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RESEARCH OF IT TRENDS IN LOGISTICS

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Abstract. *IT trends in logistics using the analysis of information provided by leaders in the field of logistics services, consulting companies and on the basis of publications from the Scopus scientometric database are studied in this paper. To generate queries to the Scopus document database, we grouped IT logistics tools and trends, which made it possible to obtain sets of terms for analytical search of publications.*

The result of the analytical query on publications related to logistics management systems reflected 2188 documents with the largest number of cited works on blockchain technology. The most popular sources of publications by the number of papers, as well as the distribution of articles and conference abstracts by research area were identified. Documents from the field of computer science account for 36.2% of the total. Analyzing publications by query using a set of terms from the group of tracking and monitoring systems, we obtained the result of publications dynamics and the list of the most active universities in this area of research. In the group of IT services for automation and optimization tools, 5679 documents with the highest citation of articles on AI and machine learning were found. Similar queries, using sets of terms appropriate to the group, were made for logistics systems for information and documentation exchange, warehouse systems and facilities, cybersecurity, cloud technologies, and sustainable and smart logistics. The main areas of research based on citations are autonomous vehicles, mobile robots, automated warehouse picking and employee assistance systems, deep learning, learning algorithms, Big Data, boundary computing, green logistics, sustainable development, and supply chain management.

IT trends of the leading logistics industry leaders by studying annual documents describing them were analyzed. Based on DHL's «Trend Radar», it was established that the groups of IT logistics trends presented and analyzed actually reflect the global trends in the development of IT in the logistics industry. It was found that the research of audio AI, transformation of green cities, e-commerce, assistive technologies for employees, and ethics of AI use are promising. Other existing technologies should be updated and rethought, taking into account new IT logistics trends.

Key words: *logistics trends, artificial intelligence, Big Data, cloud technologies, machine learning, deep learning, sustainable development.*

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1. INTRODUCTION

The development of logistics services is largely due to the rapid growth of e-commerce and the emergence of new information technologies (IT). The recent Covid-19 pandemic has reinforced these trends by limiting face-to-face communication and prompting the search for alternative options. The beginning of full-scale invasion and war in Ukraine has caused new difficulties and challenges for logistics providers to deal with. While most countries in the world are implementing peacefully the latest IT trends and approaches to shaping the logistics services market, companies in Ukraine are forced on taking into account the vulnerabilities that arise during hostilities. It is proposed to investigate these and other aspects of the formation of IT logistics service sets, taking into account the world experience in this area.

The role of IT technologies in modern logistics is key one creating conditions for efficient, fast, accurate and transparent operation of logistics processes. Implementation of IT solutions makes it possible to optimise operation, reduce costs and improve customer service. The report by the consulting company Camelot states that the introduction of artificial intelligence (AI) into logistics has 100% effect in reducing costs, 94.1% increase in flexibility, 88.2% reduction in activity duration, and 82.2% increase in the range of services [1].

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The objective of this paper is to investigate IT trends in logistics based on the analysis of information provided by world leaders in logistics services, consulting companies, and world-wide publications on the implementation and use of IT solutions in logistics, enabling us to evaluate the breadth and depth of the presentation of the topic of logistics services and identify the most promising areas of our own research. For this purpose, approaches and means of publication analysis based on the scientometric databases Scopus [2], Web of Science [3] or Google Scholar were used. This makes it possible to evaluate the influence of authors and their works in the scientific community, as well as to track the most significant investigations. The results of the content analysis are used to study publications for ideas, research directions, or the use of basic approaches in published texts. The main indicators are the frequency of the used words and phrases. NVivo or MAXQDA are the programs provide opportunities to automate this process. When it is necessary to summarize the results of various investigations on the same topic, meta-analysis which enables us to evaluate new trends and get objective picture is carried out. Analysis of scientific social networks, where connections between authors, scientific schools, institutions, and countries are observed is promising as it makes possible to track relevant publications and establish personal contacts to expand scientific activities. There are tools for visualizing such networks that simplify the work of scientists. This includes software products such as Gephi and VOSviewer.

