Marketing and logistics

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DEVELOPMENT OF THE LOGISTICS 4.0 CONCEPT
IN THE DIGITAL ECONOMY

Introduction. The digital economy is one of the priority areas for the development of national economies around the world in the global information environment. The main prerequisites for its formation and rapid development include: the globalization of the world economy and the integration of world capital markets; transnationalization of innovative production; transformation of business methods; changes in the company's capital structure; increased competition and differentiation of companies; innovativeness of the organizational structure; the use of digital technologies; the revitalization of e-commerce.

Experts from the McKinsey Global Institute [1] argue that the development of the digital economy is comparable in scale to the industrial revolution of the 18th-19th centuries, which radically changed the whole world, giving many countries an impetus to economic growth, changing the very development paradigm. An increase in the share of the digital or information economy and the acceleration of GDP growth due to digitalization are among the priority problems of a global scale [2].

The modern transition to the digital economy is becoming a key driver of GDP growth. This is due not only to the effect obtained from the automation of existing processes, but also from the introduction of new, breakthrough business models and technologies, including digital platforms, digital ecosystems, in-depth analytics of big data, Industry 4.0, Logistics 4.0.

Analysis of recent publications on the problem. The founder of the concept of "digital economy" as a virtual economic system is D. Tapscott [3]. Scientists R. Bukh, R. Heeks [4] systematized the existing terms "digital economy", highlighting 4 approaches that have their own specifics:

resource-oriented – relies on technology, information resources, that is, data processing (Brynjolfsson, Kahin [5]), as well as human resources, that is, human knowledge and creativity arising from information and communication technologies (Tapscott [3]);

procedural – the use of technology for the implementation of business transactions (Mesenbourg [6]); new flows of information and data generated by ICT (Lane [7]); ongoing transformations in technological processes (Bahl [8]);

structural – includes the transformation process (Brynjolfsson, Kahin [5]) and developing structures based on web (network) technologies as components of the digital economy;

business-oriented – new emerging business models are considered as components of the digital economy, that is, networked business and e-commerce (Mesenbourg [6]) or digital platforms.

As the analysis shows, a number of researchers note that the most important component of the digital economy is a sufficient level of applied technology that transforms relations between business entities, changing the paradigm towards the development of flexible economic organization schemes, where coordination takes place through digital technologies. For others, in addition to economic activity, the definitions touch upon the social sphere. Still others focus on the factor of techno-

logical development of the production structure and the growing role of information and communications in the process of carrying out economic activities.

R. Asanov [9], speaking about the digital economy, limits its functioning to the production of electronic goods, services and their distribution using e-commerce. But in this case, the question remains unsolved – what place in this interpretation is given to intangible values.

A. Kutsman [10], characterizing the digital economy, identifies information, knowledge and the use of digital technologies for storing, processing and transmitting information as the main resources for the production of goods and services.

A new type of economy, which includes the digital economy, requires, in turn, new approaches to management [11-20]. The complexity of building a management system in this case is determined by the variety of economic systems and the need to take into account the specific characteristics of the development of different countries [21].

Based on the conceptual provisions and own research results [22-28], it is proposed to use the term "information economy" as a system of economic relations with the use of modern information technologies, as well as an information environment that effectively develops with the help of digital technologies and the functioning of information infrastructure objects.

According to K. Peres [29], the digital economy is a new, fifth in a row, technological order, restarting competitive competition on a new basis, which means that in this market competition "the latter can become the first".

T. Pettinger [30] defines the digital economy as an economic activity that uses electronic communications and digital technologies to provide goods and services (Fig. 1).

Traditional economy	Digital economy
Factories	Data Centres / Cloud computing
High street shops	Internet website
Newspaper ads/word of mouth	Social media reviews
Transportation	E-sales – digital downloads
Banks and cash points	E-Banking
Schools/textbooks	E-learning, e-books
9-5 commute	Working from home
Physical assets	Google rankings / brand image
Construction	Website development
Real estate	Domain ownership
Cash – cheque payment	e-payment, cashless society
Labour and capital	Automation and AI.
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Fig. 1. Differences between traditional and digital economies
(built according to [30])

The advantages of the digital economy include the following: a large amount of information; saving time; cost reduction; personalization; lower barriers to entry; generating significant data that can provide new insights; the possibility of remote work (Fig. 2).

