



IMPACT OF A DECENTRALIZED COMMUNICATION MODEL ON THE EFFICIENCY OF LOGISTICS OPERATIONS

Maksym Horbunkov

ORCID: <https://orcid.org/0009-0000-8072-7709>

Truck Driver Price Rite Transport LLC,

Kremenets Taras Shevchenko Regional Academy of Humanities and Pedagogy, Ukraine

Abstract. Changes in approaches to providing logistics services in the context of digital technology integration have contributed to the transformation of approaches and methods of information exchange and communication in logistics. This paper examines the qualitative effects and advantages of a decentralized communication model in logistics in the context of the growing digitalization of the transport and supply sector, which has led to an increase in data volumes, the need for data management, and the creation of joint mechanisms for decentralized information exchange. An analysis of the efficiency of the logistics sector in the leading countries according to the EU Logistics Performance Index indicates progress in international shipments and supply tracking, although there is a deterioration in the timeliness of transport in 2018-2023. The results demonstrate the importance of a decentralized model of communication and information exchange in multimodal logistics and supply. In particular, the European experience in developing a common information exchange system in the multimodal transport and logistics supply chain allows solving the problem of data incompatibility and fragmentation, which complicates access to information for logistics companies and decision-making to improve logistics operations with the aim of developing intelligent logistics services.

Keywords: logistics operations, logistics, supply chain, communication model, information exchange, decentralization, and distribution.

Introduction

In the 1990s, the traditional approach to building logistics operations was based on identifying logistics with a commodity service, the provision of which depended on the totality of assets owned by the company to provide services. As a result, logistics operations were inefficient and created little value in the product supply chain. This situation was due to the established trade links between countries and the corresponding logistics networks created on the basis of centralized management. Accordingly, the model of communication and information exchange in logistics was characterized by a high level of centralization, hierarchical relationships, and dependence on central-level decision-making authorities.

Instead, the emergence of digital technologies has contributed to a change in approaches to the provision of logistics services towards the decentralization of logistics operations and processes management and the decentralization of information exchange. From the early 2000s to the present, the demand for highly specialized



logistics services and the integration of digital technologies into management practices have significantly reduced the level of centralization in logistics. In particular, new models of communication and connection between major transport and warehousing service providers have made it possible to pool their assets, free up financial resources, and invest in technologies that facilitate rapid data collection, instant information updates, and fast information transfer between decision-making centers, resulting in a significant increase in the efficiency of logistics operations. Under the traditional approach, logistics providers coordinated the transportation, warehousing, sorting, and storage of shippers' and recipients' assets. In contrast, in today's digital environment, specialized logistics centers (hubs) are being created to coordinate and integrate various types of logistics activities that can be provided by different operators. In such conditions, the importance of a decentralized communication model is only growing, as logistics must ensure timely, reliable, and transparent delivery of goods and rapid information exchange between senders, providers, and consumers. In this regard, research on the impact of a decentralized communication model on the efficiency of logistics operations is becoming increasingly relevant.

Research Results Logistics operations are understood as a comprehensive set of actions and processes aimed at the efficient movement and transportation of goods, services, and information from producers to consumers. Logistics operations are classified as planning, transportation, warehouse management, coordination, quality assurance, inventory, packaging, order processing, supply chain management, and other operations, the optimization of which can significantly improve the provision of logistics services and increase the income of logistics providers. Proper configuration of logistics operations is important for the provision of quality services and the smooth and timely functioning of the supply chain.

In the current economic environment, these types of operations can be provided by a single company or distributed among several firms not only within the regional, national, but also international market and supply chain. Under such conditions, it is important to establish an effective communication model capable of ensuring the uninterrupted flow of information and finances for the timely and reliable



transportation and delivery of goods and services to consumers.

The effectiveness of logistics operations depends on the approaches, methods, and tools used to establish communication between logistics service providers, shippers, and end consumers. One of the most innovative approaches in the context of digital logistics development is a strategic, collaborative approach to logistics activities, which involves the integration and use of digital technologies to improve the efficiency of logistics operations in the context of the sector's sustainable development in the global economy [1]. A joint approach to building a decentralized communication model means the synchronized use of technologies to transfer information between participants in logistics processes, quickly update information in various information systems to facilitate the smooth operation of logistics operations, and reduce delivery times.

