РЕГИОНАЛЬНАЯ И ОТРАСЛЕВАЯ ЭКОНОМИКА

УДК 658.7 Обзорная статья
DOI: 10.35330/1991-6639-2025-27-2-150-162
EDN: UPXFOO

Литературный обзор по устойчивому развитию цифровых логистических сетей в сфере сельского хозяйства

А. Н. Меконин, С. Е. Барыкин✉

Высшая школа сервиса и торговли
Санкт-Петербургского политехнического университета Петра Великого
195251, Россия, Санкт-Петербург, ул. Новороссийская, 50

Аннотация. Устойчивость цифровых логистических сетей – это сложный вопрос, который включает в себя экономическую эффективность, социальную ответственность и сохранение окружающей среды. В связи с этим растет спрос на решение логистических операций с использованием концепций цифровизации и устойчивого развития. Несмотря на быстрое развитие логистической отрасли, все еще существует пробел в исследованиях, касающихся трансформации логистики в устойчивую цифровую логистику. Таким образом, эта статья направлена на обзор эмпирических и методологических рамок текущего состояния исследований цифровой логистической сети и устойчивости с особым упором, помимо прочего, на сельскохозяйственную логистику. Для обзора и всестороннего анализа широкого круга задач были выбраны авторитетные академические источники. В результате обзора были выявлены некоторые инновационные методы, надежные модели и изучен ряд важных факторов. Оценены достоинства и недостатки источников обзора. Будущие исследования в этой области могут включать эмпирический анализ с широким охватом для анализа логистических операций различных секторов с точки зрения цифровизации и устойчивости.

Ключевые слова: сельское хозяйство, цифровая логистика, логистическая сеть, обзор, устойчивость

Поступила 06.02.2025, одобрена после рецензирования 18.02.2025, принята к публикации 06.03.2025

Для цитирования. Меконин А. Н., Барыкин С. Е. Литературный обзор по устойчивому развитию цифровых логистических сетей в сфере сельского хозяйства // Известия Кабардино-Балкарского научного центра РАН. 2025. Т. 27. № 2. С. 150–162. DOI: 10.35330/1991-6639-2025-27-2-150-162

JEL: O33 Review article

A literature review on sustainability concept of digital logistics networks in agriculture

A.N. Mekonin, S.E. Barykin✉

Graduate School of Service and Trade
Peter the Great St. Petersburg Polytechnic University
195251, Russia, St. Petersburg, 50 Novorossiyskaya street

Abstract. Sustainability in digital logistics networks is a complex issue that encompasses economic efficiency, social responsibility, and environmental preservation. Due to this, there is increasing demand to address logistics operations with the concepts of digitalization and sustainability. Despite the rapid development of the logistics industry, there is still a research gap concerning the transformation of logistics to sustainable digital logistics. Therefore, this article aims at the review of empirical and methodological frameworks of the current state of studies on the digital logistics network and sustainability with particular emphasis on, but not limited to, agricultural logistics. Reputable academic sources were selected for the review and comprehensive analysis of the wide range of tasks. The review result identified some innovative

methods, robust models, and explored certain significant factors. Merits and demerits of the review sources were assessed. Future research in this area could incorporate empirical analysis with a large scope to analyze the logistics operations of different sectors perspectives on digitalization and sustainability.

Keywords: agriculture, digital logistics, logistics network, review, sustainability

Submitted 06.02.2025, approved after reviewing 18.02.2025, accepted for publication 06.03.2025

For citation. Mekonin A.N., Barykin S.E. A literature review on sustainability concept of digital logistics networks in agriculture. *News of the Kabardino-Balkarian Scientific Center of RAS*. 2025. Vol. 27. No. 2. Pp. 150–162. DOI: 10.35330/1991-6639-2025-27-2-150-162

ВВЕДЕНИЕ / INTRODUCTION

In today's globalized and digitalized economy, logistics development is crucial to cutting costs, boosting transportation options, and improving the efficiency, quality, and safety of transportation and logistics services. While the advancement of digital logistics platforms presents competitive potential, global logistics development is progressing towards greater levels. The digital transformation of logistics platforms has a number of favourable consequences, particularly on logistics activities such as business processes, logistics prices, and logistics service quality [1]. The goal of logistics, which is a system made up of a number of interconnected operations, is to efficiently handle the movement of personnel and materials through the logistics channel. Digital logistics, or logistics 4.0, is the implementation of digital solutions and new technologies in logistics services to improve and optimize supply chain operations for different sectors. Logistics plays a pivotal role in determining the competitiveness of international trade as a major part industry for national economic development. Parts of logistics operations and services that have undergone digital transformations via the use of information and communication technology are known as digital logistics [2].

The digitalization of logistics operations is seen as beneficial by customers, suppliers, and other stakeholders due to the fact that it provides innovative information and communication. Because the industrial supply chain's digitization has become essential for customer orientation, and supply chain and logistics activation, the sharing of substantial amounts of information among supply chain participants will enhance businesses' logistics. When digital logistics is introduced, it means that advanced digital models, techniques, and tools that are based on a shared information and communication platform are available [3]. As digital technology and worldwide communication have emerged in recent decades, logistics and transportation have continued to change. Figure 1 shows how logistics evolves from logistics 1.0 to logistics 4.0.