Digital transformation today is a challenge of the times. For the first time, the term "digital transformation" was introduced into scientific circulation by researchers at the end of the 20th century, when digital management methods went beyond conventional technologies and began to significantly change the form of doing business. According to the World Economic Forum, the economic impact of digitalization will reach 1.3 trillion dollars by 2025. It has been established that the advantages of the digital transformation of the economy are the acceleration of GDP growth due to digital tech-

nologies, an increase in the share of the information economy, an increase in the level of competitiveness of companies, a decrease in production costs, an increase in labour productivity, the creation of new jobs, and an improvement in the quality of logistics services.

Transformation is a process of cardinal change of an object as a whole or of its individual elements as a result of the influence of external and internal factors. Currently, there are many definitions of the concept of "digital transformation". Analysts at the Boston Consulting Group (BCG) [31] interpret digital transformation as maximizing the full use of the potential of digital technologies in all aspects of business. This definition focuses on the scale of implementation of specific technologies, but not on the scale of change.

The Digital economy

Pros	Cons
• Greater information and choice • Saves time • Reduced costs for business • Greater personalisation • Lower barriers to entry • Greater flexibility in work, enabling people to work from home. • Benefits for developing world	• Monopoly power of tech giants • Less community • Addictive nature of technology • Privacy issues • Bypassing of labour laws. • Disruption to traditional economy and jobs. • Potential environmental costs. www.economicshelp.org

Fig. 2. Advantages and disadvantages of the digital economy
(built according to [30])

The data analyst of the Rufus Leonard agency G. King [32], in his formulation of digital transformation, focuses on the scale of transformations concerning not only the internal environment of the company, but also the external one (consumers and competitors). He defines the term as a large-scale business transformation, affecting the entire set of enterprise functions from the automation of procurement to sales and marketing, affecting both the change in the operating model and the infrastructure of the enterprise, based on digital technologies and proceeding under the influence of three main drivers: changes in user requests, technology development and increased competition.

Another group of authors emphasize the necessary results (consequences) of digital transformation. In the report of the Global Centre for Digital Business Transformation [33], the following definition is given: it is the path to the implementation of digital technologies and business models to increase productivity in quantitative terms. A similar definition was formulated by scientists at the Massachusetts Institute of Technology [34]: the use of technology to radically increase productivity or the availability of resources for enterprises.

The third group of scientists focuses on changing business thinking, decision-making and business culture. From the point of view of V. Ryzhkov [35], the digital transformation of business is a change in business thinking in the new conditions of the digital economy, driven by the modern consumer and the changing culture of communications.

Agile Elephant analyst D. Terrar [36] believes 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 style, rewarding innovation, and the adoption of new business models to improve the performance of the organization's employees, customers, suppliers, and partners.

According to B. Garifullin and V. Zyabrikov [37], the digital transformation of the economy is a process of a radical change in the form of the economic system, as a result of the search, development, implementation and use of digital technological innovations to increase the efficiency of performing their functions by all of its structural units. Digital transformation of business is a conscious, management-initiated process of cardinal improvement of business processes both in the internal and external environment of the company based on the search and development, as well as the subsequent implementation and use of digital technologies.

Based on the foregoing, it is proposed to consider digital transformation as radical changes in the complex of business processes, from product development to customer service, as well as the introduction of modern digital technologies in the organization of business processes at enterprises [22; 23].

It should be noted that the implementation of qualitatively new digital technologies is a necessary but insufficient condition for digital transformation. These technologies should bring a significant positive economic effect: increase productivity by increasing production volumes and reducing the amount of resources used for production. For such an increase in the level of productivity, a comprehensive business transformation is advisable, in which the use of digital technologies is accompanied by improvement of management. It should be emphasized that in most cases, digital business transformation yields positive results in the long term, since the initial investment in technological and related changes represent significant costs that will pay off over a long period of time.

As shown by the results of a study by Capgemini Consulting and MIT Sloan School of Management [38], the digital transformation process cannot be completely ignored. This is due to the fact that the decrease in profit in this case compared to competitors will be 24% per year. It has been found that companies' profits grow by an average of 26% if technology and new management methods are used together. If only to improve manage-

ment, without resorting to digital technologies, then the profit of companies will grow by 9%. If you invest only in technology, without paying attention to the necessary changes in management, the profit does not grow at all, but falls by 11%.

