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BIBLIOMETRIC ANALYSIS OF MULTIMODAL LOGISTICS: IDENTIFYING MAIN TRENDS AND THE ROLE OF TRANSPORTATION

NURKHAN ZHAKEN[1*], AISULU MOLDABEKOVA[2] AND FENG JIANHUI[3]

[1]Higher School of Economics and Business, Al-Farabi Kazakh National University, Almaty, Kazakhstan. [2]Institute of Economics Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan, Almaty, Kazakhstan. [3]Farabi Business School, Al-Farabi Kazakh National University, Almaty, Kazakhstan.

**Corresponding author: nurkhanzhaken02@gmail.com*

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ABSTRACT

The integration of various transportation modes is a critical aspect of global supply chain management, commonly referred to as multimodal logistics. This method is utilised to optimise cost, time, and environmental impact. This study employs a bibliometric analysis to investigate the evolving trends and the essential role of transportation in multimodal logistics. The analysis emphasises the unique advantages of trucking, rail, maritime shipping, and air transport. The study utilises keywords from the Scopus database to search for materials and analyses them based on the year of discovery, industry, producing authors, and state. The analysis is restricted to research subjects and focuses on highly specific areas such as modelling processes, digitalisation, ecological impact, and regional performance evaluation. The literature significantly focuses on the challenges of coordinating multiple transportation modes, technological advancements, and sustainability. The study identifies prevailing trends, key research areas, and future directions, differentiating between multimodal and intermodal logistics and their respective implementation challenges and advantages. Multimodal logistics, a vital sector of the economy also supports other sectors by reducing direct economic costs through efficient linkages between manufacturing and extractive industries. The study emphasises the importance of empirical research, technological integration, and sustainable practices in advancing multimodal logistics.

Introduction

Multimodal logistics, an increasingly vital aspect of global supply chain management, involves the integration of multiple modes of transportation to transport goods efficiently from origin to destination. This approach capitalises on the unique benefits of each transportation mode such as the adaptability of trucking, the efficiency of rail, the extensive reach of maritime shipping, the speed of air transport, optimising cost, time, and environmental impact. Comprehending the current trends and the significant role of transportation within the multimodal logistics framework is crucial due to its dynamic nature.

The intricacies and difficulties related to multimodal logistics have attracted considerable notice from academics and experts. The intricate coordination required among different transportation modes, the impact of technological advancements, and the increasing emphasis on sustainability are just a few factors that underscore the importance of this field. Consequently, a bibliometric analysis, which systematically evaluates the body of literature on multimodal logistics, becomes essential to identify prevailing trends, key research areas, and future directions (Wang *et al*., 2020; Tavasszy & Rodrigue, 2021).

The scientific literature contains scientific analyses and reviews concerning "multimodal logistics". The impact of multimodal logistics on low-cost companies (Babić *et al*., 2022), the impact of load on delivery speed (Ji *et al*., 2020), and network analysis of authors and keywords (Poltavskaya, 2022) have been developed. However, there are not many studies on the impact of multimodal logistics on the transport capacity of the state.

The concepts of "multimodality" and "intermodality" are critical in modern logistics and transportation systems. Although they are often used interchangeably, the significant differences between these two approaches that influence their implementation and efficiency should also be noted. Multimodal transport is executed under a single transport contract (a single ticket) between the passenger and transport operators, potentially saving time and money (Danica Babić *et al.*, 2022).

Intramodality involves simultaneously using at least two transport modes, requiring trade-offs between transport cost, duration, and physically exhausting conditions (Olvera *et al*., 2015). Intermodal transportation is a multi-actor complex system involving multiple transportation modes, stakeholders, decision-makers, operations, and planning activities (Crainic *et al.*, 2018). The choice between intermodal and multimodal transportation depends on various factors, including cost, efficiency, risk management, and the specific logistical needs of the shipment. While intermodal transport offers flexibility and potential cost savings, it requires careful coordination and management of multiple contracts. This research project will primarily concentrate on multimodal logistics, specifically highlighting its pivotal position within the transportation system.

