing the research articles and how frequently do they occur? To test RQ6, a Co-occurrence analysis (Unit of analysis: Authors keywords) was performed.

The paper consists of five chapters. The introduction is followed by a chapter that gives an overview of previous research and presents some applications of optimization methods in the supply chain. Chapters 3 and 4 refer to the research part of the paper - data description and methodology were performed and the results of the bibliometric analysis were presented. The last chapter contains the main results and conclusions, as well as recommendations for future research.

2. LITERATURE REVIEW – APPLICATION OF OPTIMIZATION METHODS IN SUPPLY CHAIN MANAGEMENT

Azizi et al. (2021) aimed to design a sustainable agile retail chain. They presented a mathematical model with five objectives: (1) "minimise costs," (2) "minimise unsatisfied demand," (3) "maximise the quality of goods supplied by suppliers," (4) "maximise social responsibility or social benefit," and (5) "minimise environmental impact." Since the model contained multiple objectives, multi-objective optimization methods were used. The model was solved using three algorithms (NSGA-II, PESA and SPEA-II) run in MATLAB software. The results showed that the SPEA-II algorithm gave the best results.

A study by Saffari et al. (2023) proposes a model for a resilient, sustainable, and responsive forward/backward logistics network that considers multiple objectives, including cost, social responsibility, CO2 emissions, water consumption, response time, and cooperation risk. Key cost impacts were identified using an experimental design, and operational risk was managed by applying a robust optimization method. Analysis of data from the iron and steel sector demonstrated the value of resilience measures and the further development of metrics for cost, sustainability, and responsiveness.

To improve and maintain corporate competitiveness in a changing market environment and global competition, new supply chain paradigms are emerging. The goal of Kovacs' (2017) article was to optimize the virtual enterprise network formed by the members of the Agile supply chain - production companies, service providers, and customers. In this way, they can react flexibly and quickly to changes in customer requirements. The optimization method, the objective function for which total cost and lead time were used, and the design constraints were elaborated. Software was developed that can be used to optimize networks at both the micro- and macro-regional levels.

To improve production efficiency and capacity utilization in production companies, supply chain production scheduling is essential. The article by Liao & Lin (2019) presents a job store supply chain scheduling optimization method based on particle swarm optimization (PSO). A simulation system to solve production scheduling problems was also developed. The mentioned system is based on an intelligent algorithm and Microsoft SQL Server platform. Problems of non-

convergence in production scheduling can be effectively overcome by PSO and quickly find out how to execute the job schedule optimally.

Kappelman and Sinha (2021) identify a dynamic food supply chain with numerous interconnected phases. The selection of suppliers and the determination of their process parameters must be decided at each step. At the step level, they make the following assumptions: (1) the quality of the goods is stochastic and (2) the quality is at a minimum acceptable level, otherwise they are rejected. They present a comprehensive strategy and use Big Data mining techniques to track how actions affect the quality of the final product and to determine the state transition matrix. In determining the best strategy, preferred suppliers and settings for their process parameters are established. The objective of the proposed strategy is to minimize the amount of product returned and maximize the expected profit of the supply chain.

The problem of blood transhipment and allocation has taken on a new dimension in the context of the COVID-19 outbreak. It involves a two-stage, interregional, multimodal transport system. Zhou et al (2023) present a new multi-criteria model for blood allocation in a two-stage transhipment system. They examine the following criteria: (1) maximizing the quality of transshipped blood, (2) satisfying the demand for blood, and (3) total cost (including the penalty for shortages). They proposed an improved integer-coded hybrid multi-objective whale optimization algorithm (MOWOA) with greedy principles to solve the model, which outperforms single-stage optimization approaches for all objectives.

The automotive industry is one of the most important industries in the world due to its economic importance and technological complexity. Supply chain efficiency can have a major impact on the automotive sector. In order to optimize performance, several objectives are pursued, often in conflict with each other. The trade-off between price and service level is modelled in Masoud & Masons (2016) in a heuristic optimization methodology for a two-stage integrated automotive supply chain. They simultaneously increase the proportion of external parts per customer and minimize the total cost of setup, inventory, and transportation.

To ensure survival and competitiveness due to facing strong competition, increasingly strict regulations on products and environmental regulations, but also lower profit margins, oil refiners are increasingly turning to optimization approaches. The article by Khor & Varvarezo (2017) provides an integrated overview of optimization methods ranging from traditional planning through linear programming to supply chain and outside-the-fence considerations. It also provides a review of the literature addressing the above topic.