Digitalization in logistics allows for the improvement of existing transportation tracking systems and ensures faster information transfer between different participants in the supply chain [6], thus ensuring transparency of logistics operations, affecting delivery speed, and reducing delivery time. The digitization of information and financial flows [6] promotes transparency in logistics operations and the exchange of information between participants in the supply chain. Modern logistics invests in the development of an intelligent digital infrastructure based on data concentrated in cyber-physical systems, which allows for the decentralization of the existing communication model and significantly expands the existing methods of interaction within traditional logistics links [8].

The integration of software in logistics has facilitated the transition from a centralized to a decentralized communication model. Cloud-based ERP, RPA, and SRM transportation management systems automate routine logistics operations and processes, including communication and information transfer, thereby significantly simplifying information exchange and accelerating the flow of information. Real-time business process management systems (TMS) provide real-time information on freight transportation, delivery routes, and costs, enabling the integration of information from various sources. Logistics companies track and optimize logistics processes in real time



thanks to built-in TMS systems with GPS to obtain information about the status of the vehicle fleet, plan maintenance processes, dynamically change routes, avoid delivery delays, and increase the efficiency of fuel and human resources. Automated WMS warehouse systems enable the rapid exchange of information about available inventory, warehouse capacity, transportation and shipping processes, customer orders, and customer needs. SCM supply chain management systems ensure the flow of information throughout the supply chain and provide information about the movement of goods and available resources. Internet of Things (IoT) technologies for collecting data from physical systems and artificial intelligence (AI) for optimizing logistics data processing allow for the partial automation of manual labor. In a decentralized communication system, information exchange occurs not only according to the “top-down” principle, but also according to the “bottom-up” principle, because the data and information collected at the lower levels of management and operations are quickly transmitted to senior management and the coordinating body thanks to its digitization (Table 1).

The advantages of a decentralized communication model in logistics include high flexibility of the information exchange system and rapid response to changes thanks to fast information flow, accelerated information exchange between various participants in logistics and supply chains, and lower dependence on decision-making centers and key management entities, as the information system continues to function even in the event of possible failures of a single node. Digital technologies ensure transparency of information exchange and reduce control over information stored in information systems, ensuring its transparency, accessibility, and rapid data updates. In a decentralized communication model, information processes are more innovative, as the implementation of information systems and software at the level of individual departments allows for remote information exchange.

Despite its numerous advantages, the decentralized communication model is characterized by a higher risk of errors and inconsistencies, duplication of information requiring human intervention, and higher coordination costs due to the need to maintain different points of interaction and information systems.



Table 1 – Comparison of centralized and decentralized communication models in logistics

Comparison criterion	Centralized communication model	Decentralized communication model
Management structure	The communication model is built on a top-down principle, with decisions being made centrally by the central coordinating body.	The communication model is built on the principles of “top-down” and “bottom-up,” with decisions being made in a coordinated manner.
System flexibility	Low flexibility, slow adaptation to environmental changes	High flexibility and rapid response to changes
Speed of information exchange	Slow, dependent on the control and coordination center where the main assets and resources are concentrated	Accelerated information exchange takes place between various participants in logistics and supply chains.
Probability of errors	Fewer errors due to standardization of information transfer processes; errors occur due to human factors	Increased risk of errors and inconsistencies, duplication of information, need for human intervention
Coordination costs	Lower thanks to the operation of a centralized communication center	Higher, it is necessary to maintain various points of interaction and information systems
Dependence on decision-making centers and key management entities	High dependency, leading to disruptions in logistics operations and transportation delays	Less dependence, because the information system continues to function even in the event of possible failures of a single node
Transparency and control	High level of control through clear management verticals	Lower level of complexity in controlling information stored in information systems, ensuring transparency, accessibility, rapid data updates, and more effective tracking
Innovation in information processes	Low due to slow implementation of innovative processes in the communication and information exchange system	High due to the rapid implementation of information systems and software at the level of individual departments to establish remote information exchange
The need for digital technologies	Moderate, basic information exchange systems integrated into the logistics management system are required.	High, information systems and technologies require synchronized operation due to the increasing complexity of IT systems (ERP, SRM, WMS, SCM IoT, AI, TMS, RPA).