Specialists of IDC FutureScape [39] have developed forecasts for the development of global digital transformation:

1) creating economic gravity through accelerated investment in DX – 65% of world GDP will be transferred by 2022, and in the period from 2020 to 2023 more than 6.8 trillion dollars in direct investment in DX will be attracted;

2) digital organizational structures and roadmaps – by 2023, 75% of organizations will have plans to implement comprehensive digital transformation (DX), up from 27% today;

3) the maturity of digital management systems – by 2023, 60% of leaders of G2000 organizations will shift the orientation of management from processes to results, creating more flexible, innovative and responsive operating models;

4) the growth of the digital platform and extended ecosystems – by 2025, due to unstable global conditions, 75% of business leaders will use digital platforms and ecosystem capabilities to adapt their value chains to new markets, industries and ecosystems;

5) digital approach to personnel management – 60% of enterprises in 2021 will invest heavily in the digitization of employee experience, which will change the relationship between employers and employees;

6) rethinking the business model – by 2021, 30% of organizations will accelerate innovation to support the rethinking of business and operating models, a transformation program to ensure that their business meets the requirements of the future;

7) sustainability and DX – by 2022, most companies will realize the great value due to the combination of digital technologies and sustainable development, which will lead to the emergence of projects based on digital technologies and ensuring sustainable development;

8) cultures of digital origin – 50% of enterprises will implement an organizational culture optimized for DX in 2025, based on customer focus and data;

9) accelerating digital experiences – by 2022, 70% of all organizations will accelerate digital transformation, transforming existing business processes to drive customer interactions, employee productivity and business resilience.

10) creating business innovation platforms – by 2023, 60% of G2000 companies will create their own business innovation platform to support innovation and growth in the new environment.

Thus, companies that are driven by new digital business models that successfully implement their enterprise strategies on digital platforms are well positioned to continue to succeed in the digital economy.

It should be noted that the organization of logistics activities and supply chain management must also adapt to the conditions of the digital economy. In this regard, logistics has transformed into a new one, modernizing the processes of purchasing, delivery, production, storage, marketing, transportation, customer service, and waste recycling. Therefore, it is necessary to solve a qualitatively new problem, which implies the application of the concept of Logistics 4.0 in the context of digital business models.

The purpose of the article is to study the features of organizing logistics activities in the context of digital transformation of business processes; considering the prerequisites for the formation of the concept of Logistics 4.0 and determining the priority areas of its further development in the context of Industry 4.0.

Outline of the main results and their justification. Logistics 4.0 is defined as intelligent logistics because its components enable processes to be managed intelligently. The components of Logistics 4.0 are [40]: automatic identification, real-time location determination, automatic data collection, connection and integration, data processing and analysis, business services.

Logistics 4.0 is a logistics system that ensures sustainable satisfaction of individual customer needs without increasing costs and supports this development in industry and commerce using digital technologies [41].

According to L. Barreto, A. Amaral, T. Pereira [42], we use the term "Logistics 4.0" to denote the combination of the use of logistics with innovations and applications with the addition of CPS. Logistics 4.0 is subject to the same terms and conditions as Smart Services and Smart Products. We then have to take into account that the technological approach used to define "smart products" and "smart services" is used to define "smart logistics". Smart products and services are those that can perform tasks that are usually performed by humans. In addition, they enable delegated activities so that employees can focus on tasks that require more intelligence than automated processes or the intelligence that a simple smart product or smart service can provide.

Logistics 4.0 should rely on and use, from our point of view, the following technological applications: resource planning; warehouse management systems; transport control systems; intelligent transport systems; Information Security.

Smart Logistic is a logistics system that can increase flexibility, adapt to market changes and bring a company closer to customer needs. This will improve the level of customer service, production optimization and lower prices for storage and production. Since Smart Logistics will change in accordance with current technologies, it depends on time, and therefore it is important to determine the state of technology [43].

Thus, Logistics 4.0 can be viewed as a modern paradigm for managing logistic (material, financial, information, transport) flows and organizing a complex of logistics activities (purchase and delivery of material resources, warehousing, production, stock formation, in-

dustrial waste recycling, customer service, transportation and sales of finished products) using breakthrough digital technologies and information systems (Fig. 3).

