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DIGITAL TOOLS AS A MEANS OF ENSURING CONTINUITY OF LOGISTICS PROCESSES DURING A CRISIS

Seleznova H., Petrovska Y., Larina T., Gorodetska T. Digital tools as a means of ensuring continuity of logistics processes during a crisis.

This research paper presents a comprehensive analysis of the impact of digitalization on the continuity of operational activities of distribution companies during acute crises. It has been demonstrated that moving away from manual supply chain management toward automated systems is a fundamental requirement for ensuring business viability. The key challenges posed by martial law have been analyzed: the destruction of transport infrastructure, energy instability, and the disruption of established routes. Priority digital tools (GPS monitoring, WMS/TMS systems, CRM, IoT sensors, and cloud platforms) are identified, which form the basis for adapting logistics to force majeure events. The use of a suite of digital solutions enables the creation of an adaptive foundation for business resilience. The key impact of these technologies lies in solving the most complex logistics challenges. The study focuses on the management of goods with specific temperature requirements (veterinary products, medicines), for which telemetry is the sole means of maintaining the 'cold chain'. Within the scope of the study, a conceptual five-stage model for deploying digital logistics infrastructure has been developed, confirming that the greatest economic and stabilizing effects are achieved through the comprehensive, synergistic implementation of innovations rather than their piecemeal application. A comparative analysis of risks and the tools for mitigating them has been carried out. The analysis showed that various types of risks can significantly affect supply chain efficiency and disrupt logistics processes. The use of modern digital technologies enables timely detection and mitigation of the negative consequences of such risks. The synergistic effect of the comprehensive implementation of innovations has been substantiated. The results of the study have practical significance for increasing the flexibility and sustainability of distribution enterprises.

Keywords: digitalization, logistics, business continuity, supply chain resilience, WMS, TMS, GPS monitoring, martial law, distribution, cold chain.



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Introduction. The current stage of development of economic relations is characterized by rapid digitalization, superimposed on extreme external shocks, particularly those caused by full-scale military aggression against Ukraine. In this context, traditional logistics management paradigms have proven to be completely unviable. Domestic supply infrastructure is being tested for strength: enterprises are forced to react with lightning speed to the blocking of familiar roads and large-scale power outages that paralyze warehouse hubs.

The distribution sector, which serves as the arteries of the country's commodity supply, felt these blows most acutely. The usual, mostly paper-based or basic tabular approaches to fleet planning and inventory management have proven to be critically inflexible and slow. In crisis conditions, any information vacuum or temporary delay in data transfer can trigger a chain reaction: from damage to entire batches of specific cargo to a complete loss of trust among customers. Enterprises that fail to adapt their logistics strategies promptly by implementing modern IT solutions risk a complete shutdown of operations. That is why the transition to innovative digital supply chain management solutions is becoming an uncontested issue of survival and maintaining operational continuity.

Analysis of recent research and publications. The problem of ensuring the resilience of supply chains and their digitalization as a response to external shocks is actively discussed in the scientific community. The basic principles of crisis management were formed in the studies of J. Sheffi and J. S. Scheffi. J. B. Rice proves that the speed of data exchange and the flexibility of processes are key to a quick recovery of the company after large-scale shocks [1]. They emphasize that an enterprise's stability is determined less by physical reserves than by the speed of information flows.

The use of complex warehouse management systems (WMS) and transport management systems (TMS) during force majeure and pandemic shocks has been extensively studied by a team of authors led by Y. Wang [2]. The theoretical and methodological foundations of the digitalization of procurement and the construction of the latest supply architectures are drawn from the works of J. S. Srαι and H. Lorentz [3]. Among Ukrainian scientists, significant contributions were made by N. Skryhun and S. Bondarenko [4], as well as by N. Chukhrai and R. Patora [10], who analyzed the challenges and opportunities of digital transformation in logistics under martial law. However, despite the existing theoretical basis, the dynamics of

hostilities constantly generate new, unpredictable situations. The issue of creating a comprehensive ecosystem of digital tools for enterprises working with specific products (which require strict temperature compliance), where the cost of a logistical error is highest, remains insufficiently addressed.