3. DATA DESCRIPTION AND METHODOLOGY

Since the purpose was to investigate which papers use optimization methods in supply chain management, a query was entered into the Web of Science Core Collection database search engine: "optimization* method*" and "supply chain*". The search was conducted in July 2023. Based on the keywords entered in the search query, 465 papers were found. Regarding the type of work, 361 articles, 88 proceeding papers, 30 review articles, 18 early access, 8 book chapters, and 1 editorial material

were found. Only articles were selected for further analysis - 361 articles. For the next filter, the language in which the article was written was used. Of the 361 articles, 1 article was in German, one was in Spanish, and 359 articles were in English. Only English-language articles remained for further analysis - 359 articles.

In 2020, CoreVian introduced the "Citation Topics" analysis function in Incites, which uses Leiden University's clustering algorithm to identify topics in the direct citation network of SCI and SSCI papers, and constructs a composite topic classification framework system, which can for users to search, identify and analyze topics at three levels: macro, meso and micro. This topic classification system assigns each paper to a single research topic, providing researchers with a stable and reliable way to identify topics (Li, 2021). In Table 1 it is possible to see how many researched papers are available on which topic at the meso level.

Table 1 Classification of articles by Citation Topics Meso

Citation Topics Meso	**Number of articles**	**Citation Topics Meso**	**Number of articles**
Supply Chain & Logistics	251	Herbicides, Pesticides & Ground Poisoning	1
Design & Manufacturing	15	Bioengineering	1
Artificial Intelligence & Machine Learning	9	Food Science & Technology	1
Sustainability Science	7	Security, Encryption & Encoding	1
Management	6	Automation & Control Systems	1
Paper & Wood Materials Science	4	Knowledge Engineering & Representation	1
Security Systems	4	Space Sciences	1
Distributed & Real Time Computing	4	Economic Theory	1
Forestry	3	Climate Change	1
Telecommunications	3	Political Science	1
Power Systems & Electric Vehicles	3	Risk Assessment	1
Transportation	3	Geotechnical Engineering	1
Testing & Maintenance	3	Energy & Fuels	1
Data Structures, Algorithms & Complexity	2	Combustion	1
Safety & Maintenance	2	Friction & Vibration	1
Comvergence & Optimization	2	Mechanics	1
Nursing	1	Thermodynamics	1

Blood Clotting	1	Sensors & Tomography	1
Nanofibers, Scaffolds & Fabrication	1	Functional Analysis	1
Catalysts	1	Articles that do not contain data in the field being analyzed	15

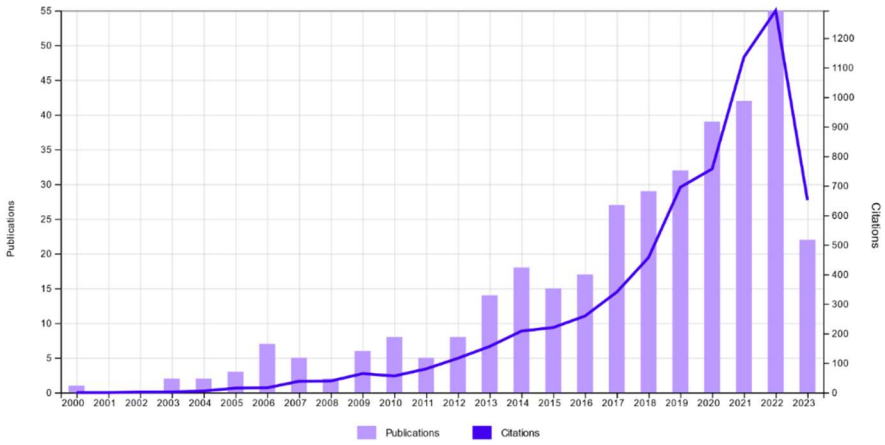
Source: Author, 2023

Table 1 shows that with regard to Citation Topics Meso, as many as 70% of the articles were published in Supply Chain & Logistics.

The search results were stored in RIS and plain text format and contained all essential information such as the title of the paper, authors' names and affiliations, journal, year of publication, abstract, keywords, and references (Fahimnia et al., 2015). The RIS data were imported into Mendeley Reference Manager to facilitate access to all searched papers. Data collected in plain text format were used in VOSviewer for bibliometric analysis (Van Eck & Waltman, 2021).