Most logistics companies publish annual reports or brochures highlighting future industry trends. Analysis of IT trends in these documents makes it possible to determine the effectiveness of technologies and approaches used to generalize indicators and select promising research directions. Due to SWOT analysis we can identify weaknesses and strengths, as well as internal and external threats that affect the development of the logistics industry. Based on PESTEL analysis, the sets of political, social, technological, economic and legal aspects directly related to logistics are formed. New technologies and prospects for their use are described in «Technology Radar», its analysis makes it possible to evaluate the possibilities of using innovations in the form of autonomous vehicles, Internet of Things, drones, artificial intelligence, and blockchain technologies. Special attention should be paid to the investigation of supply chains that are directly related to local markets and global Industry 4.0 and 5.0 trends, economic and political events in the country and the world. Sustainability analysis takes into account environmental and social trends resulting in the reduction of carbon footprint, improvement and shortening of delivery routes, and introduction of green technologies [4].

Based on the carried out analysis, the main areas of research which include tracking major publications and authors based on Scopus, Web of Science or GoogleScholar tools using trends and tendencies described in analytical documents and reports of leading logistics market leaders are formulated. Thus, a comprehensive approach to the analysis of information and development of new services, information technologies and software products taking into account the above mentioned material is used.

2. THE MAIN PART

Analysis of the content of information resources of the leading logistics companies makes it possible to classify the main IT technologies, tools and trends used in modern logistics [5–9]. Based on the carried out investigation, the following groups of IT logistics tools and trends can be formed:

- logistics management systems;
- tracking and monitoring systems;
- automation and optimization tools;
- logistic systems for information and documentation exchange;

- warehouse systems and facilities;
- cybersecurity and cloud technologies;
- sustainable and smart logistics.

The investigation of each group provides the opportunity to obtain a set of terms on the basis of which it is possible to carry out analytical search for publications and evaluate the relevance and development of each area of research in IT logistics services. For this purpose, the scientometric database Scopus and its tools for searching and analyzing publications are used.

IT trends in logistics management systems are related to supply chain management, corporate resource planning tools, warehouse management systems, goods transportation systems, order processing platforms, and transport management systems. Analytical query (TITLE-ABS-KEY («Supply Chain Management») OR TITLE-ABS-KEY («Enterprise Resource Planning») OR TITLE-ABS-KEY («Warehouse Management System») OR TITLE-ABS-KEY («Enterprise Resource Planning») OR TITLE-ABS-KEY («Transportation Management System») OR TITLE-ABS-KEY («Order Management System») OR TITLE-ABS-KEY («Yard Management System»)) AND TITLE-ABS-KEY («Logistics») AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND SUBJAREA (COMP), for publications analysis using the terms of this group of IT logistics services during the last 10 years, gives us 2188 documents with the ability to filter by citation level. The largest number of highly cited papers is devoted to blockchain technology in logistics. The analytical results of publications concerning IT logistics management systems are shown in Figure 1.