Author's development

In 2023, Singapore ranked first among the leading countries in the Global Logistics Performance Index in terms of international shipment speed, timeliness, and shipment tracking (compared to 7th place in 2018). Finland, Denmark, Germany, the Netherlands, and Switzerland were also among the leading countries in terms of logistics process efficiency. Compared to 2018, countries have made progress in



international shipments, especially Finland, and logistics tracking processes, especially Sweden. On the other hand, delivery timeliness indicators have declined slightly due to the exacerbation of geopolitical factors (Table 2).

Table 2 – Ranking of the top 15 countries according to the Global Logistics Performance Index, 2023*

№	Economy	Valuation of international shipments	Timeliness assessment	Tracking assessment
1	Singapore	4,0	4,3	4,4
2	Finland	4,1	4,3	4,2
3	Denmark	3,6	4,1	4,3
4	Germany	3,7	4,1	4,2
5	Netherlands	3,7	4,0	4,2
6	Switzerland	3,6	4,2	4,2
7	Austria	3,8	4,3	4,2
8	Belgium	3,8	4,2	4,0
9	Canada	3,6	4,1	4,1
10	Hong Kong, China	4,0	4,1	4,2
11	Sweden	3,4	4,2	4,1
12	United Arab Emirates	3,8	4,2	4,1
13	France	3,7	4,1	4,0
14	Japan	3,3	4,0	4,0
15	Spain	3,7	4,2	4,1

*[7]

The leading positions of most EU countries are the result of significant investments in the digitization of transport sector infrastructure within the framework of European and national government financing policies. The Digital Europe Program plans to develop a European federation of cloud and edge computing infrastructure for the transport sector to support mobility and data exchange with the automotive ecosystem. As part of the Horizon Europe program, with a budget of €150 million for the implementation of the Cloud Technologies – Edge – Internet of Things initiative, an additional €2 billion from the EU budget will be allocated to the purchase of cloud technologies through various support programs (projects to ensure mobility in the transport sector, smart logistics) [3]. Digitalization in the EU focuses on investments in artificial intelligence, the Internet of Things, cloud and edge computing, and 5G networks to improve mobility in the transport sector. With the rapid growth in the



volume of data generated by vehicles and their devices, the increase in the speed of information exchange is transforming logistics operations towards mobility, accessibility, and efficiency thanks to a higher level of synchronization of different types of transport [4]. The use of mobility data in the transport sector and logistics allows for more efficient service delivery, ensuring “smart” sustainable planning of infrastructure and services, more coordinated transport movements, and more competitive supply chains. The policy objective is not simply to collect and accumulate data in information systems, but to simplify data exchange and control data confidentiality in logistics and transform it into information that is acceptable for decision-making. To this end, in 2020, the EU adopted the European Data Strategy for comprehensive action to promote the availability, sharing, and use of data across all sectors of the economy, including the transport sector. The adoption of European data legislation will ensure fair data distribution, improve access to information, and create a data-driven services market in the transport sector (including insurance, repair, and maintenance services). Thanks to active cooperation between EU governments, practices for collecting, managing, and using data in the transport sector and logistics have been developed. As a result, the Digital Transport and Logistics Forum has contributed to the creation of a shared environment for data exchange in the field of freight transport and logistics [2]. The Connecting Europe Facility (CEF, Digital) allows for the creation of operational digital platforms to support the modernization of transport infrastructure based on information and communication technologies to simplify information flows, storage, and data processing for the purpose of providing intelligent services in logistics [5].

Despite the strategic actions and joint efforts of EU member states' governments to create a common European data space to improve the efficiency of multimodal logistics, improve data management, and modernize transport infrastructure, a number of threats are characteristic of the current stage of development of the new model of communication and information exchange (Table 3). and modernizing transport infrastructure, there are still a number of threats characteristic of the current stage of development of the new model of communication and information exchange (Table 3).