This paper aims to provide a bibliometric analysis of multimodal logistics, focusing on identifying main trends and elucidating the role of transportation. By analysing a comprehensive dataset of academic publications, this study will shed light on the historical development of the field, the most influential research works, and the emerging topics shaping the future of multimodal logistics. The introduction presents a literature review that explores the theoretical foundation of multimodal logistics in transportation systems, which serves as the basis for this study. The methodology employed in this research is detailed in the second section. In the third section, a bibliometric analysis is conducted. Finally, the paper concludes with a summary of the results in the fourth section.

Literature Review

This section conducts a comprehensive analysis of the authors contributing to the literature concerning the role of multimodal logistics in transportation systems. Multimodal logistics is frequently equated with intermodal logistics across various scholarly works, notwithstanding the assertion that they exhibit slight differences.

C. Hillbrand and S. Schmid (2011) offer significant insights into the potential of inter-firm multimodal logistics models to mitigate increasing logistics costs; however, the theoretical nature of their study, coupled with the absence of empirical evidence, restricts its practical applicability (Hillbrand & Schmid, 2011). Addressing these deficiencies through practical validation and an expansive exploration of implementation challenges would fortify their research's impact within the multimodal logistics domain.

According to Gernot Thorsten Liedtke's foundational work (2012), introducing a new multimodal transport system is scrutinised, specifically regarding its effects on the distribution of shipment sizes, which tends to shift towards smaller shipments. The author delineates an economic evaluation of a multimodal transport network for individual pallets, assessing whether the new system engenders reduced shipment sizes and diminished warehousing costs (Liedtke, 2012). While the study presents valuable insights into the potential of multimodal transport to enhance supply chain operations, its limited focus and lack of sensitivity analysis inhibit the generalizability of its findings.

Addressing such limitations through additional research would amplify this work's relevance in multimodal logistics. Dong *et al.* (2018) propose the notion of "synchronisation from a supply chain perspective" (SSCP) and employ a quantitative case study to examine how modal shifts may be integrated into supply chain considerations. Their methodology is grounded in empirical data, illustrating the effects of a newly introduced intermodal transport system on shipment distribution and warehousing costs (Dong *et al*., 2018).

Nonetheless, the study's reliance on a singular case study may constrain its findings' applicability to broader contexts. The authors fail to comprehensively analyse the variability in results across diverse contexts or industries, potentially leading to an incomplete understanding of the broader implications of their conclusions. Nes (2002) concludes that multimodal logistics can effectively mitigate urban transport challenges by enhancing accessibility and alleviating congestion.

The research underscores the necessity of integrating various transport modes to establish a cohesive and efficient transport network (Nes, 2002). However, the study does not thoroughly address the challenges of implementing multimodal transport systems. Issues such as funding, stakeholder coordination, and the requisite regulatory frameworks are not adequately explored. Furthermore, the study does not discuss potential trade-offs, including the impact on existing transport services and the costs associated with transitioning to multimodal systems.

To show that multimodal logistics are not only meant to solve problems of urban centres, Steadie-Seifi *et al*. (2014) present a structural review of the multimodal freight transport literature, emphasising pertinent models and solution methods from the perspectives of strategic, tactical, and operational planning, along with future research directions (Steadie-Seifi *et al*., 2014). Nevertheless, the methodology would benefit from a more explicit discourse on the criteria employed to select the articles included in the review. Despite the authors' mention of focusing on relevant models and solution methods, the lack of transparency regarding inclusion and exclusion criteria may raise questions concerning the review's comprehensiveness. Additionally, the review does not incorporate empirical case studies that could yield practical insights into applying the identified models and methods.