The use of artificial intelligence (AI) in transportation and logistics is diverse. Leading logistics organiza-

tions are already using AI and machine learning. AI-driven technologies are being developed to mimic human thinking and transcend human thinking in terms of efficient data-driven decision making.
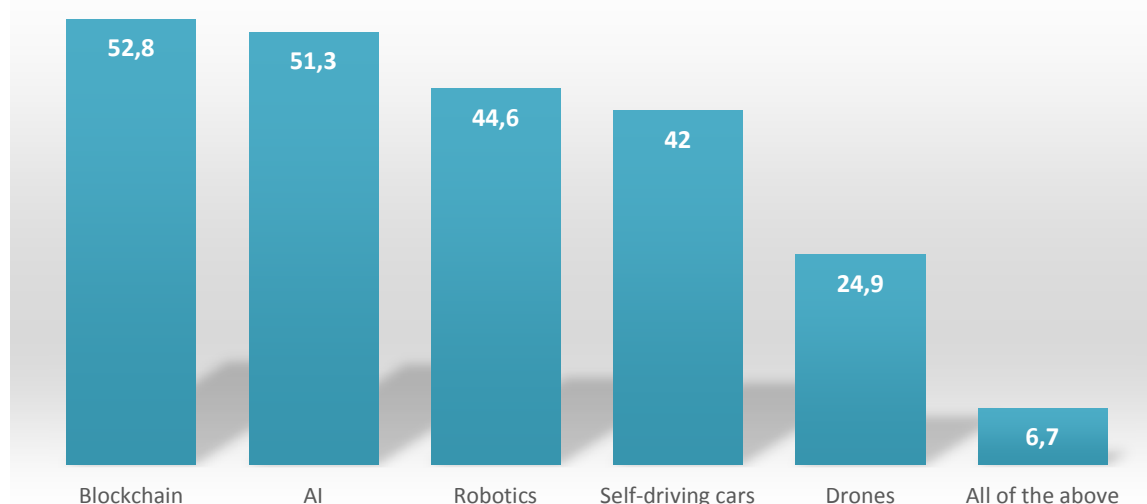

Fig. 3. Disruptive Technologies in Logistics, % of respondents
(built on the basis of [44])

AI is a tool for managing global supply chains in an asset management system. Using predictive AI analysis can help transport service providers optimize route planning and delivery schedules. In addition, the technology approach delivers improved asset performance through timely maintenance, resulting in fewer failures.

AI technologies in logistics are a necessity for an enterprise to achieve and maintain its competitive advantage. According to Forbes Insight, 65% of industry leaders believe that an era of "deep transformation" has begun for logistics, transportation and supply chain management.

The Accenture report shows that 36% of large, medium and small organizations successfully use AI for logistics and supply chain processes. And 28% of respondents are on the verge of bringing AI to logistics. At the same time, by 2035, labor productivity will increase by more than 40%. And the growth of AI revenues in logistics is axiomatic, since technologies are already modernizing the industry in various aspects (Fig. 4).

Artificial intelligence includes systems that can mimic, automate, reproduce human thinking, and take data-driven actions more efficiently than humans. In other words, AI has some abilities in common with humans. These are the abilities to perceive different types of information, understand different sets of data, learn in many ways, and generate solutions.

The key performance metric for such systems is error rate. High-quality voice assistants driven by artificial intelligence exhibit a margin of error of 5%. This is the level of performance that IBM reports when des-

cribing the state of the technology. Thus, the more mature image recognition technologies become, the more advanced the functionality of systems controlled by artificial intelligence becomes.

The introduction of AI in transportation can help reduce the burden on logistics accounting teams. Many vendors in this industry have partnered with third-party vendors to develop AI software to ensure safe, high-quality transportation. This results in a lot of invoices and other documents that the logistics provider team has to deal with.

AI logistics solutions and natural language processing (NLP) technologies can help you work with huge amounts of unstructured data and extract important information about received bills, addresses, dates, and more. Among other things, the use of technology to automate accounting tasks significantly contributes to security. For example, Ernst & Young uses an ML-based system to monitor invoice anomalies, classify documents, verify compliance with various regulations, and more. The system demonstrates high performance: it solves the problem of detecting fraud with an accuracy of 97%.