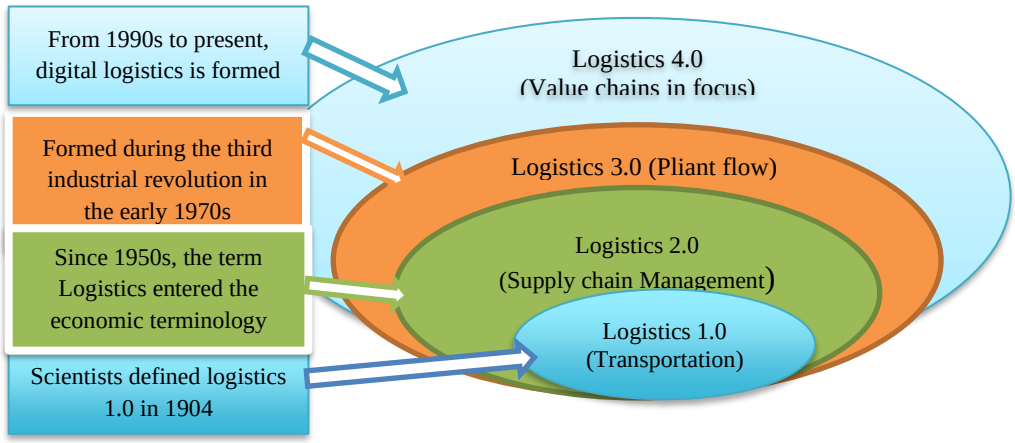

Рис. 1. *Эволюционное развитие логистики в разные эпохи*
Источник: адаптировано из [3]

Fig. 1. *Evolutionary development of logistics in different eras*
Source: Adapted from [3]

Despite the fact that several studies have been undertaken on the subject of the logistics, there is still a gap regarding sustainability issues and implementation of digital technology. Therefore, this study is devised to review the methodological and empirical frameworks of a number of studies. The authors of this study have contributed to the existing literature on the sustainability and digitalization of logistics networks by reviewing the current state of studies in the field of logistics.

МАТЕРИАЛЫ И МЕТОДЫ / MATERIALS AND METHODS

Academic articles were downloaded from reputable databases and the most relevant 40 articles were selected for the final review work. The reviewed articles were classified into three sections based on the content apparatus and subsequently discussed. Figure 2 represents algorithm of the overall review steps.

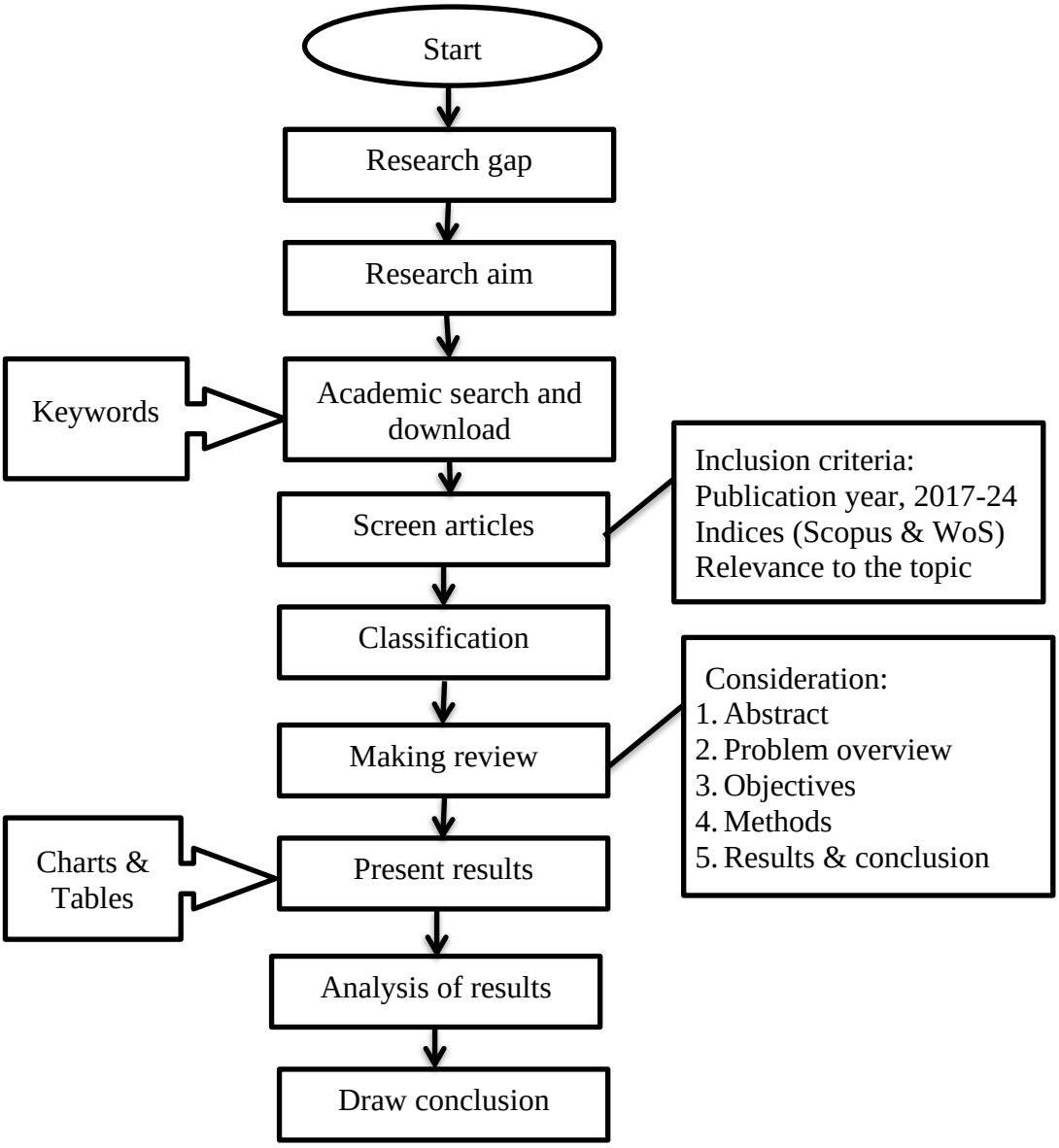

***Рис. 2**. Алгоритм процедуры рассмотрения*

***Fig. 2**. Algorithm of the review procedure*

РЕЗУЛЬТАТЫ И ОБСУЖДЕНИЕ / RESULTS AND DISCUSSION

Descriptive result

The presentation of the results starts with presentation of the data used.