M. Malyshev's (2020) research delineates the necessity for a universal methodology in managing multimodal transport processes (Malyshev, 2020). However, the absence of empirical validation and insufficient exploration of implementation challenges restrict the applicability of these insights. Addressing these limitations through additional research would bolster the robustness of the findings and enhance their relevance to multimodal logistics. Woxenius and Sjöstedt (2003) investigate the evolution of the multimodal transport industry, underscoring the necessity for a "competence leap" to achieve comprehensive integration among all traditional modes of transport. Their methodology qualitatively analyses contemporary logistics trends and their ramifications for the European intermodal transport sector (Woxenius & Sjöstedt, 2003). This qualitative approach thoroughly examines the complexities and dynamics inherent within the intermodal transport industry.

By concentrating on a "competence leap", the authors present a forward-looking perspective that advocates for innovation and adaptability in response to evolve logistics demands. This competency emphasis is especially pertinent in a rapidly transforming industry with significant technological advancements. Nevertheless, the methodology lacks empirical data to substantiate the assertions regarding the necessity for this competence leap. The lack of quantitative analysis or case studies restricts the ability to assess the magnitude of the intermodal transport industry's challenges.

Furthermore, the study fails to delineate the criteria employed to evaluate logistics trends, which may result in subjective interpretations

of the conclusions. Consequently, various conditions are outlined to investigate the impact of multimodal logistics on the developmental progress within modern logistics. Studies demonstrate that multimodal logistics addresses urban logistics challenges while simultaneously generating logistical issues within specific regions (Sitorus *et al*., 2016). Additionally, the influence of multimodal logistics on transport potential has been elucidated in this research publication.

Methodology

The systematic bibliographic analysis aims to identify available knowledge, group and sort it, and analyse and systematise suggestions for future research. The methods used in the research of Pagani *et al*. (2015) were employed to realise this study. The research method includes the following steps: Analysing bibliographic databases, identifying keywords and key phrases, creating searchable sorts in the database, removing repetitive articles, removing articles that do not fit the chosen topic, selecting articles for analysis, reading the full text of the selected articles, and conducting analyses (Pagani *et al*., 2015).

The key phrases "multimodal logistics" and "transport capacity" were selected from the Scopus database according to the search requirements. The retrieved work was collected through the Zotero® reference manager. Filtering

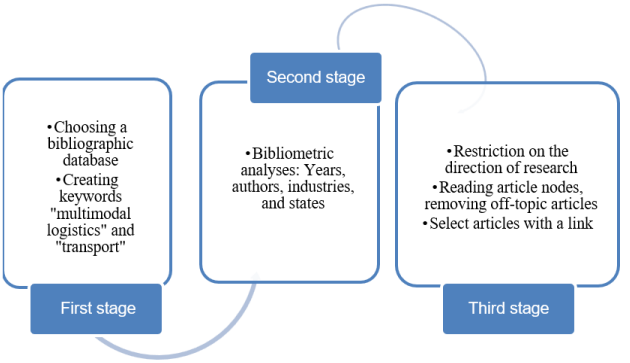

Figure 1: Steps in analysing the scientific literature
Source: Authors

procedures were applied to select articles that were directly relevant to the subject of the study. The filters applied include restriction by research area and exclusion of articles unrelated to the research topic, conducted by reading the study outcomes. In addition, 14 articles that had references were selected and analysed. The algorithm of this research work is shown in the diagram below (Figure 1).

Results and Discussion

Bibliometric analysis of the impact of multimodal logistics on transport potential was carried out according to the following parameters: Growth of studies over the intertemporal period, the largest number of authors, and studies by state. On the topic of logistics, 61,146 articles were found in the Scopus database. Then, the following commands were entered from these articles: (title-ABS-KEY ("multimodal logistics") AND ("transport*"). After this command, the number of selected articles was 138.