Large-scale supply chains must manage numerous transportation assets and facilities around the world. AI in the supply chain and logistics makes it easier to solve these problems. It helps to process and categorize related contracts, review lengthy legal documents, keep customer information up to date, verify delivery details, and eliminate duplicate information. Traditionally, such tasks require the involvement of entire departments, which is costly and unproductive. However, AI systems
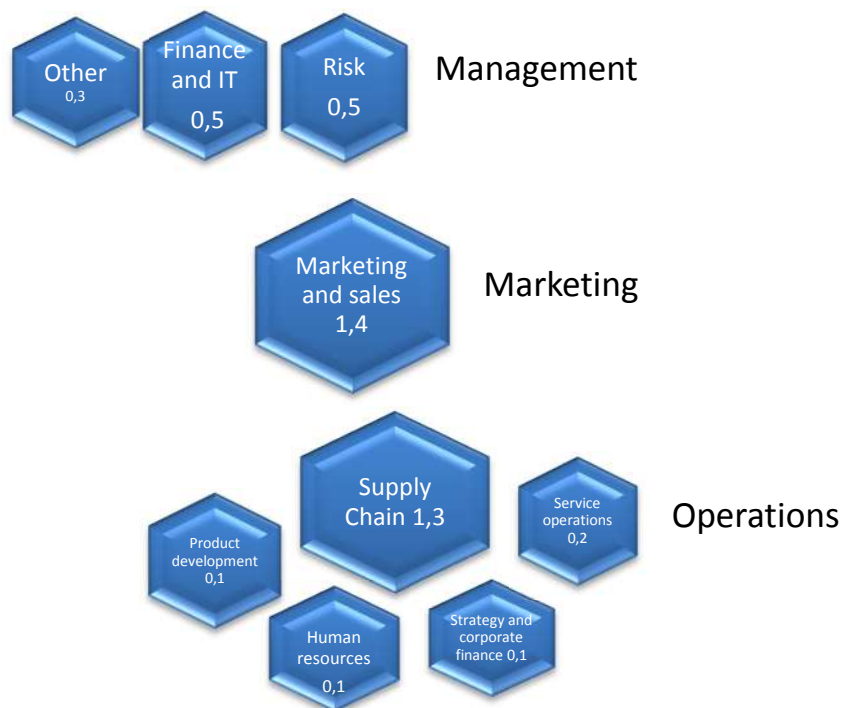
Fig. 4. Potential Economic-Value Creation from AI in the Next 20 Years, trillion dollars USA
(built on the basis of [44])

still require human oversight: the man-in-the-loop approach is best when needed to analyse the results provided by AI.

Another example is the breakthrough of AI in rail transport. AI technology can be used to create fully autonomous rail systems with smart infrastructure and self-driving trains to transport goods and people. Trains will also run with other trains, exchange data, receive notifications from human managers, and take action based on notifications. What's more, AI and rail travel are inseparable when it comes to predictive maintenance. Intelligent systems enable real-time analysis of equipment and mechanical problem detection both locally and remotely.

Global supply chains use a variety of means of transportation, including air travel, rail transport, and waterway shipping. Service providers are in dire need of risk management solutions to address industry challenges. Various problems, from natural disasters to problems related to servicing partners, can lead to interruptions in the provision of supply services.

By developing AI to improve logistics, suppliers mitigate risk and generate predictions to prevent potential breakdowns. ML solutions combined with NLP can be used to collect meaningful data from multiple social media sources, process unstructured text, conduct sentiment analysis, and identify potential risks. In addition, AI systems can use digital and satellite maps and traffic information to optimize routes. The system can take into account and process in real time the time, place, traffic status, changing customer requirements.

IBM believes that in all labour-intensive industries, that is, in transportation, organizations are faced with the challenge of maximizing the value of assets throughout the entire life cycle. This is undoubtedly true. Predictive Repair will help organizations save up to 630 billion dollars USA by 2025, according to leading consultancy McKinsey Global Institute.

Deploying AI for maintenance purposes is a powerful asset management solution for large organizations. The better the asset is maintained, the higher the performance and the longer the asset's life. AI-driven systems automatically collect and analyse asset data and warn of potential failures. Such systems can accumulate information about failures, compile statistics and, based on these statistics, plan repairs. If the provider can guarantee the employment of affordable and reliable assets, it will help to gain a competitive advantage and the trust of the service consumers.