Figure 3 shows that the majority (60%) of the articles included in the review were indexed in both the Web of Science and Scopus databases.

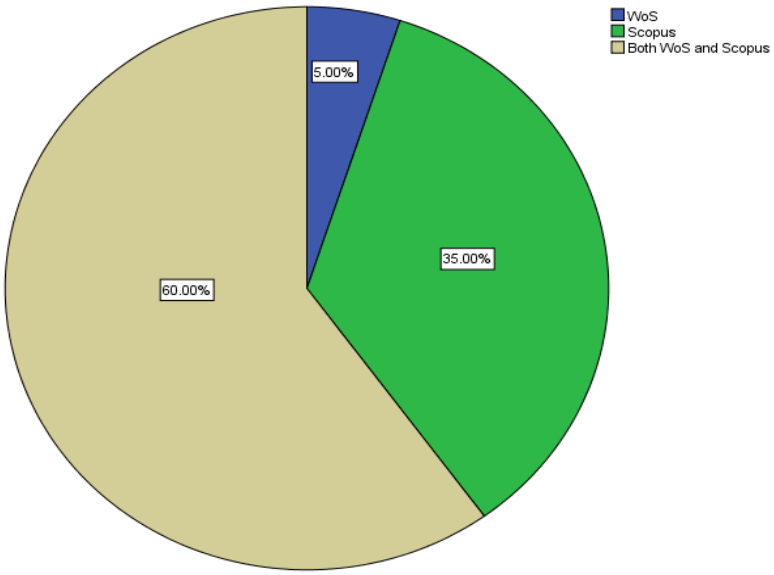

***Рис. 3**. Статьи по индексу / **Fig. 3**. Articles by Index*

Figures 4 shows 42.5% of the articles that included in the review work were undertaken in China. The publication years, however, span from 2017 to 2024, with 2023 and 2024 accounting for 22.5% and 27.5% of the articles, respectively.

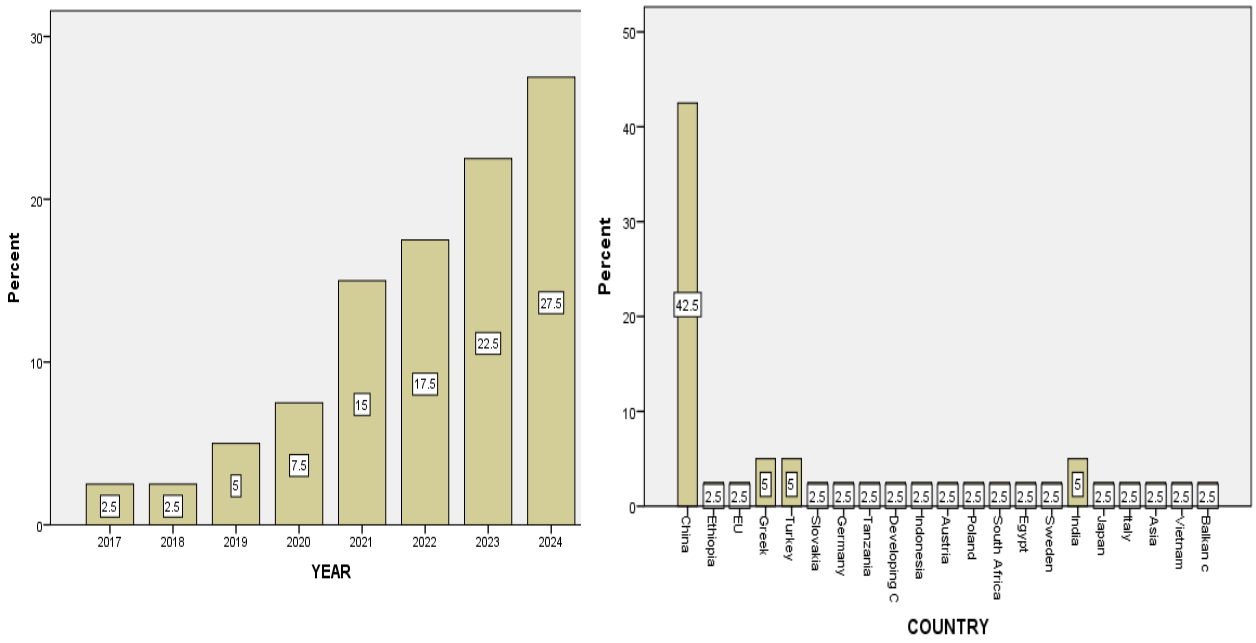

***Рис. 4**. Статьи по году публикации и стране*

***Fig. 4**. Articles by year of publication and country*

Digitalization and Logistics Networks

Digital logistics networks are a concept that comprises the adoption and appropriate implementation of digital technologies within diverse logistics operations to achieve a competitive advantage. The integration of digitalization and logistics networks is applied in a wide range of research areas, and their implications are reviewed. Table 1 presents the comprehensive review results of digitalization and logistics networks. The study conducted on digital technologies for improving logistics performance shows that the effectiveness of logistics and the efficiency of logistics services are predetermined by the integration of digital technologies and use of internet services. Fixed broadband and 4G coverage are key infrastructures that need forward pushing to enhance logistics performance [4]. The impact of digital logistics under the big environment of the economy got special attention from the researcher in China and disclosed that the number of populations, per capita GDP, and population density are highly influencing the logistics process to maximize economic development [5].

