

PEDTR 2019**18th International Scientific Conference “Problems of Enterprise Development:
Theory and Practice”****DIGITAL TRANSFORMATION OF LOGISTICS AND SCM**

A. N. Agafonova (a)*, O. D. Pokrovskaya (b), I. A. Merkulina (c)

*Corresponding author

(a) Samara State University of Economics, 443090, Soviet Army Str., 141, Samara, Russia,
agafonova.a.n@gmail.com(b) Emperor Alexander I St. Petersburg State Transport University (PGUPS), 190031, Moscow Avenue, 9, St.
Petersburg, Russia, insight1986@inbox.ru(c) Finance University under the Government of the Russian Federation, 125993,
Leningrad Avenue, 49, Moscow, Russia, IAMerkulina@fa.ru***Abstract***

During the last decades, there have been significant transformations in organizational forms, tools, technologies for managing logistics of companies and supply chains. This is mainly a result of the paradigm of business digitalization. Companies switch to large-scale automation of corporate information systems, become participants of electronic trading platforms and e-commerce services, and form their virtual clones. The advantages of information services and fast business response to changes in demand are increasingly appreciated by consumers. Despite the existence of numerous research works in this area, there is uncertainty in understanding the goals, directions, and technologies of the digitalization of logistics and SCM. The principle of logistics integration focuses on the possibility of creating a unified information field for the supply chain and providing decision-making processes with quality information. It is the key factor in optimizing resources and costs. Russian logistics and SCM market is in the early stages of development and many companies are only beginning to explore the possibilities of logistics outsourcing and provisioning. Therefore, digitalization issues are not of paramount importance. The article formulates several hypotheses that are verified by comparing the results of the analysis of the market of applied Information and communication technologies and infrastructure solutions, the results of research of world consulting companies, which requires identifying the features of digitalization of logistics and SCM in Russia and the World. The conducted research helps to determine the prerequisites and general regularities of the qualitative transformation of the industry.

2357-1330 © 2020 Published by European Publisher.

Keywords: SCM, digital logistics, Logistics 4.0, logistics infrastructure, information and communication technology in logistics.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 Unported License, permitting all non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

1. Introduction

Leading world scientists recognize the exceptional role of technologies in modern economic development and social life. Scientific discoveries embodied in technologies create new opportunities for resources, provide business growth potential, mechanisms for interaction between economic entities, new markets, and industries.

The direct influence of radical scientific discoveries and innovations on the deepest transformations that mark the transition to a new technological or economic mode of production. In the scientific environment, there is a strong belief that human history in its technological evolution from the first industrial revolution to the era of computers and telecommunications has overcome five types of technological patterns, and is currently developing a sixth. The present technological development of economic sectors is caused by the phenomenon of NBIC convergence (N - nano; B - bio; I - info; C - cogno).

The market diffusion of Nano, Bio, Information technology and Cognitive science has different impacts on economic sectors, human activities, and society. The greatest practical effect in logistics has been identified in relation to Information & Communication technology. Since the mid-twentieth century, scientists have been talking about the transformation of information into the most important productive force and resource determining success in business (P. Drucker, Al. Toffler, and others). This tendency has also been characteristic of the logistics industry. In traditional logistics and SCM, the main object of research is the material flow, in relation to which the system of optimal 7R management criteria is formed. However, the development of the industry allowed considering the information chain of value creation. Recognition of the information as a strategic economic resource, object of purchase and sale forces to reconsider the system of an assessment of indicators of efficiency of logistics and SCM. Along with the concept of "logistic material flow", the concept of "logistics information flow" is used. The logistic system integrates the information subsystem essential for performing operational and strategic management functions in logistics. Information & communication technology enables logistics and SCM to master new capabilities in global monitoring (GPS, GLONASS), controlling, analysis (Business intelligence), regulation, planning, and forecasting.

Digital economy conditions lead to the search for new forms and methods of supply chain organization and logistics management (Evtodieva, Chernova, Ivanova, & Protsenko, 2020). Logistics and marketing tools are transformed as well (Pogorelova, Yakhneeva, Agafonova, & Prokubovskaya, 2016). With the development of Web 2.0, Internet of Things (IoT), and Industry 4.0, flexible models of supply chains and logistics networks are implemented on a larger scale. The new concept of Logistics 4.0 has become an actual trend (Evtodieva, Chernova, Ivanova, & Kisteneva, 2019).