Figure 1 shows how the number of published articles that are the subject of research and the number of citations of those articles have evolved over the years. It can be seen that the oldest article was published in 2000. It is the paper Auction-theoretical coordination of production planning in the supply chain by Ertogral & Wu. It can also be seen that there is a continuity in the publication of articles from 2000 to 2023. Up to 8 articles were published annually until 2012. From 2013 to 2016, 14 to 18 articles were published annually. After 2017, the number of articles per year increased. The most articles were published in 2022 - 59 articles. By July 2023, 26 articles were published. Figure 1 also shows that the number of citations of articles moves in line with the number of articles published. There were the most citations in 2022 - 1,292 citations. In July 2023, there were 654 citations.

Figure 1 Number of published articles and their citations over the years

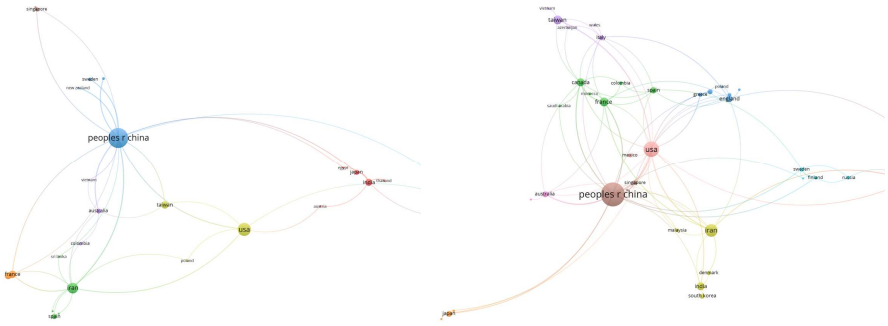


Source: Author, 2023

4. EMPIRICAL RESEARCH AND RESULTS

The articles studied were written by authors from 54 countries. Looking at the size of the circle in Figure 2, it is possible to notice that the order of the most important countries by the number of published articles and citations is the same. In terms of research area, the most significant is the Republic of China, whose author has published 140 articles that have been cited 2,125 times. The United States ranks second (60 articles, 1,616 citations) and Iran ranks third (39 articles, 877 citations). Taiwan ranks fourth by number of articles published but 15th by number of citations. France ranks fifth by number of articles published (19 articles) and fourth by number of citations (431 citations). Canada and India follow by number of articles (17 articles), but also share ninth place by number of citations (289 citations). Germany is in eighth place by the number of articles published (14), but also by the number of citations (312).

Figure 2 The most important countries according to the number of published articles and citations



Source: Author, 2023

The journal Computers and Industrial Engineering (impact factor: 7.180) published the most articles that are the subject of the analysis - 20 articles. In terms of the number of citations of articles published in the mentioned journal (306), the journal ranks 4th. In terms of the International Journal of Production Economics (Impact Factor: 11.251) and the Journal of Cleaner Production (Impact Factor: 11.072) rank second with 12 articles. With 562 citations, the International Journal of Production Economics ranks first by the number of citations, while the Journal of Cleaner Production ranks third with 369 citations. In second place by a number of citations is the journal Computers and Chemical Engineering (Impact Factor: 4.130) with 408 citations. For more journals in terms of number of articles published and number of citations, see Table 2.

Table 2 Journals by number of published articles and citations

Journal	Impact (2022-2023) (Accelerator, 2023)	Articles	Citations
Computers and Industrial Engineering	7.180	20	306
International Journal of Production Economics	11.251	12	562
Journal of Cleaner Production	11.072	12	369
Sustainability	3.889	9	63
Computers and Chemical Engineering	4.130	8	408
Optimization Methods and Software	1.832	8	44
Applied Mathematical Modelling	5.336	7	259
Expert Systems with Applications	8.665	6	151
International Journal of Production Research	9.018	5	199
Journal of Intelligent Manufacturing	7.136	5	136
Mathematical Problems in Engineering	1.430	5	19
Advanced Engineering Informatics	7.862	4	254
Annals of Operations Research	4.820	4	33
Computers and Operations Research	5.159	4	265
European Journal of Operational Research	6.363	4	99
IEEE Access	3.476	4	28
IEEE Transactions on Automation Science and Engineering	6.636	4	58
International Journal of Advanced Manufacturing Technology	3.563	4	55
International Transactions in Operational Research	3.610	4	22
Wireless Communications and Mobile Computing	2.146	4	8

Source: Author, 2023

The most prolific author is Liu, Y., who published 12 articles that are the subject of the analysis. The mentioned author is also on the list of the most cited authors with 164 citations. With 5 published articles, authors Chiu, Yuan-Shyi P. and You, F. are in the next place. Author You, F. is also on the list of most cited authors with 219 citations. Authors who have published 4 or 3 articles that are the subject of the analysis can be seen in Table 3.

