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Hubarieva Iryna, Harmash Oleh, Trushkina Nataliia, Shkrygun Yuliya, Patlachuk Tamila. «**Digital transformation of enterprise' logistics activities: bibliometric and trend analysis**». In the modern conditions of the digital economy and many force majeure events, both economic and social, the issues of providing production with the necessary material and information resources and their effective use; improving operational and strategic management of warehouses, product stocks, differentiated transport flows, sales activities and customer experience are of particular relevance. In order to ensure effective operations, enterprises must organize their activities in such a way as to achieve risk mitigation, minimize losses and costs associated with the organization of logistics processes, production, transportation, logistics services and sales, as well as maximize profitability from sales. First of all, the above tasks can be achieved by increasing the efficiency of managing the logistics activities of enterprises, taking into account the analysis of its components, their interconnection and the presence of an accelerated and uneven process of digitalization.

In view of the above, this study is devoted to the analysis of the relationship between digital transformation and the processes of logistics activities of companies using bibliometric and trend approaches. The aim of the article is to identify the main areas of scientific research, assess the dynamics of publication activity, and identify key trends and gaps in this field of knowledge. As part of the study, a bibliometric analysis of the database of scientific publications was conducted to identify the most cited works and authors, as well as a trend analysis to identify changes in the topics of research. The results of the study will allow us to obtain a holistic picture of the current state and prospects for the development of research on the digital transformation of logistics activities of enterprises of various industries, which can contribute to the formation of more effective sales and marketing policy and the concept of logistics management.

It has been established that it is advisable to develop and implement management solutions in the following key areas: management of procurement and supplies of material resources (calculation of the optimal volume of the delivery batch of material resources, optimization of the enterprise's procurement strategy, improvement of the procurement process management using the multi-criteria evaluation method of choosing the optimal supplier of material resources); management of transport flows (implementation of information systems for managing cargo flows, application of automated document processing in the process of registering cargo transportation, development of proposals for optimizing transport loading, use of Internet technology for automating transport processes); management of customer experience (analysis of product shipment volumes, forecasting product shipment volumes to consumers, development of proposals for improving the level of logistics service, formation of a system of contractual relationships with consumers, improvement of a customer-oriented approach to servicing various categories of consumers in the context of the concept of relationship marketing); sales management (substantiation of the feasibility of applying a network approach to organizing sales activities of enterprises; improvement of the mechanism for implementing public-private partnerships in managing sales activities of enterprises based on the organizational and legal form of a syndicate, a methodological approach to choosing the optimal sales channel for finished products; identification of priority areas for the development of e-commerce as an effective tool for promoting products on the market).

It has been proven that the priority area of research in the future should be the development of a strategy for the digital transformation of the customer relationship management system using digital marketing tools and artificial intelligence.

Keywords: logistics activities, logistics management, strategic management, digital transformation, digitalization, digital logistics, smart logistics, digital technologies, information and communication

systems, artificial intelligence, e-commerce, digital marketing, customer relationship management, bibliometric analysis, trend analysis

Губарева Ірина, Гармаш Олег, Трушкіна Наталія, Шкригун Юлія, Патlachук Таміла. **«Цифрова трансформація логістичної діяльності підприємств: бібліометричний і трендовий аналіз».** В сучасних умовах цифрової економіки та багатьох форс-мажорних подій, як економічного, так і соціального характеру, питання забезпечення виробництва необхідними матеріальними та інформаційними ресурсами та їх ефективного використання, удосконалення оперативного та стратегічного управління складами, товарними запасами, диференційованими транспортними потоками, збутовою діяльністю та клієнтським досвідом є особливо актуальними. Для забезпечення ефективної роботи підприємства мають організувати свою діяльність таким чином, щоб знизити ризики, мінімізувати втрати та витрати, пов'язані з організацією логістичних процесів, виробництвом, транспортуванням, логістичними послугами і збутом, а також максимізувати прибутковість від продажів. Перш за все, зазначені завдання можуть бути досягнуті шляхом підвищення ефективності управління логістичною діяльністю підприємств, враховуючи аналіз її компонентів, їх взаємозв'язок та наявність прискореного і нерівномірного процесу цифровізації.

З огляду на вищезазначене, це дослідження присвячене аналізу взаємозв'язку між цифровою трансформацією та процесами логістичної діяльності компаній із використанням бібліометричних та трендових підходів. Метою статті є визначення основних напрямів наукових досліджень, оцінка динаміки публікаційної активності, а також виявлення ключових трендів і прогалів у цій галузі знань. У межах дослідження було проведено бібліометричний аналіз бази даних наукових публікацій для визначення найбільш цитованих робіт та авторів, а також трендовий аналіз для виявлення змін у тематиці досліджень. Результати дослідження дозволять отримати цілісну картину поточного стану та перспектив розвитку досліджень цифрової трансформації логістичної діяльності підприємств різних галузей, що може сприяти формуванню більш ефективної збутової та маркетингової політики і концепції управління логістикою.

Встановлено, що доцільно розробляти та впроваджувати управлінські рішення у таких ключових напрямках: управління закупівлями та постачанням матеріальних ресурсів (розрахунок оптимального обсягу партії постачання матеріальних ресурсів, оптимізація стратегії закупівель підприємства, удосконалення управління процесом закупівель із використанням багатокритеріального методу оцінки вибору оптимального постачальника матеріальних ресурсів); управління транспортними потоками (впровадження інформаційних систем управління вантажопотоками, застосування автоматизованої обробки документів у процесі реєстрації вантажоперевезень, розробка пропозицій щодо оптимізації завантаження транспорту, використання інтернет-технологій для автоматизації транспортних процесів); управління клієнтським досвідом (аналіз обсягів відвантаження продукції, прогнозування обсягів відвантаження продукції споживачам, розробка пропозицій щодо підвищення рівня логістичного сервісу, формування системи договірних відносин із споживачами, удосконалення клієнтоорієнтованого підходу до обслуговування різних категорій споживачів у контексті концепції маркетингу відносин); управління збутом (обґрунтування доцільності застосування мережевого підходу до організації збутової діяльності підприємств; удосконалення механізму реалізації державно-приватного партнерства в управлінні збутовою діяльністю підприємств на основі організаційно-правової форми синдикату, методичний підхід до вибору оптимального каналу збуту готової продукції; визначення пріоритетних напрямів розвитку електронної комерції як ефективного інструменту просування продукції на ринку).

Доведено, що пріоритетним напрямом досліджень у майбутньому має стати розробка стратегії цифрової трансформації системи управління взаємовідносинами з клієнтами із використанням інструментів цифрового маркетингу та штучного інтелекту..

Ключові слова: логістична діяльність, управління логістикою, стратегічне управління, цифрова трансформація, цифровізація, цифрова логістика, розумна логістика, цифрові технології, інформаційно-комунікаційні системи, штучний інтелект, електронна комерція, цифровий маркетинг, управління взаємовідносинами з клієнтами, бібліометричний аналіз, трендовий аналіз.

Introduction. In today's conditions of rapid digitalization of many areas of life, in particular business activities, the aspect of logistics management as an integrated process is gaining special attention. The digital economy is characterized by digital transformation processes. D. Terrar, an analyst at the consulting company Agile Elephant [1], notes that digital transformation is the process of an organization's transition to new ways of thinking and working based on the use of social, mobile and other digital technologies. This transformation includes changes in thinking, leadership styles, a system for encouraging innovation and the adoption of new business models to improve the work of the organization's employees, its customers, suppliers and partners. This is confirmed by Statista 2022 data, which indicate that 80% of respondents in the world consider business digitalization a priority for the organization's technological breakthrough.