Considering that the articles were written in different fields of science, the articles written in the following fields of science were selected: "Social Sciences", "Business, Management and Audit", and "Economics, Econometrics and Finance". The number of remaining articles after team entry was 52. Articles on multimodal logistics started to be published in the Scopus database in 2005. Well, the last publication was in 2024. However, restrictions were introduced for periods from

2014 to 2023 to make the study more specific. After the introduction of this command, 38 articles were selected. What we can see in these teams is that the topic of multimodal logistics is not yet crowded. We can see that the interest in the topic since 2015 was a maximum of three authors and since 2015, there has been at least one author (Figure 2). We can see that the highest interest in this topic was in 2016 and the lowest in 2019.

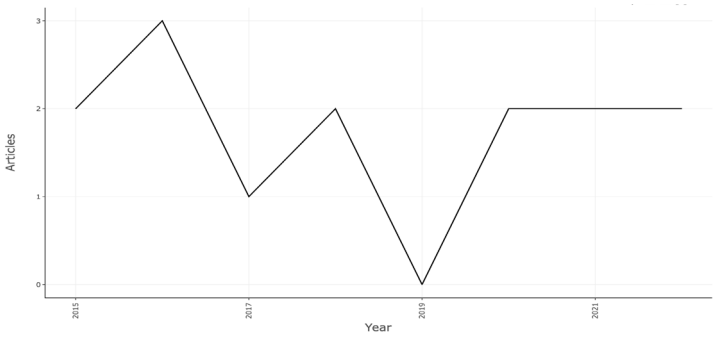

Figure 2: Materials on Scopus database on "multimodal logistics" + "transport"
Source: Authors

The Scopus database identified 39.5% (15) articles, 26.3% (10) conference paper, 26.3% (10) conference review, and 7.9% (3) book chapters (Table 1).

Table 1: Materials on Scopus based on "multimodal logistics" + "transport"

Type of Material	Quantity
Article	15
Conference paper	10
Conference review	10
Book chapters	3

Source: Authors

According to these contributions, i.e., the base conducted on the impact of multimodal logistics on transport potential, the 10 most productive authors are presented in Table 2. The productive authors in the Scopus database include Halter and Ibert. This is followed by Berg, Bjorbaek, Bouhmala, Burki, Bury, Chen, Dhar, and Grygorenko, are authors and co-authors of one article.

Table 2: Authors of Scopus-based products on "multimodal logistics" + "transport"

Authors	Quantity of Materials	Percentage (%)
Halter D.	2	16.8
Ibert M.	2	16.8
Berg	1	8.3
Bjorbaek CT.	1	8.3
Bouhmala N.	1	8.3
Burki U.	1	8.3

Chen X.	1	8.3
Grygorenko T.	1	8.3
Dhar S.	1	8.3
Bury A.	1	8.3

Source: Authors

Table 3 shows the impact of multimodal logistics on transport potential in the Scopus database. According to the database, there are 10 areas with the largest number of published materials. According to the share in the total number of published articles, the area of "social sciences" is 23.6%. The second and third places are occupied by "business, management, and accounting" and "decision sciences", respectively. Each accounts for 20% and 15.5% of the articles in the Scopus database.

Table 3: Scopus-based research areas on "multimodal logistics" + "transport"

Industries	Quantity of Materials	Percentage (%)
Social sciences	26	23.6
Business, management, and accounting	22	20
Decision sciences	17	15.5
Computer science	16	14.5
Engineering	8	7.3
Economics, econometrics, and finance	7	6.4
Mathematics	4	3.6
Environmental science	4	3.6
Energy	4	3.6
Earth and planetary science	1	0.9
Agriculture and biological sciences	1	0.9

Source: Authors

The list of published countries of Scopus database materials on the impact of multimodal logistics on transport potential includes the countries of the People's Republic of China, India, the Federal Republic of Germany, Great Britain, Brazil, Latvia, and Norway (Figure 2).