Table 3 – Main opportunities and threats of using data and information in logistics within the EU

Capabilities	Threats
The creation of a common European data space in logistics solves the problem of data fragmentation, eliminates shortcomings in data management in logistics, increases data accessibility, and provides a controlled, secure method of transmission.	Difficulties for logistics companies in accessing data due to its fragmentation, while large foreign technology companies use “big data” to grow their own businesses
Improving data management to ensure compatibility between different data sets will contribute to improving logistics operations and processes, and consequently logistics services.	Technical barriers to improving data management in different EU countries hinder effective information exchange, while incompatibility and fragmentation of data cause problems in multimodal logistics and supply.
Modernization of transport infrastructure based on ICTs that facilitate access to data, accelerate information flows, and promote the development of intelligent logistics services	Modernization of transport infrastructure requires significant investment to ensure compatibility of existing infrastructure with innovative technologies.
Transportation and logistics management, including information exchange, minimizes security risks and maximizes the efficiency of logistics operations.	The complexity of establishing integrated traffic management based on innovative communication models in logistics

Author's development

The lack of compatibility and fragmentation of different data exchange systems is identified as one of the most important problems for companies in the field of logistics and supply in European countries. To address this issue, a joint working subgroup, “Corridor Freight Information Systems,” was created with the task of developing a common information exchange system in the multimodal transport and logistics supply chain [2]. The system has created a data space for the integration of existing and innovative digital platforms as a common unified network, which will facilitate the connection of private and public players and the exchange of data in a reliable and secure environment. The EU's experience demonstrates the effectiveness of creating a decentralized communication model to establish a fully transparent supply chain and improve logistics efficiency.

Conclusions

The study examines the qualitative effects and advantages of a decentralized communication model in logistics in the context of the growing digitalization of the transport and supply sector, which has led to an increase in data volumes, the need for



data management, and the creation of joint mechanisms for decentralized information exchange. An analysis of the efficiency of the logistics sector in the leading countries according to the EU Logistics Performance Index indicates progress in international shipments and supply tracking, although there is a deterioration in the timeliness of transport in 2018-2023. The results demonstrate the importance of a decentralized model of communication and information exchange in multimodal logistics and supply. In particular, the European experience in developing a common information exchange system in the multimodal transport and logistics supply chain allows solving the problem of data incompatibility and fragmentation, which complicates access to information for logistics companies and decision-making to improve logistics operations.

References:

1. Attah R. U., Baalah M., Iwuanyanwu O. та ін. Strategic frameworks for digital transformation across logistics and energy sectors: Bridging technology with business strategy. *Open Access Research Journal of Science and Technology*. Вип. 12, № 2. С. 070–080. DOI:10.53022/oarjst.2024.12.2.0142.
2. European Commission Digital Transport and Logistics Forum (DTLF) - Mobility and Transport. URL: https://transport.ec.europa.eu/transport-themes/digital-transport-and-logistics-forum-dtlf_en (дата звернення: 28.11.2025).
3. European Commission Digitalising transport - key technologies. Shaping Europe's digital future. URL: <https://digital-strategy.ec.europa.eu/en/policies/technologies-digitalisation-transport> (дата звернення: 28.11.2025).
4. European Commission Digitalising transport - towards smart and sustainable mobility. Shaping Europe's digital future. URL: <https://digital-strategy.ec.europa.eu/en/policies/digitalisation-mobility> (дата звернення: 28.11.2025).
5. European Commission Unlocking the potential of mobility data. Shaping Europe's digital future. URL: [ISSN 2663-5712](https://digital-</div><div data-bbox=)



strategy.ec.europa.eu/en/policies/mobility-data (дата звернення: 28.11.2025).

6. Kuteyi D., Winkler H. Logistics Challenges in Sub-Saharan Africa and Opportunities for Digitalization. *Sustainability*. Вип. 14, № 4. С. 2399. DOI:10.3390/su14042399.

7. World Bank Group Logistics performance index. URL: <https://data.worldbank.org> (дата звернення: 21.10.2025).

8. Zhang L., Gong T., Tong Y. The impact of digital logistics under the big environment of economy. *PLOS ONE*. Вип. 18, № 4. С. e0283613. DOI: 10.1371/journal.pone.0283613.