It is worth emphasizing that the processes of digitalization and the organization of logistics activities are interdependent. Currently, the processes of accelerated digitalization, on the one hand, are a factor of changes in the economic and social spheres of life, and, on the other hand, are a component of these changes as a reflection of the general needs of society, which are rapidly changing. That is, digitalization is a reflection of technological, economic and social progress. At the same time, the process of digitalization has a dual nature, consisting in a combination of the characteristics of a factor and a component. At a certain stage of human development, digitalization reflects existing changes and, through this process, provokes and

determines a new round of further changes. It can be noted that in logistics activities, these processes are present to a significant extent and have long-term prospects. This is due to the fact that the digitalization of logistics activities and the spread of the consequences of this process affects the participants in the logistics market and forms further changes in the behaviour and expectations of consumers. Thus, according to Statista, revenues from the use of software for managing relationships with consumers worldwide increased by 90% in 2015-2020, or from 24 to 45.7 billion dollars. It is predicted that the value of this indicator will grow annually and will amount to 49.6 billion dollars in 2025. According to Transport Intelligence, Statista, the volume of the global e-commerce market will grow in 2026 compared to 2020 by 2.1 times, or from 368.1 to 770.8 billion euros. The average share of digital interactions with customers in the world was 58% in 2020, while in 2017 it was 20%. The level of widespread implementation of artificial intelligence for managing supply chains, according to 600 respondents surveyed worldwide was 34% in 2022.

From the point of view of most experts, the digitalization of logistics business processes will contribute to the optimization of flows, improvement of service quality, and increase of efficiency indicators and flexibility of logistics service. For example, preparation of paper documentation and delay of delivery associated with its registration constitute 10-15% of transportation costs. When implementing digital logistics on the basis of legally recognized electronic document flow, these costs and delivery times can be reduced by 20-40% [2].

Therefore, logistics processes are a significant component of operational and long-term activities of enterprises. Taking into account the digitalization of the economy, it is advisable to consider logistics processes as components of the concept of "Logistics 4.0" [3]. The close interdependence and integrated nature of logistics activities of enterprises determines the relevance of studying the relationship of this concept with digital transformation and related categories.

Literature and researches review.

Analysis of the scientific literature indicates the diversity of approaches of scientists to the definition of the concepts of "logistics" and "logistics management". Scientists use different concepts, namely: "logistics management", "strategic logistics management", "enterprise' logistics management", "supply chain management", "marketing and logistics management", etc. There are many interpretations of these terms, which are based on various scientific concepts and provisions.

Based on the theoretical generalization of existing definitions of the concept of "logistics", they are conditionally systematized into the following groups: theory (management concept, science or scientific direction, management methodology); activity (type of activity, management tool, form of market relations of participants); management activity (management process, management function, process management); flow management system (theory and practice of managing the movement of a set of flows, integrated material flow management system, flow process management system) [4].

In recent years, as the analysis shows, the concept of digital logistics has been introduced into scientific circulation. As a rule, this term is considered from the standpoint of digital service; digital-type systems; transition from the era of automation to the era of digitalization; logistics models as a "single window"; logistics, where all systems are

integrated and function only in virtual space [5].

It should be noted that when interpreting logistics activities, the vast majority of researchers emphasize such aspects as the direction of activity; a set of actions for the practical implementation of processes; the goal and objectives of implementing policy in the field of transport and logistics; a single integrated process management function, etc.

Logistics management, as a rule, is understood as a tool on the basis of which it is possible to reduce costs for logistics, inventory management, and transportation of products to consumers; synthesis of management functions (planning, organization, regulation, coordination and control) of flow processes; management of material and information flows; management of integrated business processes (from logistics to sales of finished products to consumers); integration of management theory and logistics.

Some authors use the term "logistics management", which includes management of: consumer requests, market participants' offers and establishing the relationship between them; information flows; procurement and supply processes; production activities; inventories and warehousing; financial and sales activities; service; pricing; other components of production activities and relationships with the end consumer.

Therefore, based on the generalization of existing conceptual provisions and the results of previous own research [6-11], it is proposed to consider the logistics activities of enterprises in the context of digital transformations as a set of processes (supply and purchase of material resources, contractual work with suppliers, production of products, their storage in logistics centres, waste recycling on the basis of a circular economy and reverse logistics, logistics service for consumers, transportation and sales of products), the organization of which

is carried out using digital technologies and information systems.

A significant number of scientific works are devoted to conceptual principles and scientific and methodological approaches to managing digital transformations of logistics activities of enterprises. As the analysis of scientific sources on logistics shows, leading scientists pay special attention to the study of:

various aspects of the impact of digitalization on logistics activities [12-16];

the relationship between digital, intelligent and smart logistics [17-20], digital strategy and logistics activities [21-24], smart contract and logistics activities [25-33], etc.

Despite the wide range of scientific research on the chosen topic, the multifaceted nature and debatability of individual issues require further development. And especially the solution of this problem is becoming more relevant in the era of digital transformations and the intensification of automation and digitalization processes.

Aim and objectives. The outlined problem determined the purpose of this article, which is to identify the main areas of

scientific research, assess the dynamics of publication activity, as well as identify key trends and gaps in this field of knowledge.

The theoretical and methodological basis of the study is the provisions of institutional theory, digital economy, concepts of strategic, logistical and marketing management, enterprise development, management, and customer relationship management. The following general scientific methods were used in the research process: analysis and synthesis, expert survey, bibliometric analysis, trend analysis, comparison and classification, structural and logical generalization.

Results, analysis and discussion. Based on bibliometric analysis, it was found that various issues of digital transformation of logistics activities of business entities of various industries are included in the scope of long-term scientific interests of most leading foreign scientists. By the title of articles, abstracts and keywords "digital transformation" and "logistics" in the international scientometric database Scopus, 980 documents were found in 1985-2024 (Fig. 1).

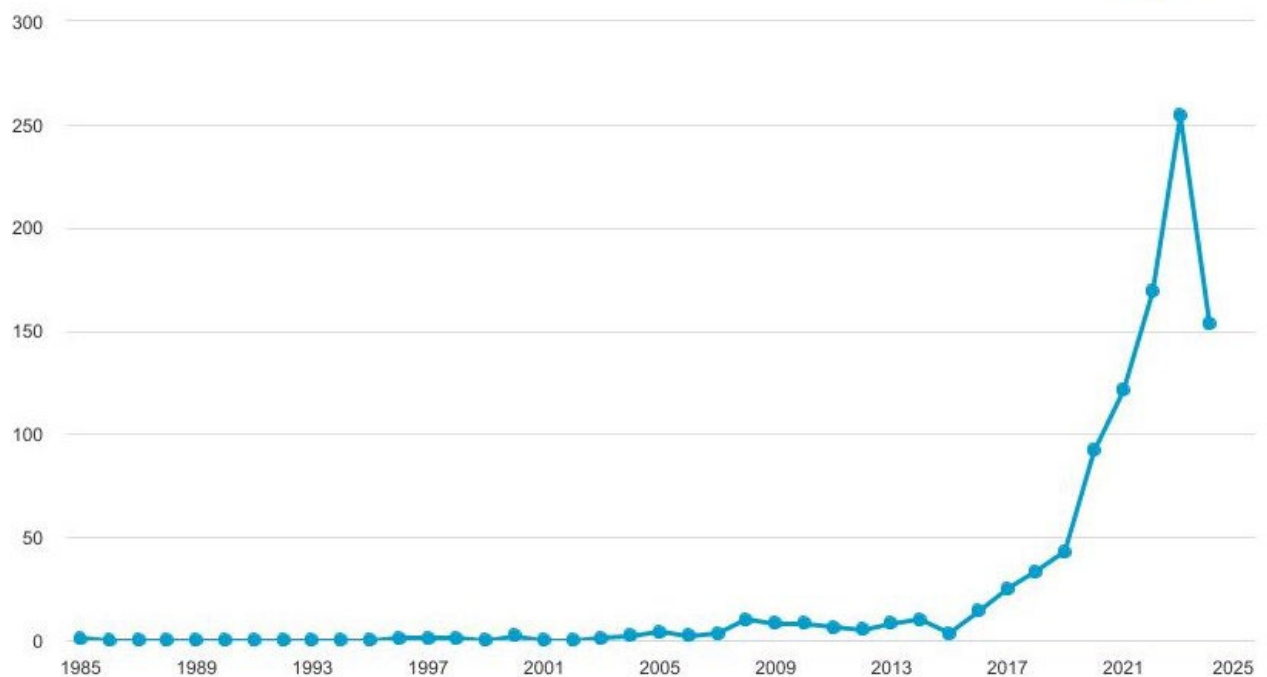


Figure 1 – Dynamics of the number of scientific publications in the Scopus database dedicated to the digital transformation of logistics activities

Source: built on the basis of data from the Scopus scientometric database.