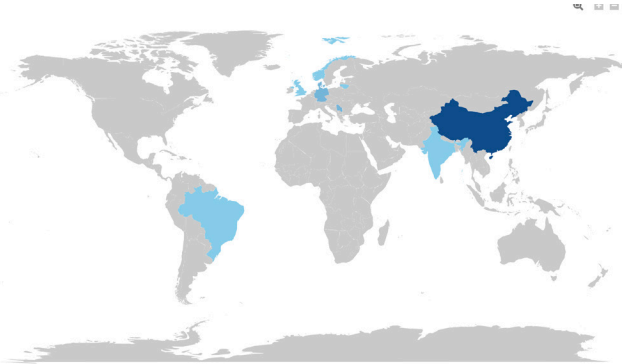

Figure 2: Countries with the highest number of published papers on Scopus on "multimodal logistics" + "transport"
Source: Authors

At the next stage of article selection from the Scopus database, the following branches were selected: “social sciences”, “business, management, and accounting”, “economics, econometrics, and finance”. As a result, the number of articles to be analysed was reduced to 14 (Table 4).

Table 4: Articles with the most citations for “multimodal logistics” + “transport” based on Scopus

Authors	Subject of the Article	Printed Data	Number of Citations
Pamucar, D. S., Tarle, S. P., Parezanovic, T. (2018)	New hybrid multi-criteria decision-making DEMATEL-MAIRCA model: Sustainable selection of a location for the development of multimodal logistics centre	Economic Research-Ekonomska Istrazivanja, том 31, выпуск 1, 1641-1665	75
Jiang, J., Zhang, D., Meng, Q., Liu, Y. (2020)	Regional multimodal logistics network design considering demand uncertainty and CO_2 emission reduction target: A system-optimisation approach	Journal of Cleaner Production, 248, 119304	48
Schøyen, H., Bjorbæk, C. T., Steger-Jensen, K., ...Jensen, T. E., Berg, Ø. (2018)	Measuring the contribution of logistics service delivery performance outcomes and deep-sea container liner connectivity on port efficiency	Research in Transportation Business and Management, 28, 66-76	33
Lopes, H.D.S., Lima, R.D.S., Leal, F., Nelson, A.D.C. (2017)	Scenario analysis of Brazilian soybean exports via discrete event simulation applied to soybean transportation: The case of Mato Grosso State	Research in Transportation Business and Management, 25, 66-75	29
Bandyopadhyay, A., Bhatnagar, S. (2023)	Impact of COVID-19 on ports, multimodal logistics and transport sector in India: Responses and policy imperatives	Transport Policy, 130, 15-25	13
Ambrosino, D., Sciomachen, A. (2021)	Impact of externalities on the design and management of multimodal logistic networks	Sustainability (Switzerland), 13(9), 5080	9
Tang, M.-C., Jhang, P.-S. (2020)	Music discovery and revisiting behaviours of individuals with different preference characteristics: An experience sampling approach	Journal of the Association for Information Science and Technology, 71(5), 540-552	7
Gupta, D., Dhar, S. (2022)	Exploring the freight transportation transitions for mitigation and development pathways of India	Transport Policy, 129, 156-175	6
Mazaraki, A., Matsiuk, V., Ilchenko, N., Kavun-Moshkovska, O., Grygorenko, T. (2020)	Development of a multimodal (railroad-water) chain of grain supply by the agent-based Simulation Method	Eastern-European Journal of Enterprise Technologies, 6(3-108), 14-22	6

Prata, J., Arsenio, E. (2017)	Assessing intermodal freight transport scenarios bringing the perspective of key stakeholders	Transportation Research Procedia, 25, страницы 900-915	5

Source: Authors

Table 4 in the article provides a comprehensive overview of essential research studies investigating the various facets of multimodal logistics and its influence on transportation. Pamucar *et al*. (2018) introduced a hybrid multi-criteria decision-making model, DEMATEL-MAIRCA to select suitable locations for multimodal logistics centres. Their research underscores the significance of sustainable practices in logistics, demonstrating how strategic location selection can enhance operational efficiency and positively impact transport capacity. This study's influence is evidenced by its 75 citations (Pamucar *et al*., 2018).