Table 3 Authors by number of articles and citations

Authors	Articles	Citations	Authors	Articles	Citations
Liu, Yankui	12	164	He, Junliang	4	309
Chiu, Yuan-Shyi Peter	5	14	Del Ser, Javier	1	260
You, Fengqi	5	219	Diez-Olivan, Alberto	1	260
Chen, Yanju	4	40	Galar, Diego	1	260
Duan, Jianguo	4	30	Sierra, Basilio	1	260
Feng, Cuiying	4	29	Yan, Wei	3	247
He, Junliang	4	309	Ahmadi-Javid, Amir	1	240
Yang, Guoqing	4	54	Seyedi, Pardis	1	240
Zhang, Yingfeng	4	164	Syam, Siddhartha S.	1	240
Brouer, Berit Dangaard	3	62	You, Fengqi	5	219
Chiu, Singa Wang	3	11	Grossmann, Ignacio E.	2	165
Dekker, Rommert	3	80	Liu, Yankui	12	164
Huang, George Q.	3	63	Zhang, Yingfeng	4	164
Huang, Youfang	3	143	Rentizelas, A. A.	1	153
Jolai, Fariborz	3	44	Tatsiopoulos, I. P.	1	153
Karsten, Christian Vad	3	62	Tolis, A.	1	153
Kovacs, Gyorgy	3	13	Huang, Youfang	3	143
Ma, Yanfang	3	22	De Vos, Martijn	1	123
Pardalos, Panos M.	3	15	Epema, Dick	1	123
Pei, Jun	3	15	Esmat, Ayman	1	123
Pisinger, David	3	62	Ghiassi-Farrokhfal, Yashar	1	123

Rezg, Nidhal	3	94	Palensky, Peter	1	123
Turki, Sadok	3	106	Chan, Fts	2	121
Yan, Wei	3	247	Chung, Sh	2	121
Zhong, Ray Y.	3	88	Hahn, G. J.	2	121
			Kuhn, H.	2	121

Source: Author, 2023

In first place by number of citations of published articles is author He, J. with 309 citations for 4 published articles. Authors Diez-Olivan, A., del Ser, J., Galar, D., & Sierra, B. authored the most cited paper in this analysis "Data fusion and machine learning for industrial prognosis: Trends and perspectives towards Industry 4.0", published in the journal Information Fusion (Impact Factor: 17.564). With the mentioned paper, they ranked second among the most cited authors with 260 citations. Author Yan, W. achieved 247 citations for the three articles analysed. Authors Ahmadi-Javid, A., Seyedi, P., & Syam, S.S. authored the second most cited article in this analysis, "A survey of healthcare facility location", published in the journal Computers and Operations Research (Impact Factor: 5.159). This article earned them third place among the most cited authors with 240 citations. Concerning the number of citations (219), the next is author You, F., who is listed as the most prolific author with 5 published articles that are the subject of the analysis. Other most cited articles can be seen in Table 4.

Table 4 The most cited articles

Year	Author	Title	Source	Impact factor	Citations
2019	Diez-Olivan, A., del Ser, J., Galar, D., & Sierra, B.	Data fusion and machine learning for industrial prognosis: Trends and perspectives towards Industry 4.0.	Information Fusion	17.564	260
2017	Ahmadi-Javid, A., Seyedi, P., & Syam, S. S.	A survey of healthcare facility location	Computers and Operations Research	5.159	240
2009	Rentizelas, A. A., Tatsiopoulos, I. P., & Tolis, A.	An optimization model for multi-biomass tri-generation energy supply	Biomass and Bioenergy	5.774	153