As can be seen from Fig. 1, these issues have become particularly relevant since 2017. During 2017-2024, the number of scientific papers increased from 25 to 153, or 6.1 times. During this period, the average growth rate was 29.5%. The following keywords are mostly used in publications: digital transformation (304 documents), Industry 4.0 (105), logistics (96), supply chain management (77), supply chains (75), digitalization (59), artificial intelligence (58), Internet of Things (53), digital technologies (52), digital storage (49), machine learning (45), managerial decision-making (44), blockchain (43), big data (39 documents), etc.

The first publication on the selected topic appeared in the international scientometric database Scopus in 1985. The author J. Kirkaldy [34] considered the problem of digital modelling of systems, justifying the relevance of the contribution to the theory of evolution and the study of artificial intelligence. It should be emphasized that until 2008 there was a low level of publication activity. Thus, in 1996, 1997, 1998, 2000, 2003, 2004, 2006, only one or two works on the

selected topic were published. And since 2008, researchers have begun to pay more attention to the processes of digitalization in the organization of logistics activities of companies. The international scientometric database Scopus has included works by such scientists as A. Dialo et al. [35]; L. Heilig et al. [36]; J. Holmström, J. Partanen [37]; K. Holzhauser, P. Schalla [38]; Z. Jin, L. Yanping [39]; Ch. Meier [40]; A. Nath et al. [41]; S. Papagiannidis et al. [42]; M. Ph. Rößler, M. Haschemi [43]; H. Zeeb [44]. These publications focus on establishing electronic supply chains as an ecosystem that combines the business ecosystem and the technology ecosystem for interaction between companies at both the macro and micro levels; exploring the forms that combinations of digital manufacturing, logistics, and equipment use can take, and how these new combinations can affect the relationship between logistics service providers (LSPs), users, and equipment manufacturers; setting new standards for customer focus, innovation, and efficiency, etc.

Table 1 – The most cited articles on the problems of digital transformation of logistics activities of companies in the scientometric database Scopus for 1985-2024

Author(s), title of publication	Year	Title of publication	Number of citations in Scopus	Number of views
Weisberg S. Applied Linear Regression: Third Edition [45]	2005	Book [Hoboken, New Jersey: Wiley Blackwell]	1348	68
Neumann W. P. et al. Industry 4.0 and the human factor – A systems framework and analysis methodology for successful development [46]	2021	International Journal of Production Economics	308	674
Kayikci Y. Sustainability impact of digitization in logistics [47]	2018	Procedia Manufacturing	230	533
Cichosz M., Wallenburg C. M., Knemeyer A. M. Digital transformation at logistics service providers: barriers, success factors and leading practices [48]	2020	International Journal of Logistics Management	222	427
Garay-Rondero C. L. et al. Digital supply chain model in Industry 4.0. [49]	2020	Journal of Manufacturing Technology Management	201	568

Source: built on the basis of data from the Scopus scientometric database.

Among the most cited publications (Table 1), the work of researcher S. Weisberg [45] deserves special attention, in which the possibilities of using logistic regression analysis methods are considered. In addition, it is worth paying attention to the work of the team of authors W. Neumann et al. [46], which states that the fourth industrial revolution is changing the role of humans in operating systems. Although automation technologies are becoming increasingly common in production and logistics, there is a consensus that people will remain an integral part of operating systems. However, the human factor is still underrepresented in this research stream, which leads to an important gap in research and application. Therefore, this paper first reveals this gap, presenting the results of a targeted content analysis of previous studies of Industry 4.0.

The main publications that publish works on the chosen topic include the following: Sustainability Switzerland (21 documents); Lecture Notes In Networks And Systems (20); ACM International Conference Proceeding Series (18); Lecture Notes In Computer Science Including Subseries Lecture Notes In

Artificial Intelligence And Lecture Notes In Bioinformatics (15); IFIP Advances In Information And Communication Technology (12); Procedia Computer Science (7); Aip Conference Proceedings, Ceur Workshop Proceedings, Communications In Computer And Information Science, Lecture Notes On Data Engineering And Communications Technologies, Smart Innovation Systems And Technologies (6 documents each); International Journal Of Logistics Research And Applications, Lecture Notes In Information Systems And Organisation, Multimedia Tools And Applications (5 documents each); Applied Sciences Switzerland, International Journal Of Logistics Management, Journal Of Transport And Supply Chain Management, Lecture Notes In Intelligent Transportation And Infrastructure, Logforum, Logistics, Management For Professionals, Studies In Computational Intelligence, Transportation Research Part E Logistics And Transportation Review, Transportation Research Procedia, ZWF Zeitschrift Fuer Wirtschaftlichen Fabrikbetrieb (4 documents each) (Fig. 2).

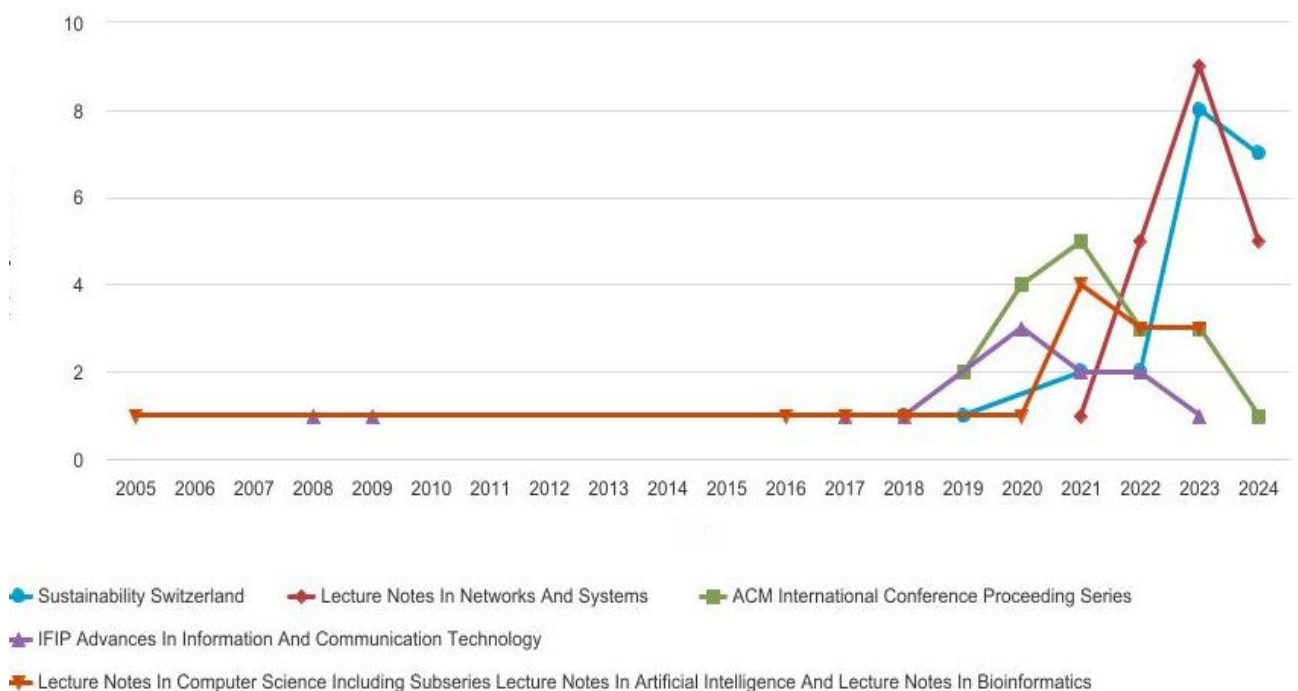


Figure 2 – Dynamics of the number of scientific publications by sources
 Source: built on the basis of data from the Scopus scientometric database.