Conclusions and prospects for further research. Logistics is entering a decade of digital transformation. Megatrends such as new technologies, e-commerce growth, sustainability will continue to be relevant. However, some areas will grow faster than others. Therefore, it is necessary to understand the main trends and their impact on logistics.

The next challenge will be to meet the logistics requirements of the future through training and professional development of personnel in increasingly technologically complex operations. This challenge will take centre stage in strategic supply chain management in the coming years. And primarily due to the impact of COVID-19.

Due to the fact that the logistics sector today is experiencing a global pandemic, like the whole world, the transformation processes have accelerated. COVID-19

has brought about faster changes with the latest innovations in logistics, automation and digitalization. Conversely, many trends that were initially perceived as revolutionary in the field of logistics have not yet realized their potential. The introduction of self-driving cars and drones continues to be hampered by legislative and technical issues, as well as a lack of public acceptance. Logistics markets are stabilizing on several leading platforms, and renowned carriers are coming into play with their own digital offerings supported by robust global logistics networks. From cloud computing to collaborative robotics, big data analytics, to artificial intelligence and the Internet of Things, logistics professionals need to understand the importance of the huge market for new technologies. Retrofitting all contact points in the supply chain is the new imperative for long-term success. Those companies that quickly introduce and scale new technologies, as well as improve the qualifications of their employees, will receive a significant competitive advantage in the logistics services market.

E-commerce continues to show stable and intensive growth [45-47]. But its share accounts for only a small part of world consumer spending on FMCG. B2B e-commerce is expected to triple the size of the consumer market. The coronavirus pandemic has served not only to accelerate the growth of e-commerce and innovation in supply chains. Key paths for scaling and adopting new technologies such as intelligent physical automation, IoT visibility and AI predictive capabilities will ultimately determine the ability to meet increased customer needs and secure industry leadership in the future.

With most governments in the world pledging to reduce CO_2 emissions and waste, sustainability is now imperative for the logistics industry. Driven by the growing demand for environmentally friendly solutions to reduce waste, as well as the use of new motion technologies and equipment optimization, this vector is also extremely relevant for supply chains. Today, there are already more than 90 national bans on single-use plastic, and due to the use of large-volume, bulky packaging, 40% of free space remains in the boxes, all this makes the question of rethinking packaging inevitable. Sustainable logistics (optimization of processes, materials, new motion technologies and smart objects) offers enormous potential for making logistics environmentally friendly. Smart containerization will also be important for developing sustainable delivery formats in densely populated cities.

The priority areas of organizing the logistics activities of enterprises using digital technologies include the following: multichannel logistics; logistics marketplaces; rethinking the use of packaging; mass personalization; Silver Economy (new services for older clients and new opportunities for older workers); sustainable logistics; sharing economy; multi-supply; customer experience; smart containerization; big data analytics; augmented and virtual reality; cloud service applications and APIs; Internet of Things (IoT); robotics and automation; new generation wireless communication; blockchain; Artificial Intelligence; unmanned aerial vehicles or "drones"; 3D printing; unmanned vehicles; quantum computing; supergrid logistics; space logistics; the use of digital platforms that unite customers and transport and logistics companies (the parties can enter into digital contracts, exchange transport booking requests and electronic documents, control the delivery of goods in real time).

All this can help to reduce costs by optimizing procurement; decrease in personnel costs and decrease in labour costs as a result of automation; reduction of errors in logistics; optimization of the supply process; efficient warehouse management; forecasting shipments; creation of optimal routes; operational planning of loads and control of delivery times; ensuring product delivery on time, improving customer loyalty; optimal interaction with customers on the "last mile".

Prospects for further scientific research are the substantiation of the conceptual provisions of the transformation of the customer experience management system in the digital economy and the development of proposals for regulatory support for the development of e-commerce in Ukraine, taking into account the best European experience.

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Трушкіна Н., Джвігол Х., Сергєєва О., Шкригун Ю. Розвиток концепції Логістика 4.0 в умовах цифрової економіки

Перехід до цифрової економіки стає ключовим чинником зростання ВВП. Це обумовлено не тільки ефектом, одержуваних від автоматизації існуючих процесів, а й від впровадження нових, проривних бізнес-моделей і технологій, серед яких цифрові платформи, цифрові екосистеми, поглиблена аналітика великих масивів даних, технології «Індустрія 4.0», «Логістика 4.0».