2. Problem Statement

There is a growing awareness among logistics managers regarding the necessity of systematic implementation of informational technologies. Along with this, the pursuit of higher profits and improved operational performance requires analyzing the IT market and the latest developments in this field. The principle of economic feasibility in terms of selecting models of information support for logistics, management, and technological functionality, is achieved by correlating TCO (Total Cost of Ownership)

logistics information systems with the advantages they bring to the company and its customers (McFarlane, Giannikas, & Lu, 2016; Yakhneeva, Agafonova, Fedorenko, Shvetsova, & Filatova, 2020).

Telematics and informatics fields have very high update dynamics. Technologies become outdated rapidly enough, and new ones emerge to replace them. This peculiarity causes market uncertainty and high risks of decision making. The implementation of information technologies requires significant investments. Mahindroo, Samalia and Verma (2018) explore the possibilities of regression analysis and development of a roadmap for analyzing the relationship between selected logistics information system structures and indicators of its economic and operational efficiency. This question is not yet been completely answered and requires a more thorough study.

The world market for logistics services is developing unevenly. For many manufacturing, commercial and logistics companies, the transition from paper to electronic document management, the use of RFID (Vaculik, Michalek, & Kolarovszki, 2009), the adoption of 3PL and 4PL are significant breakthroughs. At the same time, transnational global companies demonstrate a high level of utilization of the latest developments in Business Intelligence, Big Data analytics, IoT. Govindana, Cheng, Mishrac and Shuklad (2018) conduct an in-depth analysis of the use of Big data analytics and applications for logistics and supply chain management. The efficiency of telecommunications and information technologies in logistics is directly influenced by market conditions and its infrastructural support. Within the framework of the topic, a general analysis of the state of information infrastructure in logistics, evaluation of the quality of information resources and availability of digital services are of high importance. Review of publications on the topic has demonstrated that there is no systematic information about the transformation of paradigms of logistics automation, the positive and negative consequences of the implementation of one or another technology in terms of functional areas of logistics (transport, warehousing, inventory logistics, and others). Determination and search of preconditions and potential for qualitative change in logistics under the influence of the development of information and telecommunication technologies is another relevant issue of this study.

3. Research Questions

In the frame of this research, several hypotheses have been formulated and tested:

- Digitalization is the key factor in the transformation of logistics and SCM;
- Globally, and in Russia in particular, Logistics 4.0 infrastructure is developing.

3.1. Digitalization of logistics and SCM

Testing the hypothesis requires that the following questions be answered:

- How does communication and information technology affect logistics and SCM?
- What are the expectations of experts and business owners?

3.2. The infrastructure of Logistics 4.0

The questions that have to be studied:

- To what extent is the market of communication services, software, digital services, and specialized automated equipment developed?

- How much is the demand for communication and information technology and services by participants of logistics services and SCM market?

4. Purpose of the Study

To test hypotheses about the digital transformation of logistics, to identify current trends in logistics service development and ways to improve SCM efficiency based on Information&communication technology are the main purposes of the study. The major objective is to determine the features of the digital transformation of logistics and SCM based on public information, external research, and reports on the analysis of the IT market.

5. Research Methods

The study used methods of economic and marketing analysis, expert estimations, empirical (measurement and synthesis of research results, grouping) methods. PwC research report "Review of Transport and Logistics Trends in 2019" was applied to assess the factors of changes in logistics and SCM. The survey was conducted among managers of transport and logistics companies; 60% of them have been in management positions for 15 years; 94% are men, 36% are under 50 years old (Sachek, Antonik, Babich, Malkievich, & Matyushko, 2019). The report is based on the results of 1,239 interviews with executives in 85 countries, and 85 respondents were representatives of the transport and logistics industry. In order to determine the investment preferences of top managers in BI tools and analytics, the results of a survey (over 600 respondents) of Tibco Software were used. Data sources for the analysis of the market of applied Information and communication technologies are the research results of IDC «Russian infrastructure market in 2019» (Lebedev, 2019), Mail.Ru Cloud Solutions (2019) «IT infrastructure in 2019: Key trends, forecasts, problems and solutions», CNews Analytics (2019) «Largest IaaS Providers in Russia 2019», rankings of IT companies CNews100.