The Scopus database contains 5 documents by scientists J. Pahl, S. Voß; 4 by F. Behrendt, A. Gunasekaran, N. Schmidtke, M.

Woschank, J. Zhang; 3 works by A. Al-Banna, A. Appolloni, J. Arambarri (Fig. 3).

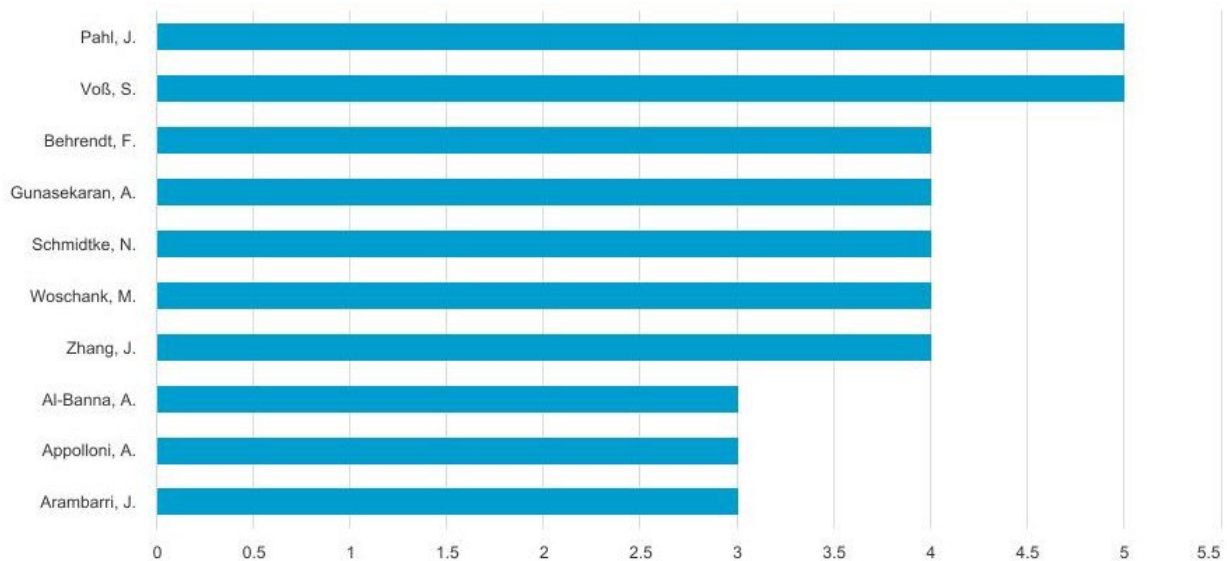


Figure 3 – Dynamics of the number of scientific publications by authors
Source: built on the basis of data from the Scopus scientometric database.

The key organizations involved in solving the problems of organizing logistics activities in the context of digitalization are: Technische Universität Dortmund (9 documents); Universität Hamburg, Universidad Politécnica de Madrid, Tallinna Tehnikaülikool, Universidad Peruana de Ciencias Aplicadas (8 works each); Technische Universität München

(7); Ministry of Education of the People's Republic of China, Tecnológico de Monterrey, Vellore Institute of Technology, Syddansk Universitet, Shanghai Maritime University, Università degli Studi di Roma Tor Vergata, Montanuniversitat Leoben, Tongji University (5 documents each) (Fig. 4).

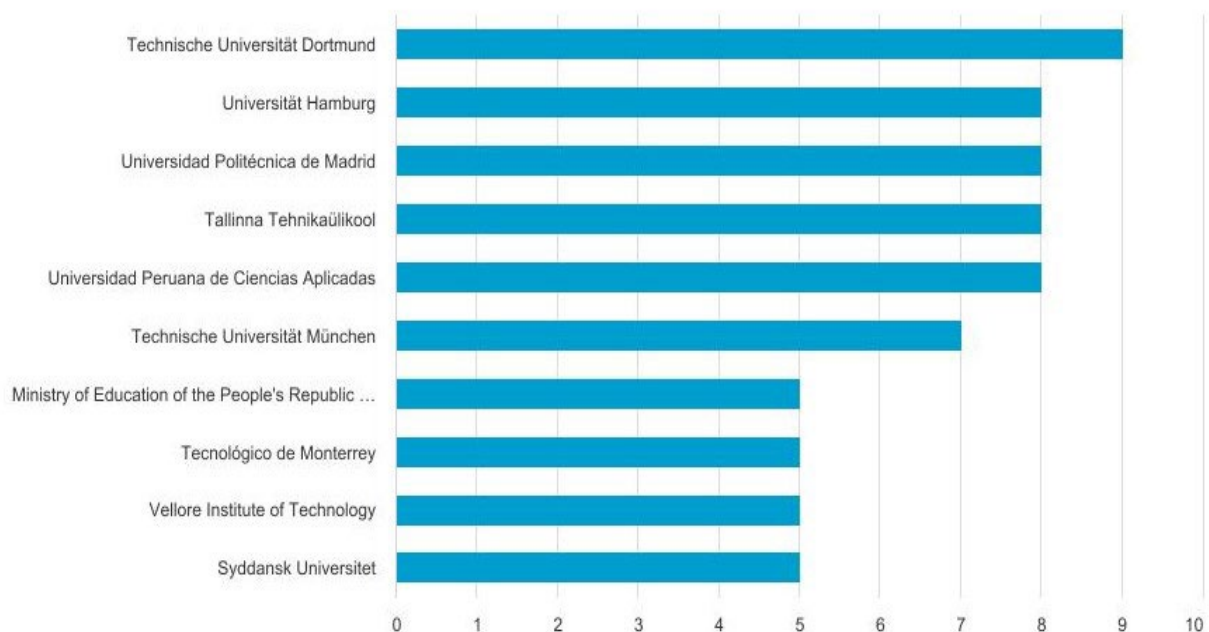


Figure 4 – Number of scientific publications by organization
Source: built on the basis of data from the Scopus scientometric database.

The results of the analysis show that most of the works on the researched issues are published by scientists from China (196 documents), Germany (106), India (86), USA (66), Great Britain (44), Italy (40), France (32),

Spain (30), Turkey (29), Australia (21), Poland (20 documents). In Ukraine, 19 documents were found using the specified search criteria (Fig. 5).