Таблица 1. Сводные результаты по цифровизации и логистическим сетям

Table 1. Summary results for digitalization and logistics networks

Author(s)	Methodology	Findings
[4]	Correlation and Regression	The efficiency and efficacy of logistics services are predetermined by the incorporation of digital technology and the utilization of internet services.
[5]	Entropy model and Regression	Population density, per capita GDP, and population size all have a significant impact on the logistics process to optimize economic growth
[6]	Regression analysis	Important determinants of supply chain and sustainable business are transportation, logistics networking, and information sharing.
[7]	Chi-square and Regression	Green logistics technology, logistics warehousing, and logistics packaging are all significantly correlated.
[8]	Qualitative content analysis	Digital B2B platforms directly affect the inclusion and exclusion of actors in the production networks of logistics.
[9]	DES model	Dynamic lot sizing lowers the average amount of semi-finished goods in stock.
[10]	Case study	Lack of resources and the intricacy of the logistics network are the primary challenges faced by logistics service providers.
[11]	Qualitative analysis	Technologies like autonomous cars and route optimization algorithms are revolutionizing last-mile logistics.
[12]	Spatial model	The logistics sector's overall degree of development has a major positive impact on the local economy.
[13]	Exploratory and descriptive	Improving digital leadership, enhancing data usage and security, and implementing customer-centric approaches are some of 3PL's main issues.
[14]	Exploratory Factor Analysis	University students' conceptual comprehension of digital logistics is not influenced by their academic standing

Source: Review result

In connection with the study of implications of green logistics on sustainable business and supply chain performance, information sharing, logistics networking, and transportation are the most significant factors that impact sustainable business and supply chain performance [6]. On the other hand, green logistics technology, certification, and standards are significantly correlated with logistics warehousing and logistics packaging [7]. The impact of digital platforms on labor in the production network of logistics is investigated in Germany and concludes that digital B2B platforms, due to their intermediary function, are found to have a direct impact on the inclusion and exclusion of actors involved in production networks of logistics [8]. A simulation approach study of robust digital production and logistics networks by implementing flexibility measures shows that dynamic lot sizing reduces the average stock of semi-finished goods [9]. However, the main obstacle of the digital transformation at the logistics service providers is the complexity of the logistics network and lack of resources [10]. According to a study on China's Belt and Road Initiative's digital integration of the global supply chain and logistics, route optimization algorithms are revolutionizing last-mile logistics, allowing for quicker and more effective delivery of goods to customers, and drones enhance last-mile delivery technologies like autonomous vehicles [11].

Digital Logistics Network and Sustainability

Sustainable logistics is a comprehensive approach to business operations and ensuring that each step in the product's journey is as green and efficient as possible. In order to meet environmental goals, digitalization for sustainability focuses on the proactive creation and application of digital tools, utilizing technology's capacity to promote favorable outcomes for the environment and its people. Table 2 displays the review result under the concepts of digitalization and sustainability in logistics operations. The study conducted in Turkey suggests that digitalization in logistics has still not reached the maturity level as it is still in the early maturation phase so that sustainability implications can be improved and changed over the years with the maturity level of digitalization [15]. On the other hand, there exists a significant positive mediation of digital enterprise and moderation of sustainability between digital enterprise and China's economic development [16]. Another study conducted on developing a sustainable logistics service quality scale for logistics service providers in Egypt [17] discussed a list of sustainability practices that should be used by logistics service providers in Egyptian culture. Despite having viable goals to meet, Egyptian-owned businesses rarely carry them out in practice, particularly in light of the presence of foreign competitors.

Таблица 2. Сводные результаты по цифровой логистике и устойчивому развитию

Table 2. Summary results for digital logistics and sustainability

Author(s)	Methodology	Findings
[15]	Qualitative analysis	Logistics digitization is still in its infancy, thus as it advances in maturity, its effects on sustainability can be enhanced and modified over time.
[16]	Bootstrapping and algorithms	Significant positive mediation of digital enterprise and moderation of sustainability between digital enterprise and economic development.
[17]	Q-sorting technique	The study explored Sustainability practices. Egyptian companies have sustainable targets to be achieved with low implementation.
[18]	Exploratory with few empirical	Idea generation, Conceptualizing, creating a sustainability business case, and execution comprise the sustainable logistics innovation.
[19]	Partial l east square	Customer satisfaction has a favorable impact on re-use intention while information, human contact, and customization qualities have a positive impact on customers' satisfaction.
[20]	Analytical Hierarchy Process	Technological infrastructures, digital solutions, and commitment of the top management affect the adoption of sustainable logistics 4.0.
[21]	Stochastic programming model	Higher collaboration levels successfully cope with demand uncertainty and improve revenues in the entire supply chain.
[22]	Content analysis and modeling	In logistics 4.0, collaborative robots, exoskeletons, and additive manufacturing are the best choices for sustainable development.
[23]	DEA and Tobit model	Logistics investment has a positive correlation with road miles, online retail sales, and firm size.
[24]	Optimization	The study reduced costs by 5.70% by partially optimizing procedures. The updated network subsequently produced overall savings of 10. 8%.
[25]	Qualitative & AHP	In landlocked nations, turnaround time has a significant impact on logistical success.