Jiang *et al*. (2020) focused on designing regional multimodal logistics networks while considering demand uncertainty and CO_2 emission reduction targets. They presented a system-optimisation approach, highlighting that effective network design can improve transport capacity and sustainability in logistics. The study has garnered 48 citations, underscoring its contribution to balancing logistics efficiency and environmental considerations (Jiang *et al*., 2020).

Schøyen *et al*. (2018) measured the impact of logistics service delivery performance and deep-sea container liner connectivity on port efficiency. Their research emphasised the role of efficient logistics services in enhancing transport capacity at ports, which is crucial for multimodal logistics operations. This study has received 33 citations, reflecting its relevance to port management and logistics efficiency (Schøyen *et al*., 2018).

Lopes *et al*. (2017) analysed Brazilian soybean exports using discrete event simulation, focusing on transportation scenarios within Mato Grosso State. Their study illustrated how multimodal logistics can optimise agricultural exports and improve transport capacity in the agricultural sector. With 29 citations, this paper is significant in agricultural logistics research (Lopes *et al*., 2017).

Bandyopadhyay and Bhatnagar (2023) examined the impact of COVID-19 on ports, multimodal logistics, and the transport sector in India. They discussed the responses and policy implications, highlighting the disruptions in logistics during the pandemic and the need for resilient logistics strategies. The study has 13 citations, reflecting its timeliness and relevance to recent global challenges (Bandyopadhyay & Bhatnagar, 2023).

Ambrosino and Sciomachen (2021) discussed the impact of externalities on the design and management of multimodal logistic networks. They provided insights into how external factors influence logistics decisions and transport capacity. With nine citations, this article contributes to understanding the complexities of multimodal logistics management (Ambrosino & Sciomachen, 2021).

Tang and Jhang (2020) explored music discovery behaviours, a less relevant study of multimodal logistics and transport capacity. This niche interest has seven citations, indicating a limited impact on logistics research (Tang & Jhang, 2020).

Gupta and Dhar (2022) investigated freight transportation transitions in India, focusing on mitigation and development pathways. They discussed how multimodal logistics can facilitate these transitions and improve transport capacity. This study has six citations, highlighting its importance in the Indian logistics context (Gupta & Dhar, 2022).

Mazaraki *et al*. (2020) developed a multimodal (railroad-water) grain supply chain using agent-based simulation methods. Their research emphasised the efficiency of multimodal logistics in agricultural supply

chains, enhancing transport capacity. The study has six citations, underscoring its relevance to agricultural logistics (Mazaraki *et al*., 2020).

Prata and Arsenio (2017) assessed intermodal freight transport scenarios from the perspective of key stakeholders. They discussed stakeholder engagement in multimodal logistics and its implications for transport capacity. This paper has five citations, indicating its relevance in stakeholder analysis within logistics (Prata & Arsenio, 2017).

The cumulative effect of these articles is to enhance comprehension of multimodal logistics and its bearing on transport capacity, encompassing a range of methodologies, case studies, and theoretical frameworks that have a bearing on contemporary practices and future research trajectories in this domain. The works were selected to examine the outcomes of the selected papers in the following areas: Modelling processes in multimodal logistics, the impact of multimodal logistics on ecology, and the performance evaluation of multimodal logistics in regional contexts (Table 5).