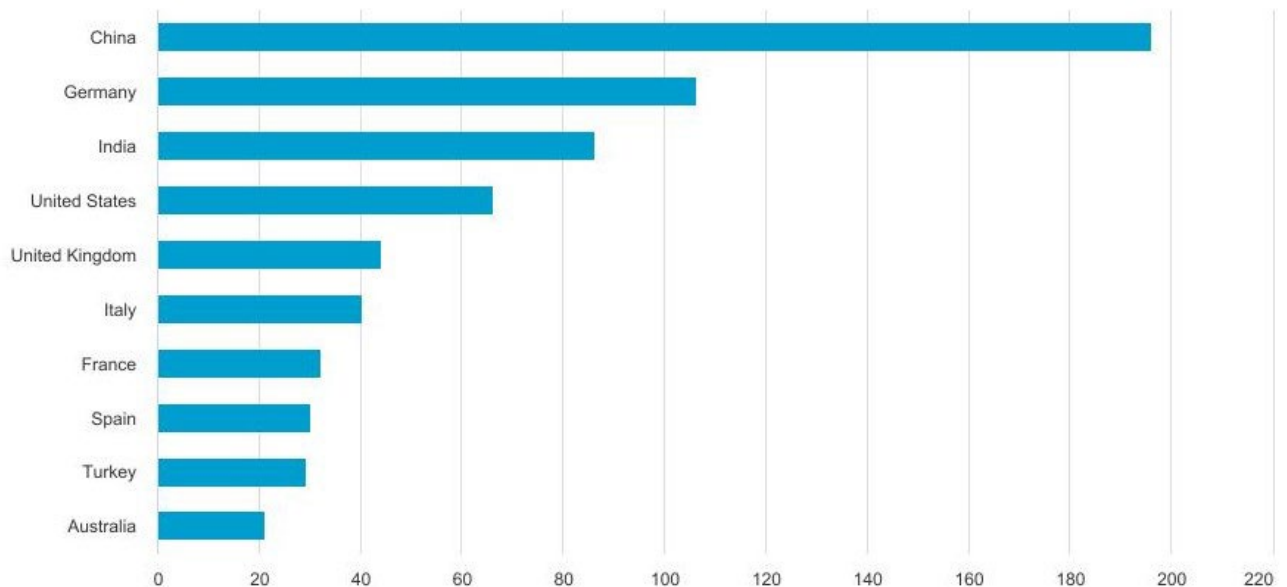


Figure 5 – Number of publications on the issues of digital transformation of logistics activities by country

Source: built on the basis of data from the Scopus scientometric database.

Most of the scientific works of the problems of digitalization of logistics activities of companies are published in the following fields of knowledge: computer science (425 documents); engineering (381); business, management and accounting (266);

decision sciences (176); social sciences (151); economics, econometrics and finance (98); energy (73 documents) (Table 2). All this indicates the multifaceted and multidisciplinary nature of the chosen research topic.

Table 2 – Total number and share of scientific publications by field of knowledge

Field of knowledge	Number of publications	Share of scientific publications, %
Computer science	425	20.6
Engineering	381	18.5
Business, management and accounting	266	12.9
Decision sciences	176	8.5
Social sciences	151	7.3
Economics, econometrics and finance	98	4.7
Energy	73	3.5

Source: built on the basis of data from the Scopus scientometric database.

The ranking of scientific works by document types is given in Table 3. As we can see, most scientists highlight the problems of implementing digital technologies for

transforming the logistics activities of enterprises in scientific articles and test them at conferences of various levels.

Table 3 – Number and share of scientific publications by document types

Type of publication	Number of scientific publications	Share of scientific publications, %
Articles	442	45.1
Conference proceedings	334	34.1
Part of a book or section of a monograph	90	9.2
Review articles	27	2,8
Books or monographs	18	1.8

Source: built on the basis of data from the Scopus scientometric database.

Among the main sponsors that finance scientific publications on the selected research topic, the following can be mentioned: National Natural Science Foundation of China (35 documents); European Commission (15); Horizon 2020 Framework Programme (14); Deutsche Forschungsgemeinschaft (8); Bundesministerium für Bildung und Forschung, Ministry of Science and Technology of the People's Republic of China (7 each); National Key Research and

Development Program of China, National Office for Philosophy and Social Sciences (6 each); Conselho Nacional de Desenvolvimento Científico e Tecnológico, Fundação para a Ciência e a Tecnologia, Ministry of Education of the People's Republic of China (5 each); Bundesministerium für Wirtschaft und Energie, European Regional Development Fund, Fundamental Research Funds for the Central Universities, H2020 Marie Skłodowska-Curie Actions (4 documents each) (Fig. 6).

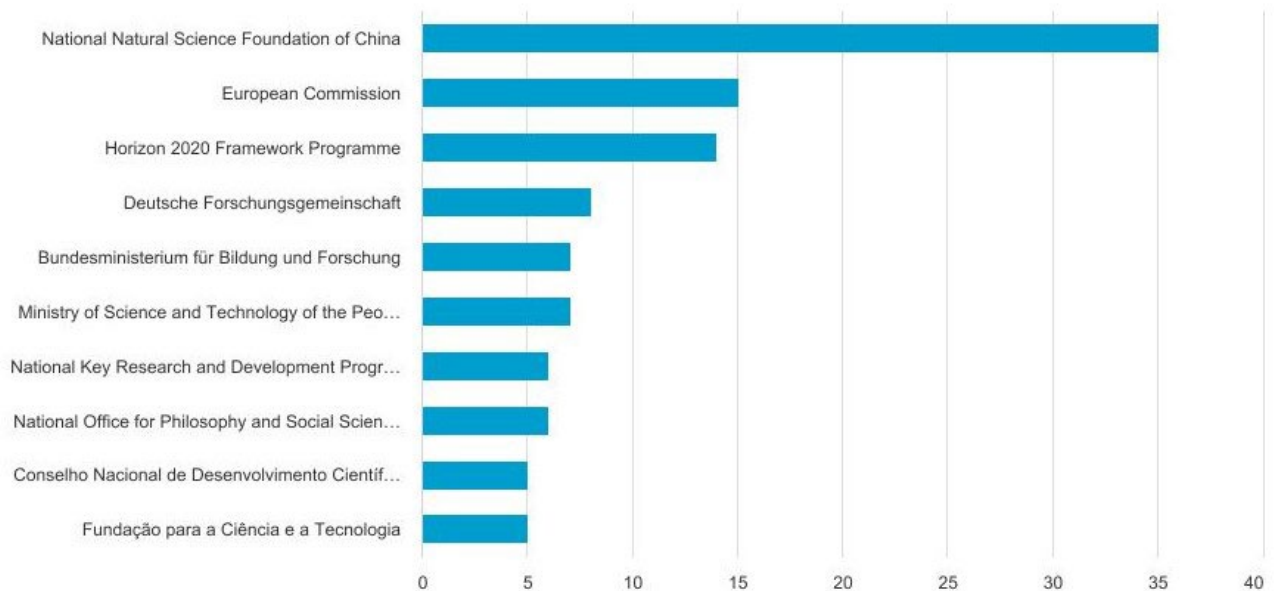


Figure 6 – List of sponsors that finance publications on the digital transformation of logistics processes in countries around the world

Source: built on the basis of data from the Scopus scientometric database.

At the next stage of the study, a search was conducted for publications posted in the international scientometric database Scopus using the following keywords: "information and communication technologies or digital technologies" and "logistics." The search

resulted in 6,025 documents published between 1976 and 2024 (Fig. 7).

If we put the conjunction "and" between the categories "information and communication technologies" and "digital

technologies", we can find only 487 publications for the years 1988-2024 (Fig. 8).