При цьому цифрова трансформація розглядається як радикальні зміни комплексу бізнес-процесів, починаючи від розробки продукції і закінчуючи обслуговуванням споживачів, а також впровадження сучасних цифрових технологій при організації бізнес-процесів на підприємствах.

Метою статті є аналіз особливостей і тенденцій організації логістичної діяльності в умовах цифрової трансформації бізнес-процесів; дослідження основних передумов становлення концепції Логістика 4.0; визначення пріоритетних напрямів її подальшого розвитку в контексті Індустрія 4.0.

На основі узагальнення наукових підходів уточнено визначення поняття «Логістика 4.0», під яким розуміється сучасна парадигма управління логістичними (матеріальними, фінансовими, інформаційними, транспортними) потоками й організації комплексу процесів логістичної діяльності (закупівля та доставка матеріальних ресурсів, складування, виробництво, формування запасів, рециклинг промислових відходів, обслуговування споживачів, транспортування і збут готової продукції) із застосуванням проривних цифрових технологій та інформаційних систем.

До пріоритетних напрямів організації логістичної діяльності підприємств з використанням цифрових технологій можна віднести такі: мультиканальна логістика; логістичні маркетплейси; переосмислення використання упаковки; масова персоналізація; «Срібна економіка» (нові послуги для літніх клієнтів і нові можливості для немолодих працівників); стала логістика; економіка спільного використання; мультипостачання; клієнтський досвід; розумна контейнеризація; аналітика великих даних; доповнена і віртуальна реальність; хмарні сервісні програми та інтерфейси прикладного програмування; Інтернет речей; робототехніка й автоматизація; бездротовий зв'язок нового покоління; блокчейн; штучний інтелект; безпілотні літальні апарати або «дрони»; 3D друк; безпілотні автомобілі; квантові обчислення; логістика супермережі; космічна логістика; використання цифрових платформ, які поєднують замовників і транспортно-логістичні компанії (сторони можуть укладати цифрові контракти, обмінюватися заявками на бронювання транспорту та електронними документами, контролювати доставку вантажів в режимі реального часу).

Все це може сприяти скороченню витрат за рахунок оптимізації закупівель; зниженню витрат на персонал і зменшенню трудовитрат у результаті автоматизації; зменшенню помилок у логістиці; оптимізації процесу поставок; ефективному управлінню складами; прогнозуванню відвантажень; створенню оптимальних маршрутів; оперативному плануванню завантажень і контролю термінів доставки; забезпеченню доставки продукції вчасно, покращуючи клієнтську лояльність; оптимальній взаємодії з клієнтами на «останній милі».

Ключові слова: цифрова економіка, Індустрія 4.0, Логістика 4.0, концепція, парадигма управління, логістична діяльність, логістичні потоки, організація, цифрові технології, інформаційні системи, переваги, оптимізація, ефективність.

Trushkina N., Dzwigol H., Serhieieva O., Shkrygun Yu. Development of the Logistics 4.0 Concept in the Digital Economy

The transition to a digital economy is becoming a key driver of GDP growth. This is due not only to the effect obtained from the automation of existing processes, but also from the introduction of new, breakthrough business models and technologies, including digital platforms, digital ecosystems, in-depth analytics of big data, Industry 4.0, Logistics 4.0.

At the same time, digital transformation is seen as a radical change in the complex of business processes, from product development to customer service, as well as the introduction of modern digital technologies in the organization of business processes in enterprises.

The purpose of the article is to analysis the features and trends of organizing logistics activities in the context of digital transformation of business processes; research of the main prerequisites for the formation of the Logistics 4.0 concept; determination of priority directions for its further development in the context of Industry 4.0.

Based on the generalization of scientific approaches, the definition of the concept of "Logistics 4.0" has been clarified, which means the modern paradigm of managing logistic (material, financial, information, transport) flows and organizing a complex of logistics activities (purchase and delivery of material resources, warehousing, production, stock formation, recycling of industrial waste, customer service, transportation and sale of finished products) using breakthrough digital technologies and information systems.