Formulation of the purpose of the article. The article aims to comprehensively examine the essence, features, and effectiveness of introducing digital tools as a key mechanism to ensure the continuity of logistics processes at distribution enterprises during an acute crisis.

To achieve the goal, the following tasks have been formed:

- to identify the main destabilizing factors affecting modern domestic logistics;
- classify IT solutions in accordance with their anti-crisis functions;
- to analyze the features of telemetry control during the transportation of sensitive goods (for example, the preservation of the "cold chain");
- to develop a conceptual model of digital transformation of enterprise logistics.

Presentation of the main material. The current macroeconomic and security situation has created several critical barriers that have disrupted traditional algorithms for distribution activities. The transformation of logistics management is due to the need for an instant response to the following key challenges:

- large-scale destruction of the road transport network and bridge crossings, which makes it impossible to use optimal routes;
- emergency changes in logistics corridors due to the proximity of hostilities, the presence of checkpoints, and curfews;
- systematic blackouts that critically affect the operation of warehouse terminals, electronic databases, and climate control systems;
- acute shortage of qualified line personnel (drivers, warehouse workers);
- high volatility in fuel and lubricant costs.

Under these conditions, classical dispatching methods will fail completely. Digitalization is turning from a long-term innovation strategy into a daily tool for business survival. Using a set of digital solutions allows you to build an adaptive framework for stability. The main instruments and their impact on operational activities are given in the table. 1.

Table 1

Digital tools to ensure the continuity of logistics processes

Tool	Function in a crisis	Effect on the enterprise
GPS Vehicle Monitoring	Continuous monitoring of the geolocation of rolling stock and quick redirection of vehicles in case of obstacles.	Minimization of downtime, preventive protection of cargo from loss or damage in hazardous areas.
WMS (Warehouse Management System)	Automation of inventory accounting, optimization of equipment with limited personnel.	Radical reduction in the level of errors in picking, and significant acceleration of the order fulfillment cycle.
TMS (Transport Management System)	Algorithmic construction of flights, considering infrastructure and time constraints, with transparent control of delivery stages.	Saving fuel and lubricating resources, stabilizing or increasing the On-Time Delivery Index (OTIF).
CRM system	Maintaining continuous communication with counterparties and automating the process of accepting requests for supplies.	Reducing customer churn and building trusting relationships through transparency and prompt information.
Cloud platforms	Decentralized storage of information, which guarantees access to it even in the event of physical loss of local servers or blackouts.	Absolute continuity of document flow and protection of critical corporate information.

Source: developed by the authors

For a comprehensive understanding of how these tools ensure the continuity of business processes, this study conducted a comparative analysis of logistics risks and digital mechanisms for their mitigation, as presented in the table 2.

Table 2

Comparative analysis of logistics risks and IT tools for their leveling

Type of risk	Potential implications for the supply chain	Digital Risk Mitigation Tool
Infrastructure (destruction of roads, closures)	Failure to deliver deadlines, damage to vehicles in dangerous areas	AI-powered dynamic routing (TMS + GPS)
Energy (long blackouts)	Complete shutdown of warehouse processes, inability to complete documentation	Cloud ERP systems, transition to mobile terminals (TZD) with offline mode
Climatic / Technological	Violation of the "cold chain", damage to batches of goods	IoT temperature and humidity sensors with online telemetry
Communication	Loss of communication with the driver or customer due to network interruptions	Multi-channel CRM portals for customers, satellite car tracking

Source: developed by the authors

The analysis of supply chain risks and tools for their digital leveling shows that modern digital technologies play an important role in ensuring the continuity of logistics processes and in increasing the enterprise's resilience to external threats. The use of digitalization tools allows you to respond to infrastructure, energy, climate, and communication risks in a timely manner, minimizing the negative impact on the company's activities. The use of artificial intelligence technologies, cloud systems, IoT solutions, and modern communication methods helps increase the flexibility of logistics processes, reduce losses, and optimize management decisions. Therefore, the introduction of digital tools into the supply chain management system is a prerequisite for ensuring the stability of enterprises' operations amid growing uncertainty and modern challenges.