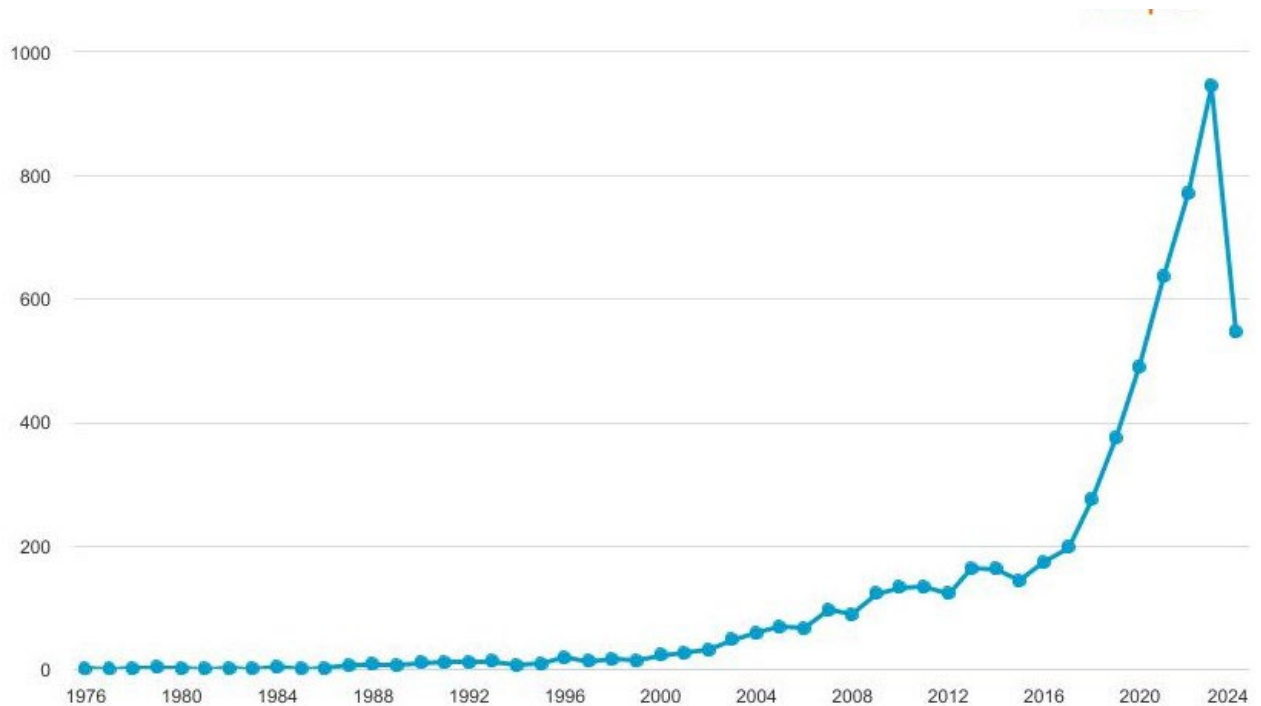


Figure 7 – Dynamics of the number of scientific publications in the Scopus database that cover the issue of ICT implementation in the field of logistics
Source: built on the basis of data from the Scopus scientometric database.

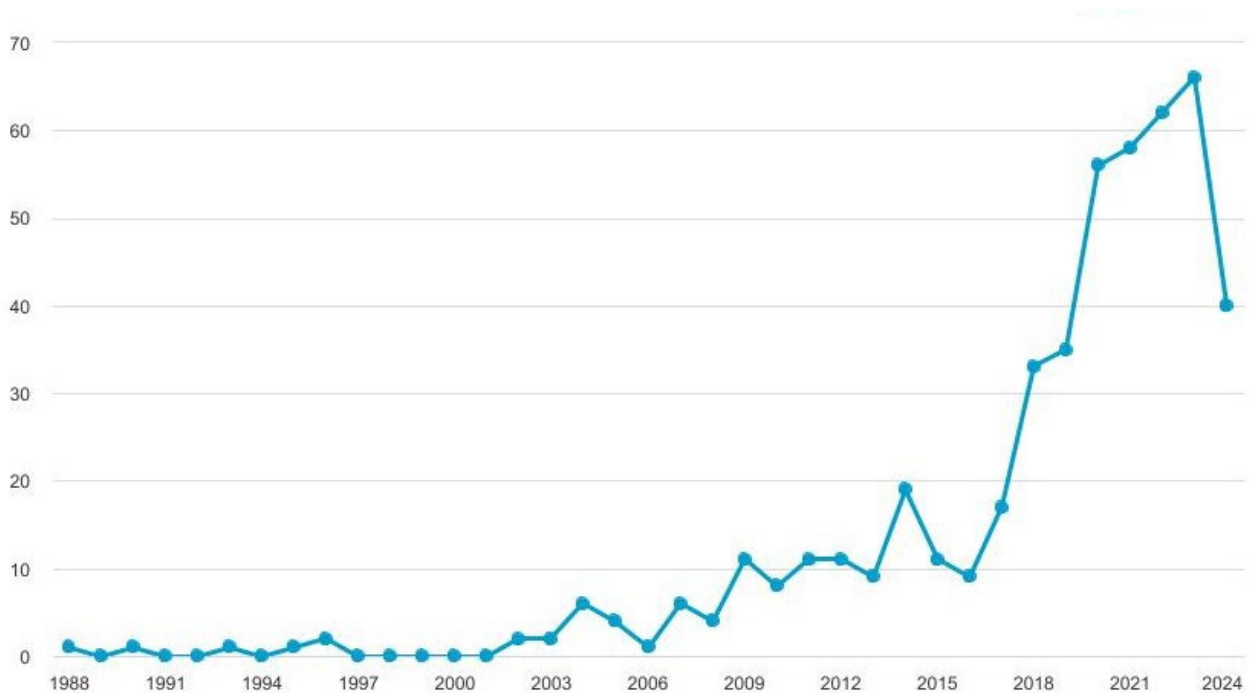


Figure 8 – Dynamics of the number of scientific publications in the Scopus database that cover the issues of implementing ICT and digital technologies in the field of logistics
Source: built on the basis of data from the Scopus scientometric database.

By the title of the articles, abstracts and keywords "information and communication technologies" or "digital technologies" and "logistics activities" in the international scientometric database Scopus, 738 documents were found for the years 1984-

2024 (Fig. 9). As the analysis shows, the publication activity of scientists has begun to grow since 2005. Over the years 2005-2024, the number of publications increased 6.6 times or from 11 to 73. The average annual growth rate was 9.9%.

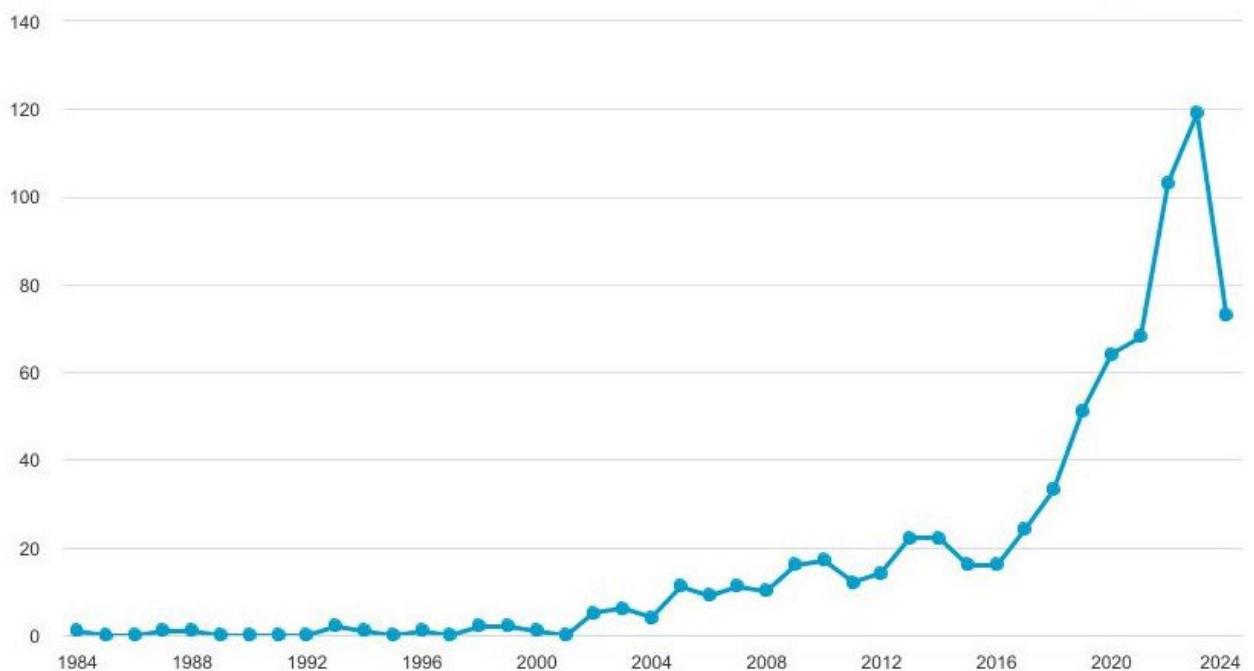


Figure 9 – Dynamics of the number of scientific publications in the Scopus database that cover the issue of implementing ICT or digital technologies in the field of logistics

Source: built on the basis of data from the Scopus scientometric database.