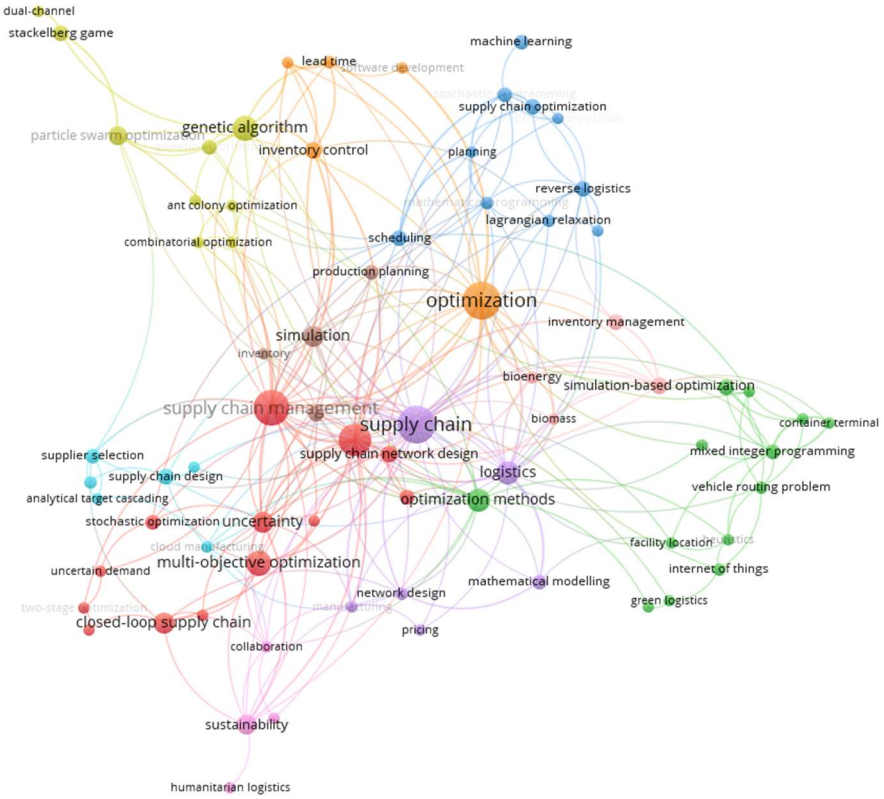
2012	Grossmann, I. E.	Advances in mathematical programming models for enterprise-wide optimization	Computers & Chemical Engineering	4.130	139
2021	Esmat, A., de Vos, M., Ghiassi-Farrokhfal, Y., Palensky, P., & Epema, D.	A novel decentralized platform for peer-to-peer energy trading market with blockchain technology	Applied Energy	11.446	123
2015	He, J. L., Huang, Y. F., & Yan, W.	Pharmaceutical Supply Yard crane scheduling in a container terminal for the trade-off between efficiency and energy consumption	Advanced Engineering Informatics	7.862	112
2000	Ertogral, K., & Wu, S. D.	Auction-theoretic coordination of production planning in the supply chain	IISE Transactions	3.425	99
2005	Ding, H. W., Benyoucef, L., & Xie, X. L. (	A simulation optimization methodology for supplier selection problem	International Journal of Computer Integrated Manufacturing	4.420	96
2012	Hahn, G. J., & Kuhn, H.	Coordinating Investment, Production, and Subcontracting	Decision Support Systems	6.969	95

Source: Author, 2023

In creating 359 researched articles, the authors used 1,250 keywords. The most frequently used keyword is "supply chain" with 33 repetitions. Right behind is "optimization," which was used 32 times as a keyword in the researched articles. The

keyword "supply chain management" was used just as frequently, with 30 repetitions. In terms of the number of repetitions, the keywords "robust optimization" (24), genetic algorithm and multi-objective optimization (both keywords with 15 repetitions), logistics and optimization methods (with 13 repetitions each) and 10 repetitions for the following keywords: "closed-loop supply chain", "simulation" and "uncertainty". To obtain an optimal keyword network, Figure 3 shows the keywords that occur at least three times.

Figure 3 Keywords with at least three repetitions



Source: Author, 2023

74 keywords met the threshold. The keywords are divided into 10 clusters. Table 5 shows the distribution of keywords by clusters.