Source: Review result

Idea generation, idea selection, concept development, creating a sustainability business case, execution, and learning comprise the sustainable logistics innovation process. Formalization of the logistics innovation is positively related to the success of sustainable logistics innovation [18]. Customer satisfaction and re-use intention are influenced by the quality of logistics services while operational resources, information, human contact, and customized features favorably affect customer satisfaction [19]. The digital initiatives for sustainability in logistics with the concept of sustainable logistics 4.0 were empirically discussed in India [20]. The results indicate that the main determinants of the adoption of sustainable logistics 4. 0 are technological infrastructure, digital solutions, top management commitment, and governmental regulations. The study [21] shows that higher collaboration level successfully copes with demand uncertainty and improves

revenues in the entire supply chain. According to [22], the best technologies, such as additive manufacturing, exoskeletons, and collaborative robots, are the most suitable options for achieving sustainable development goals within Logistics 4.0.

Digital Logistics of Agriculture and Sustainability

Agriculture must include suitable sophisticated technology, digital, and innovations to become more environmentally, economically, and socially sustainable. Making well-informed decisions through digital farming and data-driven agricultural field operations can support agricultural sustainability and resilience. Table 3 presents the review results of digital logistics in agriculture and sustainability. The study conducted in China [26] shows that there is a significant effect of digital economic development on the intensity of agricultural carbon emissions. In the same country, the effect of the digital economy on sustainable agriculture is investigated, and the finding reveals that participation in digital production, digital sales, and digital finance significantly promotes farmers' adoption of ecological agricultural technologies [27].

Таблица 3. *Сводные результаты по цифровой логистике и устойчивому развитию в сельском хозяйстве*

Table 3. Summary results for agricultural digital logistics and sustainability

Author(s)	Methodology	Result
[26]	Regression analysis	The rise of the digital economy considerably reduces the intensity of carbon emissions from agriculture.
[27]	Treatment effect models	Digital sales and digital finance significantly promote farmers' adoption of ecological agricultural technologies.
[28]	Two-stage least square (2SLS)	Access to credit and extension services, education, and government support are key determinants for agricultural digitalization.
[29]	Content analysis	The integration of digitalization into the agricultural supply chain is severely hampered by rural areas' inconsistent electrical supplies and limited internet connection.
[30]	Supply chain models	Agricultural product vendors prefer to work with 3PL companies when the cost coefficient is low, but they prefer to use their own self-managed logistics when the coefficient rises.
[31]	Path optimization modeling	Effective uses of IoT technology solves problem of lagging agricultural product information, making agriculture product add value in the distribution process.
[32]	Developed sustainable model	The agricultural product logistics industry based on intelligent Blockchain technology could achieved at least 40% of the additional revenue.
[33]	Super efficiency SBM model, spatial models	Both low-carbon logistics efficiency and the level of digital economic development exhibit significant spatial positive correlation.
[34]	DEA and Tobit model	The level of agricultural logistics operation and the level of education of the labor force affect the efficiency of agricultural logistics.
[35]	Co-integration test, ARDL model	Capital, labor and urbanization have long-run positive relationship with both economic growth and carbon emission, respectively.
[36]	Multivariate regression	Logistics enterprise's capacity, demand, human resources, technology adoption have significant impact on agricultural logistics chain.
[37]	What if scenario	The distributed governance strategy for fresh agriculture products shortens processing time and reduces logistics costs.
[38]	Chi-squared test, contingency coefficient	The introduction of digitization and transfer of Big Data in agriculture will lead to better decisions and higher operational efficiency.
[39]	Difference in differences	National Agriculture Market e-trading platform increases the average wholesale prices of selected agri-commodities.
[40]	Spatial Durbin model	Added value of logistics fixed assets, highway mileage, truck number and railway mileage had a positive effect on the growth of agriculture.
[41]	GMM	Carbon emissions per capita and energy consumption from fossil fuels are negatively connected with green logistics.
[42]	Regression analysis	The development of digital economy reduces the carbon emission and promotes the innovation of agricultural green technology.
[43]	Fixed effect model	A significant and positive correlation between carbon dioxide emission and logistics performance was documented.

Source: Review result

On the other side, access to credit, extension services, education, and government support are key determinants for agricultural digitalization in developing countries [28]. Agricultural supply chain resilience is an important topic of discussion when considering the digitalization of the sector. However, limited internet access and unstable electricity supply in rural areas pose major obstacles to integrating digitalization into the agricultural supply chain [29]. The study on optimal logistics service strategies in green agricultural product supply chains with e-commerce platforms argues that agricultural product sellers prefer to cooperate with 3PL enterprises when the cost coefficient is small while they prefer to choose self-managed logistics when the cost coefficient increases [30].

According to the results of path optimization modeling, the problem of lagging agricultural product information can be resolved by using IoT technology effectively [31]. On the other hand, intelligent product logistics integration is effective with the integration of Blockchain technology such that the agricultural product logistics industry based on intelligent Blockchain technology could achieve at least 40% of the additional revenue [32]. Low-carbon logistics efficiency and the level of digital economic development exhibit significant spatial positive correlation [33]. The level of rural goods turnover, the level of agricultural logistics operation, and the level of education of the labour force are the main factors affecting the efficiency of agricultural logistics [34]. Capital, labour, and urbanization have a long-run positive relationship with both economic growth and carbon emissions, respectively, from the perspective of Blockchain technology.

Discussion of Merits and Demerits

Merits: The study provided significant variables with innovative approaches. The challenges of logistics industry are discussed. Integration and development of digital technologies, use of internet access, digital infrastructures, and government policy are among the top contributing factors of digital logistics development and its sustainability. Information sharing, logistics networking, and transportation have an impact on sustainable business and supply chain performance. Logistics enterprises capacity, demand, logistics human resources, technology applications, infrastructure development strategy, service quality, regional linkage in logistics, and priorities in policies have a significant impact on the development of logistics services chains for agricultural products. The complexity of the logistics network and lack of digital infrastructure and resources are identified as the key challenges of the logistics sector. Sustainability implications can be improved and changed over the years with the maturity level of digitization.