The most frequently used keywords in the publications are logistics (97 documents), information and communication technologies (53), supply chain management (50), digital transformation (39), Industry 4.0 (38), Internet of Things (36), digital technologies (36), artificial intelligence (39 documents).

The most cited scientific works include:

1) Rai A., Patnayakuni R., Seth N. "Firm performance impacts of digitally enabled supply chain integration capabilities" [50] – which states that digital platforms play a crucial role in supply chain management and partnerships that provide increased efficiency for companies. The results indicate that integrated IT infrastructures allow companies to develop higher-level integration capabilities of supply chain processes. This capability allows companies to separate

information flows from physical flows and share information with their supply chain partners to create information-based approaches for better demand planning, for locating and moving physical products, and for optimizing large and complex financial workflows. . In addition, the ability to integrate the supply chain with IT support leads to significant and sustainable improvements in firm performance, especially in operational excellence and revenue growth. Managerial initiatives should be aimed at developing an integrated IT infrastructure and using it to create process capabilities for integrating resource flows between the firm and its supply chain partners;

2) Bosona T., Gebresenbet G. "Food traceability as an integral part of logistics management in food and agricultural supply

Table 4 – Characteristics of clusters of keyword phrases in scientific research on the problems of digitalization of logistics processes

Cluster	Most used terms	Number of keywords	Related keywords
1 (red)	time	182	Concept, supply chain, supply chain management, digital supply chain, logistics, logistics activity
2 (green)	participant	157	Behavior, logistics model, ICTs, digital divide, digital device, association
3 (blue)	operation	73	Theory, planning, software, algorithm, evaluation, modeling, technologies, networks, risk assessment
4 (yellow)	provider	22	Item, expectation, intervention, self management, smart technology

Source: formed by the authors using the VOSviewer program.

As can be seen from Table 4, each of the clusters symbolizes a separate direction of scientific research on the development of critical infrastructure. The grouped keywords in the first cluster indicate that scientists consider the digital transformation of logistics activities from the perspective of temporal changes. Particular attention is paid to digital supply chains and supply chain management.

The second cluster takes into account the principles of partnership and cooperation in organizing logistics activities in the context of digitalization. The third cluster is related to the issues of planning and modelling logistics processes and risk assessment. The fourth is aimed at the work of providers using smart technologies.

Secondary clusters include the 5th cluster (purple), which contains 12 keywords; the 6th (turquoise) – 8 words; the 7th (orange) – 2 keywords.

The last stage of our research is to determine the contextual and temporal

patterns of the development of scientists' views on the problems of digital transformation of logistics activities of enterprises using trend analysis.

Trend analysis using the Google Trends tool confirms the high level of interest worldwide in the topic of "digital transformation" (average 71 points) (Fig. 11). Thus, at present, there is a pattern in the use of such concepts as digital business transformation, business transformation, digital transformation management, digital strategy, digital technologies. Among the leaders in popularity are the following topics: digital transformation (100 points); digital business transformation (58); business transformation (57); digital strategy transformation (34); digital transformation management (30); digital technology (28); digital industry transformation (28); digital transformation technology (28); digital data transformation (27); digital transformation services (26 points).

● digital transformation ● Logistics activity

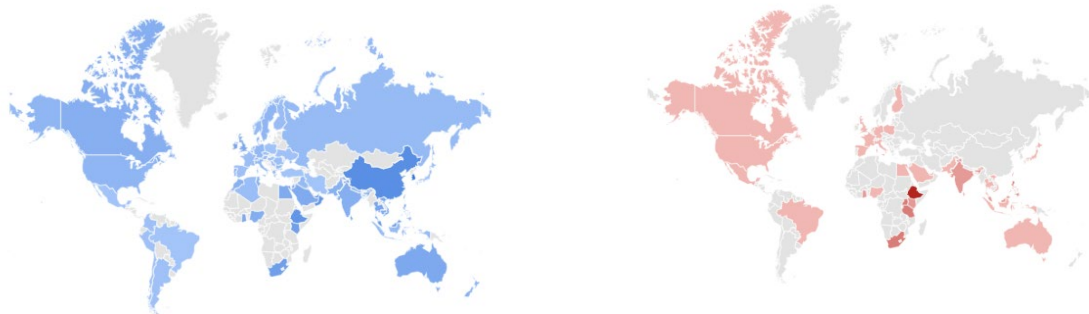


Figure 11 – Popularity of user searches for the topics “Digital transformation” and “Logistics activity” in the world since 2020-2024 Note: colour intensity depends on the percentage of queries.

Source: built using the Google Trends tool.

It should be noted that the query for the concept of “logistics” has a low level of popularity in the world (on average 1 point). The most popular queries are logistics, logistics management, supply chains. The

leaders in user searches include logistics (93 points); logistics management (35); supply chain (30); value added chain (19); supply chain management (18 points) (Fig. 12).



a) Digital transformation

b) Logistics activity

Figure 12 – Popularity of selected topics by world region for 2020-2024 Note: colour intensity depends on the percentage of queries.

Source: constructed using Google Trends tools.

The results of trend analysis using Google Trends tools are shown in Fig. 13.



Figure 13 – Dynamics of search frequency changes in terms of definitions “Digital transformation” and “Logistics activities” in the world

Notes: digital transformation (blue), logistics activities (red).

Source: built using the Google Trends toolkit.

As trend analysis shows, in most countries of the world in the last five years, topics related to the development of the concepts of digital, intelligent logistics, smart logistics and logistics 4.0 have been popular (Fig. 14, 15). At the same time, in most countries of the world,

various aspects of the development and implementation of digital logistics and smart logistics development strategies are gaining popularity and prevalence among search sources (Table 5).

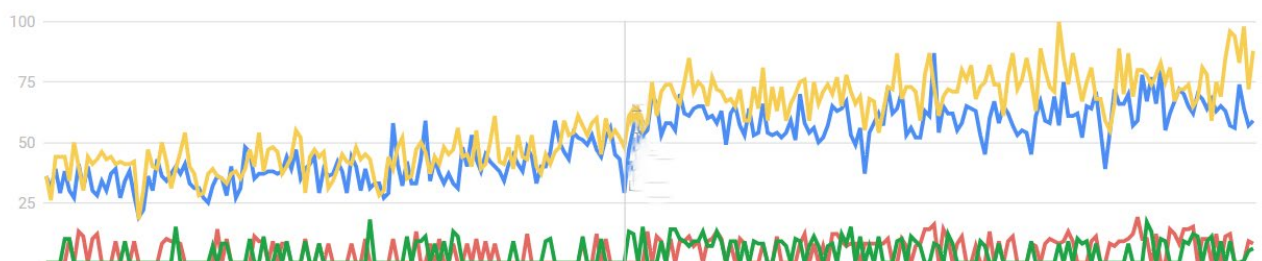


Figure 14 – Dynamics of search frequency changes in terms of definitions “Digital Logistics”, “Intelligent Logistics”, “Smart Logistics”, “Logistics 4.0” in the world for the period 2020-2024

Notes: Digital Logistics (blue colour), Intelligent Logistics (red), Smart Logistics (yellow), Logistics 4.0 (green).