6. Findings

These studies illustrate the evolution in logistics and CRM caused by the implementation of the information and communication technology and by the adaptation of logistics concepts to the new digital economy framework. In "Review of transport and logistics trends in 2019" by PricewaterhouseCoopers, digitalization has been mentioned as the most important factor influencing the development of the transport and logistics industry (Sachek, Antonik, Babich, Malkievich, & Matyushko, 2019). 68% of transportation and logistics executives expect that changes in key production and service technologies will have a breakthrough impact on their business.

The analysis of the international and Russian ICT markets reveals its maturity, diversity of application software solutions of different levels of complexity, functionality and price. Supply grows due to the implementation of new technologies of processing and transmission of data, including its big volumes and variability of structure, new intellectual services, virtualization of management of logistic processes and infrastructure. One of the popular models of informational support of logistics and SCM is outsourcing. The IT infrastructure of the supply chain increasingly acquires virtual, scalable, and flexible quality, which

is ensured by "Infrastructure as a Service" technologies. Logistic services built on the principle of aggregation of information resources and transactions are in high demand. Increasingly, companies refuse proprietary on-premise systems by selecting public cloud technologies. This indicates the democratization of logistic information and the overcoming of entropy of the market. Optimization of supply chains is often performed in real-time, which is ensured by new identification and geolocation technologies, software products, and BI services.

6.1. Infrastructure and technological preconditions for digitalization of logistics and SCM

Analysts from International Data Corporation have identified ICT industry leaders: mobile devices, social technologies, cloud computing, Big Data. A review of current research and expert opinions has demonstrated that the most important requirements for the IT infrastructure of a company currently are the following: uninterrupted operation, scalability, security, speed of change, transparency and manageability, adequate cost of ownership (Lebedev, 2019).

ICT infrastructure trends:

- "Digital transformation" or deep transformations in the IT system, which allow companies to better cope with the attraction of customers, more effectively manage operating activities, enter new markets. The key condition for making such changes is the criterion of infrastructure flexibility, which is, in practice, often achieved by virtualization of the infrastructure, including cloud computing-based solutions;
- The importance of the Application Programming Interface for improving business infrastructure. This eliminates downtime, increases both storage capacity and server computing capabilities, and increases the efficiency of business IT infrastructure;
- Transferring data generation processes out of corporate data center;
- Active development of a decentralized system for data collection and processing based on Edge Computing technology. The so-called "peripheral computing", i.e. for example, performed on user devices, instead of in data centers, demonstrates higher efficiency than the traditional data center model, which, according to experts, will significantly affect the infrastructure strategies of companies;
- Redefining the scope of responsibility of IT infrastructure support specialists. With the advent of new management tools and the active utilization of cloud services, it will expand, resulting in the requirement to consider changes in educational programs and HR.

In 2018, the global IT market amounted to \$3.69 trillion (compared to 2017, it increased by 4.5%). The volume of the Russian IT market in 2018 totaled \$22.6 billion, which is 4% more than in 2017 (Lebedev, 2019). The volume of the aggregated market for software and IT services in 2018 was \$9917 million. The growth forecast for 2019 is 9.4%, and for 2020. - 8.6% compared to the previous year. A significant segment of the IT market is the market of IT services: the volume in 2018 was \$6347 million, and the forecast for 2019 is \$6926 million (with a growth rate of 9.1%).

Global trends in digitalization and virtualization of business IT infrastructure are confirmed by the data of CNews IaaS rating (CNews ,2019), the revenue of the 10 largest domestic IaaS (Infrastructure as a

Service) service providers in Russia increased by 56% to €16.1 billion. At the same time, high growth rates (over 50%) have been maintained for 4 consecutive years.

6.2. Qualitative transformations of logistics and SCM in Digital economy

Three out of five key logistics transformation factors are related directly to the ICT industry: digitalization, changes in core processes caused by the implementation of new software, changes in core processes caused by the adoption of new technology.