The importance and application of advanced technologies for the digitalization and sustainability of logistics operations are clearly indicated in the reviewed articles. For instance, digital B2B platforms have an intermediary function and can decide the inclusion and exclusion of the actors in the production network of sustainable logistics. The introduction of digitalization and Big Data technology in sustainable agricultural logistics will lead to better decisions for higher operational efficiency and promote productivity in the sector. Drones improve last-mile delivery technologies like autonomous vehicles. Additive manufacturing, exoskeletons, and collaborative robots are the most suitable options for achieving suitable development goals within logistics 4.0.

Effective use of IoT technologies solves the problem of lagging agricultural product information and increases the competition and overall benefits of the agricultural market. Intelligent Blockchain technology could achieve at least 40 percent of the additional revenue in

the agricultural product logistics industry. Interesting topics such as green logistics management, logistics network governance, sustainability impact of digitalization in logistics, intelligent logistics, carbon logistics efficiency, optimal logistics service, and robust digital production and logistics networks were studied. Robust model approach studies were conducted on agricultural logistics under the concept of digitalization [26, 28, 31, 33, 34, 41].

Demerits: As drawbacks of the sources used in the current review work, the generalizability problem could be of great concern. Generalization is an act of reasoning that involves drawing broad inferences from particular observations and is widely acknowledged as a quality standard in quantitative research but more controversial in qualitative research. Sources such as [8, 10, 11, 13, 17, 22, 29, 37] employed research methodologies such as what-if scenarios, qualitative analysis, and case studies so that they are more likely to have generalization problems. There are also sources that have a limited scope and small data set for the analysis.

It is easy to generate reliable quantitative results if the data has been properly gathered from the intended source. For example, [25] gathered information by creating a systematic questionnaire to examine important logistical performance metrics in low-income nations. Nevertheless, they used rudimentary descriptive analysis to arrive at a conclusion that was applicable to all low-income nations. Furthermore, [13] used qualitative research techniques to evaluate digital transformation at third-party logistics providers. A quantitative analysis would be highly sound, particularly in light of the company's level of digital preparedness.

The inclusion of biased information in the analysis leads to erroneous conclusions, which affects the reliability of policy decisions. For example, [19] used an online survey to study the impact of digital platforms on labour in production networks. This type of collecting information is highly susceptible to yielding biased information. Additionally, sustainability in digital logistics can be measured in a number of ways. However, some reviewed articles show a deficiency in dealing with the sustainability of digital logistics applied in a wide range of research areas.

Заключение / Conclusion

The review result explored that the digitalization in logistics sectors is increasing rapidly due to the integration of advanced digital technologies. The role of advanced technologies such as digital B2B platforms, Big Data technology, drones, additive manufacturing, exoskeletons, collaborative robots, IoT, and Blockchain technologies in the logistics industry is highly important for the sustainability and development of the logistics sector during the digital era. Digital B2B platforms have an intermediary function while Big Data technology leads to better decisions in production networks. Drones improve delivery time while IoT solves the problem of lagging product information. Additive manufacturing, exoskeletons, and collaborative robots are most suitable for the development goals with logistics 4.0. Significant variables contributing to the development of logistics and key challenges existing in the sector are identified and explained. The outcome of the review also identified deficiencies. These include generalization problem, the inclusion of biased information in the analysis, limited scope, and lack of quantitative approach, and the exclusion of sustainability issues in some works. The authors' contribution lies in their conceptual development and critical review of the existing sources. Furthermore, the authors think that the findings of this review may provide a theoretical foundation and pave the way for further research in this area. According to the authors, future studies in digital logistics could cover a wide range of topics, including sustainability concerns and quantitative analysis.

СПИСОК ЛИТЕРАТУРЫ / REFERENCES

1. Barykin S., Provotorov I., Sergeev S. et al. Modeling of transport flows of energy resources in digital logistics based on the methodology of multidimensional network structures. *Transport research procedia.* 2022. Vol. 63. Pp. 628–638. DOI: 10.1016/j.trpro.2022.06.056

2. Strandhagen J.O., Vallandingham L.R., Fragapane G. et al. Logistics 4.0 and emerging sustainable business models. *Advances in Manufacturing*. 2017. Vol. 5. Pp. 359–369. DOI: 10.1007/s40436-017-0198-1

3. Mihai N. Digital logistics: Historical background and current key development trends. *Admiral Makarov National University of Shipbuilding*. Pp. 8–26.

4. Moldabekova A., Philipp R., Reimers H. Digital technologies for improving logistics performance of countries. *Transport and telecommunication.* 2021. Vol. 22. No. 2. Pp. 207–266. DOI: 10.2478/ttj-2021-0016

5. Zhang L., Gong L., Tong Y. The impact of digital logistics under the big environment of economy. *PLoS ONE*. 2023. Vol. 22. No. 4. Pp. 1–19. DOI: 10.1371/journal.pone.0283613

6. Trivellas T., Malindretos G., Reklitis P. Implications of green logistics management on sustainable business and supply Chain performance: evidence from a survey in the greek agri-food sector. *Sustainability.* 2020. Vol. 12. Pp. 1–29. DOI: 10.3390/su122410515

7. Yunlin C. Awareness of green logistics technology, certification, and standards by logistics practitioners at Chinese e-commerce company, Jing Dong. *Journal of Shipping and Logistics.* 2023. Vol. 39. Pp. 37–46. DOI: 10.1016/j.ajsl.2023.10.004