Source: built using Google Trends tools.

- digital logistics
- Intelligent logistics
- Smart logistics
- Logistics 4.0

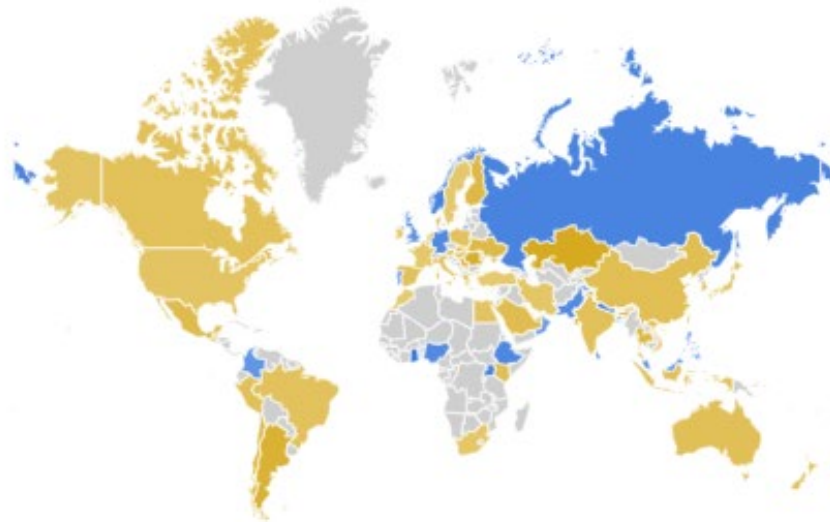


Figure 15 – Popularity of selected topics by world region for 2020-2024
 Note: colour intensity depends on the percentage of queries.
 Source: built using Google Trends tools.

The most common user search queries in countries around the world include: digital marketing (100 points), Industry 4.0 (100), smart tracking (100), digital supply chain (76),

logistics management (64), smart city (52), supply chain 4.0 (39), smart logistics (23 points).

Table 5 – Level of interest in the topic by world regions, %

Region	Search queries			
	Digital Logistics	Intelligent Logistics	Smart Logistics	Logistics 4.0
Norway	61	0	39	0
Germany	55	10	27	8
Singapore	54	5	36	5
UK	47	10	39	4
Denmark	46	0	54	0
USA	44	8	46	2
Korea	42	4	43	11
Switzerland	41	11	38	10
Canada	40	6	51	3
Portugal	39	12	32	17
Poland	37	6	48	9
Ukraine	32	8	60	0
Japan	30	9	52	9
China	24	22	54	0

Note: share of total number of queries in the country.
 Source: built using Google Trends tools.

In most countries of the world, in the last five years, there has been a trend of increasing popularity of topics such as the use of digital technologies (average 60 points) and

information and communication technologies (average 7 points) (Fig. 16, Table 6).

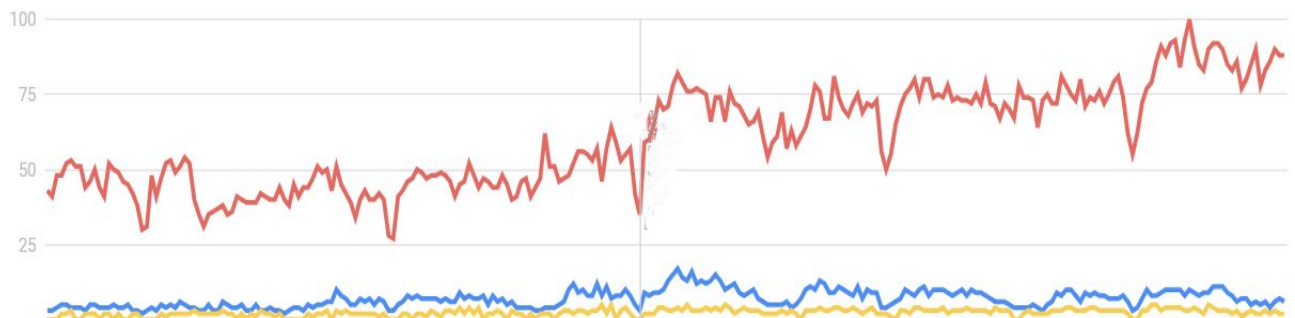


Figure 16 – Dynamics of search frequency changes in the context of the definitions of “Information and communication technologies”, “Digital technologies”, “Logistics activity” in the world for the period 2020-2024

Notes: Information and communication technologies (blue colour), Digital technologies (red), Logistics activity (yellow colour).

Source: built using the Google Trends toolkit.

If we consider Ukraine, it is worth noting that over the past five years, topics related to digital transformations and digital

technologies have been of significant interest in search.

Table 6 – Level of interest in the topic by world regions, %

Region	Search queries		
	ICT	Digital technologies	Logistics activity
Turkey	25	75	0
Portugal	20	80	0
Romania	19	81	0
Slovakia, Ukraine	18	82	0
Czech Republic	14	86	0
Spain	13	86	1
USA	10	84	6
Lithuania	10	90	0
Poland	10	88	2
Korea	9	91	0
China	8	92	0
Canada	8	88	4
Finland	7	88	5
Japan	6	91	3
Italy	5	94	1
Germany	4	95	1
United Kingdom	3	96	1

Note: share of the total number of queries in the country.

Source: built using the Google Trends tool.

Thus, research into trend patterns of publication activity on the digital transformation of logistics activities of enterprises has shown the significant popularity of this issue in academic circles, as well as its permanent growth.

However, based on the results of the trend analysis (based on the analysis of the dynamics of the number of publications on the topic under study, indexed by the Scopus scientometric database, for 1976-2024, analysis of trends in user interest in this issue based on the Google Trends tool for the period 2020-2024), as well as a generalization of the conceptual developments existing in the scientific literature on substantiating the digital transformation of logistics activities, it can be concluded that this problem is complex and multifaceted, it has a synergistic effect on the national economy and is inextricably linked with ensuring economic and food security.

Conclusions. Based on the results of the study, the following conclusions can be drawn. The number of publications indexed in Scopus, the titles, abstracts and keywords of which contain the terms "digital transformation", "information and communication technologies", "digital technologies", "logistics activity" is growing at an accelerated pace every year. Research on transformational changes in logistics activities has been gaining increasing popularity since the 2000s. The main reasons for the growth in the popularity of these scientific studies are: the search for new ideas, the transformation of the logistics management paradigm, the introduction of

the concepts of digital and smart logistics, the activation of the development of digital technologies.

The term "digital transformation of logistics activities" is interdisciplinary in nature, used in research in various fields of science, namely: it is found in publications on engineering, computer science, social sciences, management, economics, decision science, etc.

Visualization of the keyword network map based on bibliographic data allowed us to identify 7 clusters that characterize key areas of research: temporal changes, principles of partnership and cooperation, operational management, provider services using smart technologies.

The leaders in the number of publications indexed in the international scientometric database Scopus and containing the term "digital transformation of logistics activities" are China, Germany, India, the USA, Great Britain, Italy, France, Spain, Turkey, etc.

It should be emphasized that the transformation of logistics activities of companies in publications is mostly considered from the perspective of the application of digital technologies. This, in turn, requires the formation of fundamentally new approaches to the organization of logistics activities based on digitalization. This is also confirmed by the bibliometric analysis, which identified gaps and possible directions for further scientific research. One of such gaps is insufficient substantiation of the strategy for the digital transformation of logistics activities of enterprises. This issue requires special attention and may become a direction for further scientific research.

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