The fundamental impact of these technologies is revealed through the solution of the most complex logistics problems. This is especially evident in the example of companies that work with specific products - veterinary drugs, vaccines, or heat-sensitive foods. For large-scale distributors required to maintain tight cold chain controls, transforming legacy transport and warehouse systems into digital, adaptive supply chains are critical.

Let's imagine a practical scenario: a refrigerated truck carrying a batch of vital medicines or vaccines gets stuck in a traffic jam for several hours due to a highway closure. In such conditions, any temperature fluctuation can

destroy the entire batch of goods. In this context, the synergy between IoT modules and TMS is unmatched. Sensors inside the body transmit temperature data to a cloud server every minute. In the event of a critical deviation, the system automatically notifies the dispatcher and driver, allowing you to save the cargo (for example, by overloading it or urgently starting a backup generator).

In response to external environmental challenges, this study has developed a five-stage conceptual model of the digital transformation of enterprise logistics, as shown in Fig. 1.

This model forms a systematic management approach to the deployment of IT infrastructure:

1. Initial diagnostic audit. At this stage, the company conducts an in-depth screening of its processes: it assesses warehouse capacity, the age and technical condition of the fleet, and the presence of blind spots in accounting. It is important to identify the bottlenecks that are the first to collapse during stress tests - for example, dependence on paper waybills or the inability to contact the driver in the absence of a mobile network.

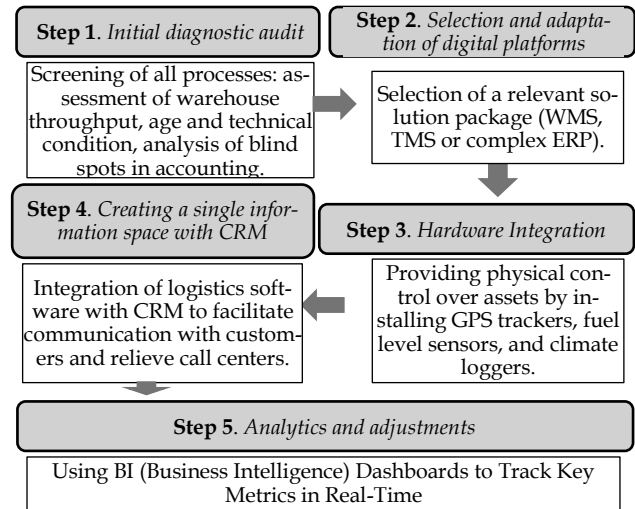


Fig. 1. Conceptual model of digital transformation.

Source: developed by the authors.

2. Selection and adaptation of digital platforms. Based on the audit, a relevant solution package (WMS, TMS, or comprehensive ERP) is selected. The main requirement today is the ability to deploy infrastructure in the cloud and the availability of autonomous mobile applications for data collection terminals (DDD) that can synchronize after the connection is restored.

3. Hardware integration. Providing physical control over assets by installing GPS trackers, fuel level sensors, and climate loggers in transportation and warehouses.

4. Creation of a single information space with CRM. In a state of permanent stress, clients demand maximum transparency. The integration of logistics software with CRM allows you to automatically send customers' delivery status updates (via push notifications or SMS) and warn them about force majeure delays. This enormously reduces the load on the call center and increases loyalty.

5. Analytics and adjustments. Use of BI (Business Intelligence) panels to track key indicators in real time: OTIF (On-Time In-Full). On Empirical data confirm the effectiveness of such an integrated approach: the implementation of the On Empirical in distribution companies can reduce overall operating losses by 20-30% [8]. At the same time, the quality of customer service (OTIF) increases by an average of 15-20% [9], even under unstable infrastructure conditions, and algorithmic routing saves 10-15% [10] of the budget for fuel and lubricants.

Conclusions and prospects for further exploration.