8. Helwind V., Verfürth P., Franz M. Trucking (un) limited – the impact of digital platforms on labor in production networks of logistics. *Advances in Economic Geography.* 2023. Vol. 67. No. 4. Pp. 177–188. DOI: 10.1515/zfw-2021-0032

9. Birkmaier A., Oberegger B., Felsberger A. et al. Towards a robust digital production and logistics network by implementing flexibility measures. *Procedia CIRP*. 2021. Vol. 104. Pp. 1310–1315. DOI: 10.1016/j.procir.2021.11.220

10. Cichosz M., Wallenburg C.M., Knemeyer A.M. Digital transformation at logistics service providers : barriers, success factors and leading practices. *International Journal of Logistics and Management.* 2020. Vol. 31. No. 2. Pp. 209–238. DOI: 10.1108/IJLM-08-2019-0229

11. Wang M., Childerhouse P., Abareshi A. Global logistics and supply chain integration in the digital era : a focus on China's Belt and Road Initiative. *Journal of international logistics and trade.* 2024. Vol. 22. No. 2. Pp. 58–79. DOI: 10.1108/JILT-03-2023-0018

12. Li X., Chen F. Impact of logistics development on economic growth : an empirical research from Guangdong Province in China. *Complexity.* 2021. Pp. 1–12. DOI: 10.1155/2021/9950935

13. Mvubu M., Naude M.J. Digital transformation at third-party logistics providers : Challenges and best practices. *Journal of transport and supply chain management.* 2024. Vol. 18. Pp. 1–16. DOI: 10.4102/ jtscm.v18i0.1023

14. Emre A., Somuncu S., Korkmaz M., Demirci E. Conceptual awareness levels of digital logistics among Turkish university students. *Humanities & social sciences communications.* 2024. DOI: 10.1057/s41599-024-02907-8

15. Kayikci Y Sustainability impact of digitization in logistics. *Procedia.* 2018. Vol. 21. Pp. 782–789. DOI: 10.1016/j.promfg.2018.02.184

16. Pei J. Approaches toward building the digital enterprise and sustainable economic developmen. *Frontier in Psychology.* 2022. Vol. 13. Pp. 1–11. DOI: 10.3389/fpsyg.2022.835602

17. Ali A.H., Melkonyan A., Noche B., Gruchmann T. Developing a sustainable logistics service quality scale for logistics service providers in Egypt. *Logistics.* 2021. Vol. 5. No. 21. Pp. 1–16. DOI: 10.3390/logistics5020021

18. Björklund, M., Forslund, H. Exploring the sustainable logistics innovation process, *Industrial management & data systems*. 2018. Vol. 118. No. 1. Pp. 204–217. DOI: 10.1108/IMDS-02-2017-0058

19. Lin X., Mamun A.A., Yang Q., Masukujjaman M. Examining the effect of logistics service quality on customer satisfaction and re-use. *PLoS ONE.* 2023. Vol. 18. No. 5. Pp. 1–24. DOI: 10.1371/journal.pone.0286382

20. Parhi S., Joshi K., Gunasekaran A., Sethuraman K. Reflecting on an empirical study of the digitalization initiatives for sustainability on logistics: The concept of sustainable logistics 4.0. *Cleanerlogistics and supply chain.* 2022. Vol. 4. Pp. 1–14. DOI: 10.1016/j.clscn.2022.100058

21. Ito A., Kaihara T., Kokuryo D., Fujii N. A study on collaborative logistics network design with truck Sharing under demand uncertainty. *IFAC* online. 2023. Vol. 56. No. 2. Pp. 5227–5232. DOI: 10.1016/j.ifacol.2023.10.120

22. Ferraro S., Cantini A., Leoni L., De Carlo F. Sustainable logistics 4.0: a study on selecting the best technology for internal material handling. *Sustainability.* 2023. Vol. 15. Pp. 1–22. DOI: https://doi.org/10.3390/su15097067

23. Tong J., Wu X., Yin Y. Logistics efficiency evaluation and empirical research under the new retailing model: the way toward sustainable development. *Sustainability.* 2023. Vol. 15. P. 15028. DOI: 10.3390/su152015028

24. Karagiannis G., Minis I., Arampantzi C., Dikas G. Warehousing and distribution network design from a third-party logistics (3PL) company perspective. *International journal of production research*. 2024. Vol. 62. Pp. 260–270. DOI: 10.1080/00207543.2023.2248280

25. Tadesse M.D., Kine H.Z., Gebresenbet G. et al. Key logistics performance indicators in low-income countries: the case of the import – export Chain in Ethiopia. *Sustainabilty*. 2022. Vol. 14. 12204. Pp. 1–25. DOI: 10.3390/su141912204

26. Tong L., Wang C., Qi Q. et al. Study on the impact of China's digital economy on agricultural carbon emissions. *Global NEST journal*. 2024. Vol. 26. No. 6. 06183. Pp. 1–13. DOI: 10.30955/gnj.006183

27. Chunfang Y., Xing J., Changming C. et al. Digital economy empowers sustainable agriculture: Implications for farmers' adoption of ecological agricultural technologies. *Ecological indicators*. 2024. Vol. 159. 111723. Pp. 1–15. DOI: 10.1016/j.ecolind.2024.111723

28. Kitole F.A., Mkuna E., Sesabo J.K. Technology digitalization and agricultural transformation in developing countries: empirical evidence from Tanzania agriculture sector. *Smart Agricultural Technology*. 2024. Vol. 7. 100379. Pp. 1–7. DOI: 10.1016/j.atech.2023.100379

29. Keefe D.M.S., Jang H., Sur J. Digitalization for agricultural supply chains resilience: perspectives from Indonesia as an ASEAN member. *Asian journal of Shipping and Logistics*. 2024. Vol. 40. Pp. 180–186. DOI: 10.1016/j.ajsl.2024.09.001