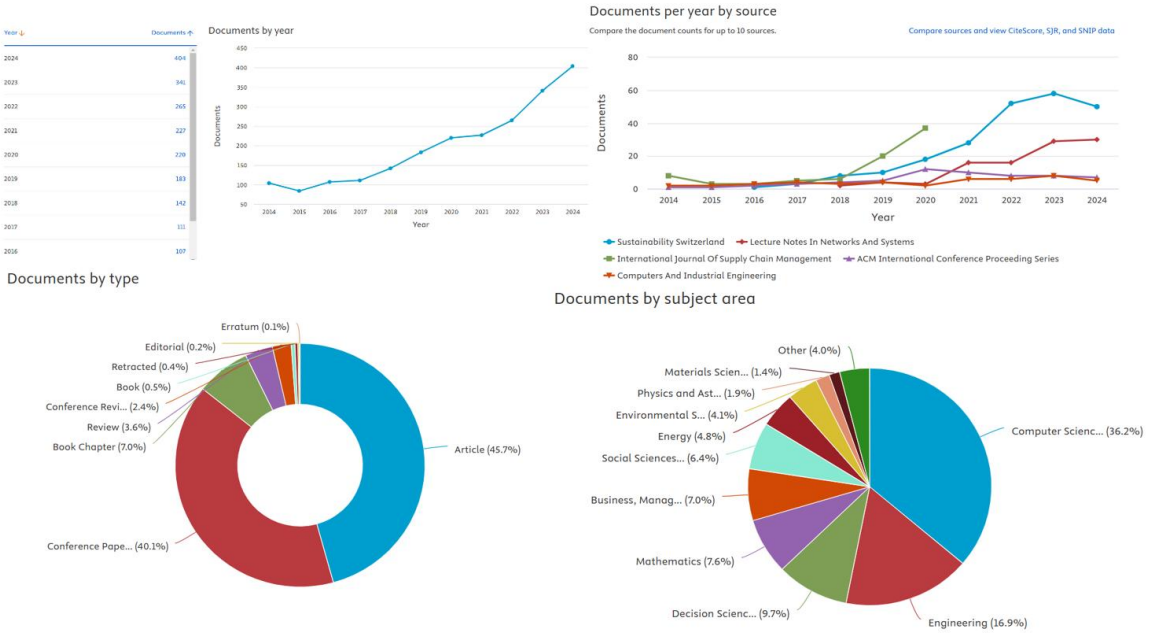

Figure 1. Result of analytical query of the investigation of IT publications about logistics management systems

We can observe the increase in the number of publications over the years, which indicates the interest in this area of research. The largest number of documents concerning this topic was published in Sustainability Switzerland, and according to the type of documents the articles (45.7%) and conference abstracts (40.1%) dominated. Rubric analysis shows that documents in the field of computer science account for 36.2% of the total number of publications and are the predominant researches in comparison with other fields.

In order to analyze tracking and monitoring systems, let us execute the query (TITLE-ABS-KEY («Radio Frequency Identification») OR TITLE-ABS-KEY («Global Positioning System») OR TITLE-ABS-KEY («Internet of Things») OR TITLE-ABS-KEY («Telematics») OR TITLE-ABS-KEY («Geo fencing») OR TITLE-ABS-KEY («Cold Chain Monitoring»)) AND TITLE-ABS-KEY («Logistics») AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND SUBJAREA(COMP). We have found 3413 documents where the most cited ones are related to Industry 4.0 and Internet of Things (IoT) technologies. The dynamics of publications is positive with slight decline in 2024. The top three most active authors are Huang G. Q., Zhong R. Y. and Babbar H. On the basis of analysis we can established that the top three most productive universities in terms of the number of publications are SRM Institute of Science and Technology (40), Chitkara University (32), Punjab and Amity University (31).

While investigating IT services group of automation and optimization tools, the query (TITLE-ABS-KEY («Artificial Intelligence») OR TITLE-ABS-KEY («Big Data Analytics») OR TITLE-ABS-KEY («Robotic Process Automation») OR TITLE-ABS-KEY («Digital Twins») OR TITLE-ABS-KEY («Predictive Analytics») OR TITLE-ABS-KEY («Last Mile Delivery Optimization»)) AND TITLE-ABS-KEY («Logistics») AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND SUBJAREA(COMP) was created. 5679 documents with the highest citations of articles related to AI (2815) and machine learning (1757) were found.

The query (TITLE-ABS-KEY («Electronic Data Interchange») OR TITLE-ABS-KEY («Electronic Consignment Note») OR TITLE-ABS-KEY («Application Programming Interface») OR TITLE-ABS-KEY («Blockchain») OR TITLE-ABS-KEY («Smart Contracts»)) AND TITLE-ABS-KEY («Logistics») AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND SUBJAREA(COMP) was performed for the analytical investigation of publications concerning logistics information and documentation exchange systems. 1392 documents with the highest number of citations related to blockchain technology (900), supply chain (254) and IoT (232) were found. Sources with the largest number of publications are Lecture Notes In Networks And Systems (70), ACM International Conference Proceeding Series (44), Sustainability Switzerland (42), IEEE Access (41). China, India, and the United States are the leading coutries engaged in the research area mentioned above. The most active universities that published documents upon request are The Hong Kong Polytechnic University (16), SRM Institute of Science and Technology (16), King Abdulaziz University (12), Amity University (12).

While analysing publications concerning IT trends in warehouse systems and facilities, we performed the query (TITLE-ABS-KEY («Automated Storage») OR TITLE-ABS-KEY («Drones»)) AND TITLE-ABS-KEY («Logistics») AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND SUBJAREA(COMP), from which 739 documents were found. The largest number of investigations were carried out on drones (435) and communications (153). The researchers were also interested in autonomous vehicles, mobile robots, automated warehouse picking systems and systems assisting employees in receiving goods.