The study proves that the digital transformation of logistics processes has gone beyond exclusively optimization measures and has become the basic strategy for the survival of distribution enterprises during a prolonged crisis. It has

been established that digitalization spans all levels of interaction: from physical control of cargo movement (GPS, IoT) to information security (cloud environments) and counterparty loyalty management (CRM). The effect of automation is especially noticeable in the supply of goods with strict climatic requirements. Maintaining the viability of the "cold chain" during rolling blackouts and unpredictable delays is impossible without 100% deployment of telemetry systems across the fleet and warehouses for continuous monitoring.

The risk analysis and the model proposed in the article demonstrate that the maximum economic and stabilization effects are achieved only under the condition of

synergistic, rather than targeted, implementation of innovations. Therefore, investments in digital logistics should be prioritized. Such developments are of significant scientific and practical interest for further research, particularly in the process of writing qualification or diploma theses on improving logistics processes and the organization of delivery. It is advisable to direct further scientific research toward developing mathematical models to assess the digital maturity of Ukrainian logistics providers and toward creating industry standards for data exchange among participants in a single supply chain.

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Abstract

Селезньова Г. О., Петровська Є. М., Ларіна Т. Ф., Городецька Т. Е. Цифрові інструменти як засіб забезпечення безперервності логістичних процесів під час кризи.

Ця стаття фокусується на комплексному аналізі впливу діджиталізації на збереження безперебійної операційної діяльності дистрибуторських компаній у періоді гострих криз. Доведено, що відмова від ручного управління постачанням на користь автоматизованих систем є фундаментальною вимогою для забезпечення життєздатності бізнесу. Проаналізовано ключові виклики воєнного стану: руйнування транспортної інфраструктури, енергетична нестабільність і розрив успалених маршрутів. Визначено пріоритетні цифрові інструменти (GPS-моніторинг, WMS/TMS-системи, CRM, IoT-датчики та хмарні платформи), які формують основу для адаптації логістики до форс-мажорних ситуацій. Використання комплексу цифрових рішень дає змогу сформувати адаптивну основу стійкості підприємства. Ключовий вплив цих технологій проявляється у вирішенні найскладніших логістичних завдань. У дослідженні акцентовано увагу на управлінні поставками товарів зі специфічними температурними вимогами (ветеринарні препарати, ліки), де телеметрія є єдиним гарантом збереження «холодового ланцюга». Здійснено порівняльний аналіз ризиків та інструментів їх нівелювання. Проведений аналіз показав, що різні види ризиків можуть суттєво впливати на ефективність функціонування ланцюгів постачання та призводити до порушення логістичних процесів. Використання сучасних цифрових технологій дозволяє своєчасно виявляти та мінімізувати негативні наслідки таких ризиків. У межах дослідження розроблено концептуальну модель згоргортання цифрової логістичної інфраструктури, яка підтверджує, що найбільший економічний і стабілізаційний ефект забезпечується за умови комплексного, синергетичного впровадження інновацій, а не їх фрагментарного застосування. Обґрунтовано синергетичний ефект комплексного впровадження інновацій. Результати дослідження мають практичне значення для підвищення гнучкості та стійкості підприємств дистрибуційної сфери.

Ключові слова: цифровізація, логістика, логістична система, логістична інфраструктура, національна безпека, безперервність бізнес-процесів, ланцюги постачання, WMS, TMS, GPS-моніторинг, воєнний стан, логістичні процеси, військова криза, дистрибуція

Стаття надійшла до редакції / Received 24.04.2026 Прийнята до друку / Accepted 05.05.2026 Оpubліковано/ Published 31.05.2026
Бібліографічний опис статті:

Селезньова Г. О., Петровська Є. М., Ларіна Т. Ф., Городецька Т. Е. Цифрові інструменти як засіб забезпечення безперервності логістичних процесів під час кризи. *Актуальні проблеми інноваційної економіки та права*. 2026. № 2. С. 41–43.

Seleznova H., Petrovska Y., Larina T., Gorodetska T. Digital tools as a means of ensuring continuity of logistics processes during a crisis. *Actual problems of innovative economy and law*. 2026. No. 2, pp. 41–43.