30. Zhou C., Bai D., Liu Z. et al. Optimal logistics service strategies in green agricultural product supply chains with E-commerce platforms. *Sustainable Operations and Computers*. 2024. Vol. 5. Pp. 156–166. DOI: 10.1016/j.susoc.2024.06.002

31. Ai X., Zhang Y. Modeling analysis of intelligent logistics distribution path of agricultural products under internet of things environment. *Springer International Publishing*. 2019.Vol. 279. Pp. 322–329. DOI: 10.1007/978-3-030-19086-6

32. Zheng F., Zhou X. Sustainable model of agricultural product logistics integration based on intelligent blockchain technology. *Sustainable Energy Technologies and Assessments*. 2023. Vol. 57. 103258. Pp. 1–8. DOI: 10.1016/j.seta.2023.103258

33. Zhang J., Liu H., Wang J., Huang Q. Spatial impact of the digital economy on low-carbon logistics efficiency in RCEP countries. *Journal of Environmental Management*. 2024. Vol. 360. 121221. Pp. 1–8. DOI: 10.1016/j.jenvman.2024.121221

34. Automatisés S., Hao H., Yin S. et al. Research on agricultural logistics efficiency based on DEA and tobit regression models. 2022. Vol. 55. Pp. 71–79. DOI: 10.18280/jesa.550107

35. Gu Z., Malik H.A., Chupradit S. et al. Green supply chain management with sustainable economic growth by CS-ARDL technique: perspective to blockchain technology. *Frontier in Public Health.* 2022. Vol. 9. Pp. 1–13. DOI: 10.3389/fpubh.2021.818614

36. Loi N.T., Hoa H.T.T., Danh N.T. Affecting the development of a logistics service chain for agricultural products in the Mekong Delta, Vietnam. *Transportation Research Procedia.* 2024. Vol. 80. Pp. 127–136. DOI: 10.1016/j.trpro.2024.09.017

37. Perdana T., Tjahjono B., Kusnandar K. et al. Fresh agricultural product logistics network governance: insights from small-holder farms in a developing country. *International Journal of Logistics Research and Applications*. 2023. Vol. 26. Pp. 1761–1784. DOI: 10.1080/13675567.2022.2107625

38. Dupaľ A., Richnák P., Szabo Ľ., Porubanová K. Modern trends in logistics of agricultural enterprises. *Agricultural Economics*. 2019. Vol. 65. No. 8. Pp. 359–365. DOI: 10.17221/367/2018

39. Chaudhary S., Suri P.K. The impact of digitalisation on the agricultural wholesale prices to aid agrarian income. *Agricultural Economics.* 2022. Vol. 68. Pp. 361–370. DOI: 10.17221/113/2022

40. Li X., Jiang J., Cifuentes-faura J. The impact of logistic environment and spatial spillover on agricultural economic growth: An empirical study based on East, Central and West China. *PLoS ONE.* 2023. Vol. 18. No. 7. Pp. 1–19. DOI: 10.1371/journal.pone.0287307

41. Li B., Gao Y. Impact and transmission mechanism of digital economy on agricultural energy carbon emission reduction. *International Review of Economic and Finance.* 2024. Vol. 95. 103457. Pp. 1–15. DOI: 10.1016/j.iref.2024.103457

42. Karaduman H.A., Karaman-akgül A., Caglar M., Akba H.E. The relationship between logistics performance and carbon emissions: an empirical investigation on Balkan countries. *International Journal of Climate Change Strategies and Management.* 2020. Vol. 12. No. 4. Pp. 449–461. DOI: 10.1108/IJCCSM-05-2020-0041

Финансирование. Исследование проведено без финансовой поддержки.

Funding. The study was performed without external funding.

Конфликт интересов. Авторы заявляют об отсутствии конфликта интересов.

Conflict of interest. The authors declare no conflict of interest.

Вклад авторов:

С. Е. Барыкин – методическое руководство работой над статьей;
А. Н. Меконин – сбор и анализ материала для статьи.

Contribution of the authors:

S.E. Barykin – methodological guidance for the work on the article;
A.N. Mekonin – collection and analysis of material for the article.

Информация об авторах

Меконин Абера Негери, аспирант, Высшая школа сервиса и торговли, Санкт-Петербургский политехнический университет Петра Великого;

195251, Россия, Санкт-Петербург, ул. Новороссийская, 50;

tgmoke@gmail.com, ORCID: https://orcid.org/ 0000-0002-2879-7459

Барыкин Сергей Евгеньевич, д-р экон. наук, профессор, заместитель директора по научным исследованиям и разработкам, Высшая школа сервиса и торговли, Санкт-Петербургский политехнический университет Петра Великого;

195251, Россия, Санкт-Петербург, ул. Новороссийская, 50;

sbe@list.ru, ORCID: https://orcid.org/0000-0002-9048-009X, SPIN-код: 9382-2074

Information about the authors

Abera N. Mekonin, Post-graduate Student, Graduate School of Service and Trade, Peter the Great St. Petersburg Polytechnic University;

195251, Russia, St. Petersburg, 50 Novorossiyskaya street;

tgmoke@gmail.com, ORCID: https://orcid.org/0000-0002-2879-7459

Sergey E. Barykin, Doctor of Economic Sciences, Professor, Deputy Director for Scientific Research and Development, Graduate School of Service and Trade, Peter the Great St. Petersburg Polytechnic University;

195251, Russia, St. Petersburg, 50 Novorossiyskaya street;

sbe@list.ru, ORCID: https://orcid.org/0000-0002-9048-009X, SPIN-code: 9382-2074