Table 5: The main trends of multimodal logistics based on literature and Scopus papers

Modelling processes in multimodal logistics	Pamucar *et al*. (2018) Ambrosino, D., & Sciomachen, A. (2021) Mazaraki, A. *et al*. (2020) Provotorov, V. V. *et al*. (2021) Bendavid, Y. (2015)
Multimodal logistics and digitalisation	Kanchaveli, L. (2022), Tagiltseva *et al*. (2021), Chechenova, L. (2022), Pokhylchenko, O., & Flyk, I. (2020), Tagiltseva *et al*. (2021), Molero *et al*. (2019), Elmay *et al.* (2022)
Impact of multimodal logistics on ecology	Jiang *et al.* (2020) Prata, J., & Arsenio, E. (2017) Paraskevadakis, D. *et al*. (2021) Li, H., Jiang, C. (2015)
Performance evaluation of multimodal logistics in regional logistics	Schøyen, H. *et al*. (2018) Lopes, H. D. S. *et al*. (2017) Bandyopadhyay, A., & Bhatnagar, S. (2023) Gupta, D., & Dhar, S. (2022) Bharadwaj, D. (2020) Balakrishnan, A. S., & Suresh, J. (2017) Ibert, M., & Halter, D. (2016) Zhu, R. *et al*. (2016)

Source: Authors

Modelling Processes in Multimodal Logistics

According to the authors, by modelling multimodal logistics trends, it is possible to see their efficiency and process algorithm. This should lead to an increase in direct transport potential. Pamucar *et al*. (2018) highlight that not only one type of modelling but alternative models should be used to develop the multimodal field. The main purpose of using these models is to see the main ways of solving practical problems. It also uses different software (AnyLogic RE, Java SE, and MARITO) to perform modelling processes in multimodal logistics (Pamucar *et al.*, 2018; Mazaraki *et al.*, 2020; Provotorov *et al.*, 2020; Ambrosino & Sciomachen, 2021). Thus, during the implementation of multimodal logistics, modelling processes run continuously. Modelling processes can help to solve problems that may arise in the process of meeting customer needs in advance.

Multimodal Logistics and Digitalisation

Automation and digitisation are transforming multimodal logistics by enhancing efficiency, safety, and customer satisfaction. These innovations are crucial for optimising logistics processes, reducing costs, and improving the overall performance of the logistics industry. Integrating modern digital technologies and intelligent transport management systems significantly improves the delivery of goods, increases competitiveness, and enhances client-oriented approaches in logistics companies (Tagiltseva *et al.*, 2021; Chechenova, 2022; Kanchaveli, 2022).

Digital tools such as RFID systems, GPS tracking, and electronic document management optimise various logistics processes, reduce human errors, and speed up operations (Pokhylchenko & Flyk, 2020). Digital coordination of container services and the formation of digital transport corridors enhance the efficiency of multimodal cargo transportation. The implementation of intelligent transportation systems automates cargo flow management, improves decision-making, and ensures sustainable development in international multimodal transportation (Tagiltseva *et al*., 2021).

Digitalisation is crucial for increasing safety and security in transporting dangerous goods by minimising human errors and enhancing efficiency (Molero *et al*., 2019). Blockchain-based solutions allow users to trace and track container shipments in a decentralised, transparent, auditable, secure, and trustworthy manner in unimodal and multimodal logistics (Elmay *et al*., 2022). The integration of automation and digitisation in multimodal logistics leads to significant improvements in efficiency, safety, and customer satisfaction. By leveraging intelligent transport systems, digital platforms, and innovative technologies, logistics companies can optimise their operations, reduce costs, and enhance their competitive edge in the market. These advancements are essential for the sustainable development and growth of the logistics industry.

Impact of Multimodal Logistics on Ecology

Papers in the scientific literature refer to the impact of multimodal logistics on the environment. Jiang *et al*. (2020) explain the existence of a centralised cluster and the need to choose an environmentally efficient mode of transport to deliver goods to nearby facilities in order to minimise the environmental damage caused by multimodal logistics. They also report on the cluster's activity at times when logistics demand was different. The necessity of selecting modes of transport that are environmentally and economically efficient is highlighted by the links between the speed of delivery of goods and the amount of carbonic acid emitted into the air (Jiang *et al*., 2020; Prata & Arsenio, 2020; Paraskevadakis *et al*., 2020). The authors justify that during multimodal logistics, it is noted that the state is not subject to economic losses, drawing attention to economic and environmental factors.