The highest level of digitalization in the commercial transport sector is observed in case of horizontal integration of the value chain (44% of companies), customer access to systems of the manufacturer, sales and marketing channels (37%), vertical integration of the value chain (36%), product design and development (25%), digital business models and portfolio of products and services (21%) (Sachek, Antonik, Babich, Malkievich, & Matyushko, 2019).

Experts believe that digital logistics solutions have already evolved beyond information and communication technologies. They contribute to the creation of new business models, types of operations, marketplaces and services that can become new revenue sources. New ecosystems, such as logistics online platforms, are emerging. There is a qualitative change from a bulletin board with orders for transportation services to unified business and IT solutions, which connect more players of logistics and related markets. The principle of aggregation of logistics services is becoming more and more relevant. The single window system provides search and interaction with contractors, smart insurance, factoring, transaction systems, transport management software, map services, transport price indexes, quality rating system for suppliers and carriers, remote signing of contracts with electronic digital signature and others. In Russia, such aggregate systems are ATI, TRAFFIC, RailCommerce.

PwC expects the global market of business process robotization and preventative maintenance in logistics to grow by more than 35% in 2016-2021. Besides, blockchain and, in the wider sense, Distributed ledger technology is expected to impact on logistics no earlier than 3 years from today. Although, the technology already demonstrates promising results for postal and CEP operators (courier, express, parcels), since they perform operations with high levels of distribution and decentralization. Such solutions are implemented in large logistics companies such as Maersk, which, in collaboration with IBM, develops a blockchain-platform. Blockchain in logistics is designed to provide end-to-end product authentication, transparency and simultaneity of operation confidentiality, automation of document processing and logistics flow management (Sachek, Antonik, Babich, Malkievich, & Matyushko, 2019).

A promising trend in the development of digital logistics services is geo-informational technologies, which perform functions of transport movement monitoring, measurement of environmental and cargo parameters, data collection from surrounding objects and transferring of this data to a unified center for online analysis and control. The market volume of geo-services in Russia is about \$6 billion (CNews Analytics, 2019).

Transport and logistics have become the most significant area of application for the Industrial Internet of Things (Chulanova & Serguchenkova, 2019). In 2018, more than 40 million commercial vehicles worldwide were connected to cloud platforms, and the annual revenue of providers was approximately \$12 billion. This is mainly due to the high level of penetration of cloud platforms, through

which customers are able to monitor and optimize the utilization of commercial vehicles. Most developers of applications for the transport industry are already working on the public cloud model; there is a tendency to integrate IIoT-platforms of fleet management - Fleet Management (99% of the entire market) and facilities implementing telemetry of objects (M2M). IIoT platforms are mostly demanded in Europe and North America (35% and 26% of the world market respectively). In Russia, this market is almost non-existent (less than \$3 million), and the functionality of data collection from connected transport objects was implemented mainly through proprietary on-premise Fleet Management systems, the size of implementation and technical support of which totaled \$11.4 billion excluding communication costs (Rudycheva, 2019).

According to the global trend of development of the Analytics 3.0 concept, BI instruments are increasingly being used in logistics. The market of analytics funds is rapidly growing, almost by 10% per year, and by the end of 2020 will exceed \$22.8 billion (Mail.Ru Cloud Solutions, 2019). The important feature of the industry is the usage of predictive analytics in logistics and SCM (for example, in "Safe Driving" modules, when assessing logistics risks, or forecasting the value of logistics costs).

7. Conclusion

The field of logistics and SCM is experiencing significant changes caused by the digitalization factor. Technologies of stream processes management that involve a high degree of human physical labor, which do not allow interactive monitoring of operations and quality control of their execution, and paper workflow, become inefficient and outdated. Application of Information and communication technology increasingly determines the level of competitiveness of logistics companies. The degree of digitalization largely determines the speed, accuracy of operations, and provides opportunities to develop adaptability and flexibility of SCM. This leads to new perspectives for companies and their customers: risk management based on rating and user community engagement, joint developments, forms of self-service and complex outsourcing. Smart logistics becomes a reliable basis for the development of international business, supporting the optimization of the involvement of world resources. The change in priorities from physical to virtual infrastructure, from owned to leased or utilized as a service, indicates a change in the nature of supply chains, their spontaneity, and orientation towards real-time solutions. The study of preconditions for the formation of logistic digital ecosystems, including at the meso-, macro- and global levels of functioning, can be an important direction of development of this study.