The priority areas of organizing the logistics activities of enterprises using digital technologies include the following: multichannel logistics; logistics marketplaces; rethinking the use of packaging; mass personalization; Silver Economy (new services for older clients and new opportunities for older workers); sustainable logistics; sharing economy; multi-supply; customer experience; smart containerization; big data analytics; augmented and virtual reality; cloud service applications and APIs; Internet of Things; robotics and automation; new generation wireless communication; blockchain; Artificial Intelligence; unmanned aerial vehicles or "drones"; 3D printing; unmanned vehicles; quantum computing; supergrid logistics;

space logistics; the use of digital platforms that unite customers and transport and logistics companies (the parties can enter into digital contracts, exchange transport booking requests and electronic documents, control the delivery of goods in real time).

All this can help to reduce costs by optimizing procurement; decrease in personnel costs and decrease in labour costs as a result of automation; reduction of errors in logistics; optimization of the supply process; efficient warehouse management; forecasting shipments; creation of optimal routes; operational planning of loads and control of delivery times; ensuring product delivery on time, improving customer loyalty; optimal interaction with customers on the "last mile".

Keywords: digital economy, Industry 4.0, Logistics 4.0, concept, management paradigm, logistics activities, logistics flows, organization, digital technologies, information systems, advantages, optimization, efficiency.

Трушкина Н., Джвигол Х., Сергеева Е., Шкрыгун Ю. Развитие концепции Логистика 4.0 в условиях цифровой экономики

Переход к цифровой экономике становится ключевым фактором роста ВВП. Это обусловлено не только эффектом, получаемым от автоматизации существующих процессов, но и от внедрения новых, прорывных бизнес-моделей и технологий, среди которых цифровые платформы, цифровые экосистемы, углублённая аналитика больших массивов данных, технологии «Индустрия 4.0», «Логистика 4.0».

При этом цифровая трансформация рассматривается как радикальные изменения комплекса бизнес-процессов, начиная от разработки продукции и заканчивая обслуживанием потребителей, а также внедрение современных цифровых технологий при организации бизнес-процессов на предприятиях.

Целью статьи является анализ особенностей и тенденций организации логистической деятельности в условиях цифровой трансформации бизнес-процессов; исследование основных предпосылок становления концепции Логистика 4.0; определение приоритетных направлений ее дальнейшего развития в контексте Индустрия 4.0.

На основе обобщения научных подходов уточнено определение понятия «Логистика 4.0», под которым понимается современная парадигма управления логистическими (материальными, финансовыми, информационными, транспортными) потоками и организации комплекса процессов логистической деятельности (закупка и доставка материальных ресурсов, складирование, производство, формирование запасов, рециклинг промышленных отходов, обслуживание потребителей, транспортировка и сбыт готовой продукции) с применением прорывных цифровых технологий и информационных систем.

К приоритетным направлениям организации логистической деятельности предприятий с использованием цифровых технологий можно отнести такие: мультиканальная логистика; логистические маркетплейсы; переосмысление использования упаковки; массовая персонализация; «серебряная экономика» (новые услуги для пожилых клиентов и новые возможности для немолодых работников); устойчивая логистика; экономика совместного использования; мультиснабжение; клиентский опыт; умная контейнеризация; аналитика больших данных; дополненная и виртуальная реальность; облачные сервисные приложения и интерфейсы прикладного программирования; Интернет вещей; робототехника и автоматизация; беспроводная связь нового поколения; блокчейн; искусственный интеллект; беспилотные летательные аппараты или «дроны»; 3D печать; беспилотные автомобили; квантовые вычисления; логистика суперсетей; космическая логистика; использование цифровых платформ, которые объединяют заказчиков и транспортно-логистические компании (стороны могут заключать цифровые контракты, обмениваться заявками на бронирование транспорта и электронными документами, контролировать доставку грузов в режиме реального времени).

Все это может способствовать сокращению затрат за счёт оптимизации закупок; снижению затрат на персонал и уменьшение трудозатрат в результате автоматизации; уменьшению ошибок в логистике; оптимизации процесса поставок; эффективному управлению складами; прогнозированию отгрузок; созданию оптимальных маршрутов; оперативному планированию загрузок и контролю сроков доставки; обеспечению доставки продукции вовремя, улучшая клиентскую лояльность; оптимальному взаимодействию с клиентами на «последней миле».

Ключевые слова: цифровая экономика, Индустрия 4.0, Логистика 4.0, концепция, парадигма управления, логистическая деятельность, логистические потоки, организация, цифровые технологии, информационные системы, преимущества, оптимизация, эффективность.