Table 5 Classification of keywords into clusters

Cluster	Keywords
Cluster 1 (red) 13 items	Closed-loop supply chain, distributionally robust optimization, fuzzy optimization, multi-objective optimization, risk management, robust optimization, stochastic optimization, supply chain management, supply chain network design (scnd), sustainable supply chain management, two-stage optimization, uncertain demand, uncertainty
Cluster 2 (green) 13 items	Container terminal, energy consumption, facility location, gis, green logistics, heuristics, hybrid algorithm, internet of things, mixed integer programming, operations research, optimization methods, simulation optimization, vehicle routing problem
Cluster 3 (blue) 10 items	Benders decomposition, carbon emissions, lagrangian relaxation, machine learning, mathematical programming, planning, reverse logistics, scheduling, stohastic programming, supply chain optimization
Cluster 4 (gelb) 9 items	Ant colony optimization, combinatorial optimization, differential evolution, dual-channel, genetic algorithm, particle swarm optimization (pso), simulated annealing, stackelberg game
Cluster 5 (purple) 6 items	Logistics, manufacturing, mathematical modelling, network design, pricing, supply chain
Cluster 6 (turquoise) 6 items	Analytical target cascading, cloud manufacturing, location-allocation, supplier selection, supply chain configuration, supply chain design
Cluster 7 (orange) – 5 items	Inventory control, inventory optimization, lead time, optimization, software development
Cluster 8 (brown) – 4 items	Inventory, production, production planning, simulation
Cluster 9 (pink) 4 items	Collaboration, humanitarian logistics, resilience, sustainability
Cluster 10 (light brown) 4 items	Bioenergy, biomass, inventory managment, simulation-based optimization method

Source: Author, 2023

In Figure 3, but also in Table 5, it can be seen that the largest clusters form around the words "supply chain management" and "optimization methods" (both with 13 keywords). The keyword "supply chain management" is in the red cluster (Cluster 1, as indicated in Table 5). It may appear in the researched articles together with some other red-coloured keywords, e.g..: "multi-objective optimization", "supply chain network design (scnd)". Other keywords it may occur with are listed in Table 5. The

keyword "optimization methods" is located in the green cluster (Cluster 2, see Table 5). It may occur in researched articles along with some of the other green-coloured keywords, for example: "facility location", "mixed integer programming", "vehicle routing problem". Other keywords it may occur with are also listed in Table 5. above can be done for all other keywords as well.

As can be seen in Figure 3, but also in Table 5, the second keyword of the search query "supply chain" is colored purple. It may appear in several researched articles along with one of the other purple colored keywords, for example: logistics, mathematical modeling. Other keywords it may occur with can be found in Table 5. If it is a purple cluster, you can tell it is Cluster 5.

5. CONCLUSION

To investigate papers that use optimization methods in supply chain management, a review of papers found in the Web of Science Core Collection database was conducted. The search was conducted in July 2023 and resulted in 465 articles. After excluding from the search all papers that were not articles and articles that were not in English, 359 articles remained for further analysis. As for the Citation Topics Meso, 70% of the articles were published in Supply Chain & Logistics. *RQ1*: The oldest published article corresponding to the query under study was published in 2000, and a continuity in article publication has been observed since then. The most articles were published in 2022 - 59 articles. The number of citations of articles moves in line with the number of articles published. There were the most citations in 2022 - 1,292 citations. *RQ2*: The articles that are the subject of the analysis were written by authors from 54 countries. The order of the most important countries is the same according to the number of published works and citations. The most important country is the Republic of China with 140 published articles and 2,125 citations. *RQ3*: The journal Computers and Industrial Engineering (Impact Factor: 7.180) published the most articles subjected to analysis-20 articles. With 562 citations, the International Journal of Production Economics ranks first in terms of number of citations. *RQ4*: The most prolific author is Liu, Y., who published 12 articles that are the subject of analysis. In the first place, in terms of the number of citations of published works, is the author He, J. with 309 citations for 4 published articles. *RQ5*: The most cited article in this analysis, with 260 citations, is Data Fusion and Machine Learning for Industrial Prognosis: Trends and perspectives toward Industry 4.0. published in the journal Information Fusion (Impact Factor: 17.564). *RQ6*: In creating 359 researched articles, the authors used 1,250 keywords. The most frequently used keyword is "supply chain" with 33 repetitions. Right behind is "optimization," which was used 32 times as a keyword in the researched articles. The keyword "supply chain management" was used just as frequently, with 30 repetitions.

In future research, it is possible to conduct further bibliometric analysis: Co-authorship (Unit of analysis: organisations), Citation analysis (Unit of analysis: organisations), Bibliographic coupling (Unit of analysis: Documents, Sources, Authors, Organizations, Countries), Co-citation analysis (Unit of analysis: Cited

references, Cited sources and Cited Authors). It is also possible to extend the search to the Scopus database to find relevant literature.

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