References

- Chulanova, V., & Serguchenkova, M. (2019). First coming: How digitalization will change the Russian logistics market? Retrieved from http://logirus.ru/articles/analythics/pervoe_prishestvie_kak_tsifra_izmenit_rynok_rossiyskoy_logistiki.html Accessed: 11.11.2019.
- CNews Analytics (2019). CNews Analytics: Largest IaaS Providers in Russia 2019. Retrieved from https://www.cnews.ru/reviews/oblachnye_servisy_2019/review_table/61a5222f16e359fa6aae5813943e576a270f86c4 Accessed: 13.11.2019.
- Evtodieva, T. E., Chernova, D. V., Ivanova, N. V., & Kisteneva, N. S. (2019). Logistics 4.0. In S. Ashmarina, M. Vochozka (Eds.), *Sustainable Growth and Development of Economic Systems. Contributions to Economics* (pp. 207-219). Cham: Springer. DOI: 10.1007/978-3-030-11754-2_16.

- Evtodieva, T. E., Chernova, D. V., Ivanova, N. V., & Protsenko, O. D. (2020). Business analytics of supply chains in the digital economy. In S. Ashmarina, A. Mesquita, M. Vochozka (Eds.), *Digital Transformation of the Economy: Challenges, Trends and New Opportunities. Advances in Intelligent Systems and Computing*, 908 (pp. 329-336). Cham: Springer.
- Govindana, K., Cheng, T. C. E., Mishrac, N., & Shuklad, N. (2018). Research of the delivery logistics management information system based on big data. *Transportation Research Part E: Logistics and Transportation Review*, 114, 343-349. DOI: 10.1016/j.tre.2018.03.011
- Lebedev, M. (2019). Russia hyperconverged infrastructure 2019–2023 market forecast. Retrieved from: <https://www.idc.com/getdoc.jsp?containerId=prEUR245605119> Accessed: 13.11.2019.
- Mahindroo, A., Samalia, H. V., & Verma, P. (2018). Information systems road map to enhance economic and operational reverse logistics performance. *International Journal of Logistics Systems and Management*, 29(2), 215-240.
- Mail.Ru Cloud Solutions (2019). IT infrastructure in 2019: Key trends, forecasts, problems and solutions. Retrieved from <https://mcs.mail.ru/blog/it-infrastructure-2019/> Accessed: 11.11.2019.
- McFarlane, D., Giannikas, V., & Lu, W. (2016). Intelligent logistics: Involving the customer. *Computers in Industry*, 81, 105-115.
- Pogorelova, E. V., Yakhneeva, I. V., Agafonova, A. N., & Prokubovskaya, A. O. (2016). Marketing mix for e-commerce. *International Journal of Environmental and Science Education*, 11(14), 6744-6759.
- Rudycheva, N. (2019). Digitalization of transport is hampered by a lack of standards and economic feasibility. *CNews*. Retrieved from https://www.cnews.ru/reviews/it_v_transportnoj_otrasli_2019/articles/tsifrovizatsiyu_transporta_tormozit_otsutstvie_standartov_i_ekonomicheskoy Accessed: 10.11.2019.
- Sachek, T., Antonik, D., Babich, A., Malkievich, R., & Matyushko, M. (2019). Review of transport and logistics trends in 2019. Retrieved from <https://www.pwc.ru/ru/publications/transport-and-logistics-trends-2019.html> Accessed: 11.11.2019.
- Vaculik, J., Michalek, I., & Kolarovszki, P. (2009). Principles of selection, implementation and utilization of RFID in supply chain management. *Promet-Traffic & Transportation*, 21(1), 41-8. DOI: 10.7307/PTT.V21I1.911
- Yakhneeva, I. V., Agafonova, A. N., Fedorenko, R. V., Shvetsova, E. V., & Filatova, D. V. (2020). On collaborations between software producer and customer: A kind of two-player strategic game. In S. Ashmarina, A. Mesquita, M. Vochozka (Eds.), *Digital Transformation of the Economy: Challenges, Trends and New Opportunities. Advances in Intelligent Systems and Computing*, 908 (pp. 570-580). Cham: Springer.