The increased application of IT technologies in logistics has created conditions for threats to their functioning. Cybersecurity and cloud technologies in logistics assist to solve existing challenges and support future technologies. Analysis of publications in this area of investigation was carried out using the query based on the relevant terms (TITLE-ABS-KEY («Cybersecurity») OR TITLE-ABS-KEY («Cloud») OR TITLE-ABS-KEY («Software as a Service») OR TITLE-ABS-KEY («Edge Computing»)) AND TITLE-ABS-KEY («Logistics») AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND SUBJAREA(COMP). We found 2616 documents with the following research topics: machine learning (568), IoT (510), logistic regression (499), cybersecurity (460), cloud computing (431). The universities that have paid the most attention to this area are Deakin University (31), Chitkara University, Punjab (31), Anhui University (27), Chinese Academy of Sciences (27), SRM Institute of Science and

Technology (26). Top 5 sources of publications by number of published documents are Lecture Notes In Networks And Systems (85), Lecture Notes In Computer Science Including Subseries Lecture Notes In Artificial Intelligence And Lecture Notes In Bioinformatics (76), ACM International Conference Proceeding Series (68), IEEE Access (64), Communications In Computer And Information Science (54). The majority of documents are conference abstracts (52.5%) and articles (32.8%) in the field of computer science (40.8%). The researchers were also interested in deep learning, learning algorithms, AI, Big Data, edge computing, etc.

Sustainable and smart logistics is an integral part of the industry's digital transformation. IT logistics trends related to green technologies in route planning for the reduction of carbon footprint, the use of electric cars and electric trucks with autonomous or augmented control systems make it possible to create the foundation for the industry development in the direction of Industry 5.0. The research of publications in this group of IT logistics services was carried out by means of the query (TITLE-ABS-KEY («Green Logistics IT») OR TITLE-ABS-KEY («Carbon Footprint Tracking») OR TITLE-ABS-KEY («Smart Cities Logistics») OR TITLE-ABS-KEY («Electric Vehicle Fleets»)) AND TITLE-ABS-KEY («Logistics») AND PUBYEAR > 2013 AND PUBYEAR < 2025 AND SUBJAREA(COMP). We found 394 documents describing IT trends in green logistics (226), logistics (109), vehicle routing (58), sustainable development (53), and supply chain management (38).

There are many logistics companies that reflect global trends in the logistics market [10]. Analysis of IT trends of the top leaders in this industry makes it possible to evaluate the prospects for the future development of logistics services [7, 11–16]. DHL's «Trend Radar» [15, 16], where the company describes existing and promising IT solutions based on their research of the logistics services market is shown in Figure 2.

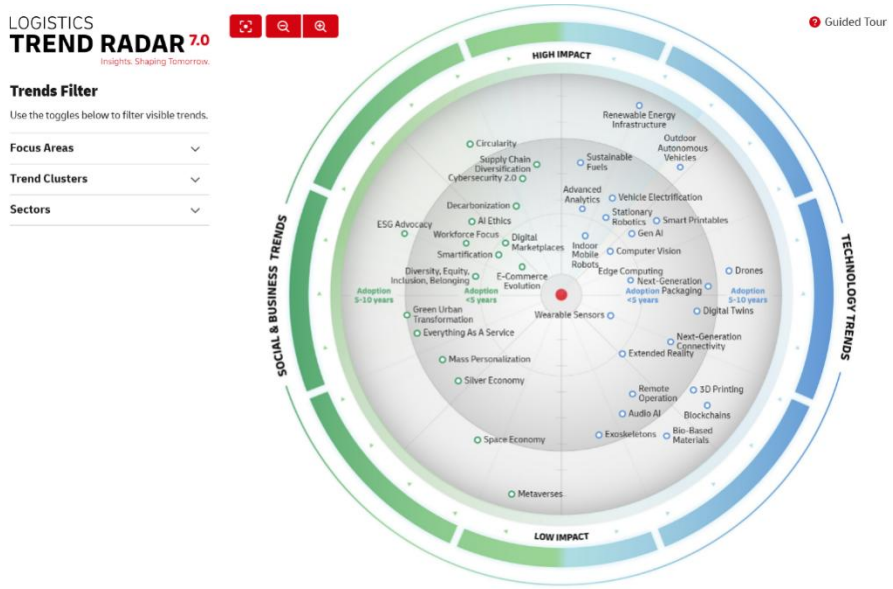

Figure 2. DHL Trend Radar 7.0

Analysis of «Technology Radar» shows that the above mentioned groups of IT logistics trends actually reflect global trends in the development of the IT logistics industry. The most promising are the investigations of audio AI, transformation of green cities, e-commerce development, assistive technologies for employees, and the ethics of AI application. IT technologies that require further research and rethinking include interactive AI, Big Data analytics, next-generation communication technologies, smart tags, remote work and the use of teleoperators, alternative energy sources, and sustainable development The use of automation