Performance Evaluation of Multimodal Logistics in Regional Logistics

The following papers address the problem of the impact of multimodal logistics in order to improve the efficiency of regional logistics. Schøyen *et al*. (2018) found that due to the competition in the region and the fact that many logistics routes of European states are route-based, multimodal logistics can have an economic advantage. It is also noted that the efficiency of container ports in the state continues to decline as the state's maritime border is on land. Lopes *et al*. (2017) stated that despite Brazil's high share of soybean exports worldwide, it has low economic efficiency. Consequently, the state's economic performance does not increase if the routes of the logistic path are not adequately designed despite the low cost of goods. To solve this problem, the authors say it is necessary to develop multimodal logistics, as direct routes can be used along this path.

According to the authors' works, the use of multimodal logistics makes it easier to combat the effects of factors such as the state of infrastructure in the region, the political

orientation of the state, and the level of economic security of the population. The state emphasises the need to use multimodal logistics despite the influence of these factors, ignoring the problems that are difficult to change (Bharadwaj, 2020; Gupta & Dhar, 2022; Bandyopadhyay & Bhatnagar, 2023). To increase the speed of logistics demand-supply in the region and the speed of execution of logistics processes, it is important to choose an efficient mode of transport. By doing so, the fulfilment of logistics orders increases the state budget and the logistics turnover in the region (Ibert & Halter, 2016; Balakrishnan & Suresh, 2017).

The practical implications and interconnections between multimodal logistics and the economy of transport are of great interest in terms of growth potential. At the same time, multimodal logistics can serve as an infrastructure for other sectors of the economy. This is because multimodal logistics, which link the manufacturing and extractive industries, reduces direct economic costs. To further increase the capability of multimodal logistics to function, this process uses the processes of cost optimisation and multimodal logistics modelling.

Currently, companies engaged in mineral extraction in Kazakhstan and firms transporting goods along international routes are utilising multimodal logistics. These entities are implementing advanced technologies to enhance the efficiency of their logistics systems. As a result, they can reduce the cost of their services, increasing their competitiveness. The benefits of employing multimodal logistics are significant, given Kazakhstan's wealth of mineral resources and strategic location.

Conclusions and Implication

This study highlights the importance of multimodal logistics in enhancing the transport capacity of states. The bibliometric analysis of Scopus data from 2014 to 2023 reveals that while there is growing interest in this field, the research remains fragmented and underexplored. The analysis identified key areas of focus: Modelling processes in multimodal logistics, the impact of multimodal logistics on ecology, and the performance evaluation of multimodal logistics in regional contexts. The research emphasises the distinction between multimodal and intermodal logistics, noting their advantages and implementation challenges.

The studies in question are not devoid of limitations. For instance, the latter portion of the sample comprised the most frequently cited materials; however, this does not imply that the highest citations were unattainable or that materials released in the last year were devoid of relevance. It is important to note that only scientific community-approved resources were incorporated, with an equal distribution of research areas. Furthermore, future research may incorporate analyses encompassing materials from additional databases such as Google Scholar and Web of Science (WoS).

Future studies should prioritise empirical research to validate theoretical models and frameworks in multimodal logistics. This would provide practical insights and enhance the applicability of existing theories. Conducting detailed case studies across different regions and industries can offer a comprehensive understanding of multimodal logistics' impact. Such studies help identify best practices and potential challenges in implementation.

Research should explore the role of emerging technologies such as blockchain, IoT, and AI in optimising multimodal logistics. Understanding how these technologies can be integrated to improve efficiency, reduce costs, and enhance security. Further investigation into the environmental benefits and challenges of multimodal logistics is needed. Studies should assess how different transportation modes can be balanced to minimise carbon footprints and promote sustainable practices.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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