and robotics, digitalization and intelligent technologies, environmental and social sustainability, last-mile technologies, new business models and e-commerce trends, digital security and information protection will open new opportunities of further research in order to develop ideas for new information technologies and solutions in the field of logistics services.

3. CONCLUSIONS

IT logistics trends based on data provided by global logistics companies and with the use Scopus advanced search and analysis tools is analyzed in this paper. Groups of IT logistics tools and trends were formed. This made it possible to obtain the set of terms on the basis of which the relevant queries to the Scopus scientometric database were created. Analysis of IT logistics trends for each group was carried out and the most promising research areas based on the number of publications in the relevant area were identified. The activity of authors based on the level of citation and universities by the number of publications in each group is analyzed.

Various options for the investigation of publication by means of content analysis, meta-analysis, and social media analysis with the examples of tools for automating these processes automation are presented in this paper. It is proposed to use available documents to analyse trends in the development of logistics market with SWOT, PESTEL and «Technology Radar» analysis, due to which it is possible to form appropriate queries for the search of publications meeting the objectives of a particular research.

DHL's «Technology Radar» (TrendRadar 7.0) was used to form promising research directions and the list of existing ones that require a new look and rethinking is provided.

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ДОСЛІДЖЕННЯ ІТ ТРЕНДІВ У ЛОГІСТИЦІ

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Резюме. *Здійснено дослідження ІТ трендів у логістиці, використовуючи аналіз інформації, поданої лідерами в галузі логістичних послуг, консалтинговими компаніями та на основі публікацій з наукометричної бази Scopus. Для формування запитів до бази документів Scopus проведено групування ІТ логістичних засобів і трендів, що дало змогу отримати набори термінів для аналітичного пошуку публікацій. Результат аналітичного запиту щодо публікацій, пов'язаних з логістичними системами управління відобразив 2188 документів з найбільшою кількістю цитованих праць, присвячених технології блокчейн. Визначено найпопулярніші джерела публікацій за кількістю праць, а також розподіл статей і тез конференцій за галузями досліджень. Документи з галузі комп'ютерні науки займають 36,2% від загальної кількості. Аналізуючи публікації через запит з використанням набору термінів із групи систем відслідковування та моніторингу, отримано результат динаміки публікацій, список найактивніших університетів за даним напрямом дослідження. У групі ІТ сервісів засобів автоматизації та оптимізації виявлено 5679 документів з найбільшим цитуванням статей щодо ШІ та машинного навчання. Аналогічні запити, використовуючи відповідні до групи набори термінів, виконано для логістичних систем обміну інформацією та документацією, складських систем та засобів, кібербезпеки, хмарних технологій, сталої та розумної логістики. Основними напрямками досліджень за рівнем цитувань у них виявлено автономні транспортні засоби, мобільні роботи, автоматизовані системи отримання зі складу й допомоги працівникам, глибоке навчання, алгоритми навчання, великі дані, граничні обрахунки, зелена логістика, сталий розвиток, управління ланцюгами постачання.*

Здійснено аналіз ІТ трендів провідних лідерів логістичної галузі через дослідження щорічних документів з їх описом. На основі «Технологічного радару» від компанії DHL встановлено, що наведені та проаналізовані групи ІТ логістичних трендів актуально відображають світові тенденції розвитку ІТ логістичної галузі. Виявлено, що перспективними при цьому є дослідження аудіо ШІ, трансформації зелених міст, електронної комерції, допоміжних технологій для працівників, етики використання ШІ. Інші існуючі технології потребують актуалізації та переосмислення, враховуючи нові ІТ тренди логістики.

Ключові слова: *логістичні тренди, штучний інтелект, великі дані, хмарні технології, машинне навчання, глибоке навчання, сталий розвиток.*

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