# THEORETICAL AND METHODOLOGICAL PRINCIPLES OF EVALUATING THE FLEXIBILITY AND ADAPTABILITY OF ENTERPRISE LOGISTICS SYSTEMS

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## INTRODUCTION

**Introduction.** Modern enterprises operate in an unstable environment characterized by global economic turbulence, military actions in Ukraine, logistical chain disruptions, and accelerated digital transformation. These factors have changed the nature of logistics management and increased the importance of system resilience, flexibility, and adaptability. Traditional approaches focused on efficiency under stable conditions no longer ensure effective functioning of logistics systems in a volatile context. Under such circumstances, enterprises need methodological tools for diagnosing their ability to adapt to environmental fluctuations, recover from disruptions, and sustain performance. The flexibility and adaptability of logistics systems become key determinants of competitiveness and sustainable development of enterprises in the transport and logistics sector.

**The aim of the research.** The purpose of this study is to develop and substantiate a theoretical and methodological approach to the comprehensive evaluation of the flexibility and adaptability of enterprise logistics systems. The proposed approach integrates quantitative and qualitative characteristics of logistics performance into a single framework, which allows for identifying the degree of system responsiveness and for supporting managerial decisions aimed at improving resilience and efficiency.

**Objectives.** To achieve the stated aim, the following objectives were defined: to analyze existing theoretical and practical approaches to assessing logistics system performance in conditions of instability; to identify key indicators that reflect the flexibility and adaptability of enterprise logistics systems; to form a structured system of indicators grouped by functional dimensions of logistics; to develop an integrated method for evaluating logistics flexibility based on expert weighting and normalization of indicators; to substantiate an algorithm for practical implementation of the comprehensive assessment at the enterprise level; to provide interpretation criteria for managerial decision-making and monitoring of logistics system development.

**The methods of the research.** The methodological basis of the study includes the system-functional and complex approaches, which ensure the interconnection between structural, functional, and dynamic characteristics of the logistics system. The research methods comprise analytical, comparative, and expert evaluation techniques. For data integration, normalization of indicators to a 0–1 scale is applied, followed by aggregation using the weighted sum method. The analytic hierarchy process is used to determine the significance of indicators. The synthesis of these tools allows for combining heterogeneous data and forming an integral assessment of the flexibility and adaptability of logistics systems. Expert assessments, correlation analysis, and benchmarking are employed to ensure validity and reliability of the obtained results.

## Theoretical background

The theoretical foundation of the study is based on the works of both foreign and Ukrainian scholars in the field of logistics and systems management. The classical concepts of logistics efficiency were developed by D. J. Bowersox and D. J. Closs, who emphasized the integration of logistics processes as a basis for competitiveness. J. R. Stock and D. M. Lambert focused on the systematization of logistics functions and the importance of performance indicators. Later studies by M. Christopher and H. Peck introduced the concept of supply chain resilience, highlighting the ability to anticipate and recover from disruptions. In Ukrainian scientific literature, important contributions were made by O. I. Kuzmin, N. P. Chukhrai, O. V. Chornopyska, and V. P. Onyshchenko, who studied adaptive mechanisms and diagnostic models of logistics systems. Despite these valuable developments, there remains a lack of an integrated methodology that simultaneously assesses flexibility, adaptability, and overall logistics system efficiency. The proposed approach fills this gap by uniting structural and dynamic assessment components and providing a quantitative interpretation framework suitable for enterprises operating in crisis and post-crisis conditions.

## Main findings

The application of the proposed methodological approach provides enterprises with a structured and reliable tool for diagnosing the flexibility and adaptability of their logistics systems under conditions of uncertainty and external disruptions. The developed system of indicators (Table 1) reflects all key functional dimensions of logistics activity — operational, financial and economic, adaptive, information-analytical, and service — which together form an integrated view of how effectively the system responds to environmental changes.

Table 1

**Structure of indicators for evaluating logistics system flexibility and adaptability**

| Group of indicators | Examples of indicators | Characteristic |
|---|---|---|
| Operational | Order fulfillment time, delivery time, transportation reliability | Reflects the speed, rhythm, and coordination of logistics processes |
| Financial and economic | Logistics costs, warehouse and inventory costs, delivery cost per unit | Characterizes the economic stability and cost efficiency of logistics operations |
| Adaptive | Frequency of route rescheduling, recovery time after disruptions, level of supply continuity | Shows the ability of the logistics system to reorganize and adapt under changing conditions |
| Information-analytical | Level of digitalization, speed of information processing, use of monitoring systems | Reflects technological readiness and flexibility of information flows |
| Service | Customer satisfaction, on-time delivery rate, service reliability | Demonstrates external flexibility and the ability to maintain customer-oriented logistics services |

Unlike traditional methods that focus mainly on cost reduction or process efficiency, this approach evaluates the enterprise's ability to reorganize its logistics processes, maintain the continuity of flows, and ensure stable interaction with partners and clients in crisis situations. The normalization of indicators to a unified 0–1 scale and their weighting through expert evaluation allow for objective integration of quantitative and qualitative data into the composite Flexibility and Adaptability Index (FAI). The obtained index serves not only as a diagnostic measure but also as a management instrument. It helps to identify bottlenecks in logistics operations, determine priority areas for development, and evaluate the effectiveness of previous improvement measures. For example, a low value of adaptive indicators points to the need for enhancing reconfiguration capabilities and reducing recovery time after disruptions. A low information-analytical component indicates insufficient digitalization or lack of real-time monitoring, while weak service indicators may signal problems with reliability or customer satisfaction. The algorithm for implementing the methodical approach (Table 2) allows enterprises to perform assessment consistently at different stages of operation and to use it as part of internal monitoring. This enables management to track the dynamics of logistics flexibility, compare results with industry benchmarks, and make evidence-based decisions regarding organizational changes, technology implementation, and resource allocation.

Table 2

**Algorithm for implementing the methodical approach to comprehensive assessment of flexibility and adaptability of an enterprise logistics system**

| Step | Description | Input data | Methods / criteria | Output | Execution logic |
|---|---|---|---|---|---|
| 1 | Definition of the objectives and scope of assessment. Identification of the object (enterprise, division, process), evaluation period, and operating conditions (stable, crisis, or post-crisis). | Enterprise profile, structure, assessment period | Analytical identification, system boundary definition | Clear boundaries and conditions of evaluation | Ensures comparability and consistent interpretation of results |
| 2 | Formation of an indicator system for flexibility and adaptability assessment. | Statistical, accounting, and operational data | System-functional analysis | List of indicators structured by functional groups | Provides completeness and balance of indicators |
| 3 | Collection and verification of source data. | Reports, databases, expert information | Analytical verification, correlation analysis | Reliable and consistent data set | Ensures accuracy of subsequent calculations |
| 4 | Normalization of indicators to a unified scale (0–1). | Collected indicator values | Linear normalization method | Normalized indicator matrix | Enables comparison of different indicators |
| 5 | Expert evaluation and determination of indicator weights. | Normalized indicator set, expert judgments | Analytic Hierarchy Process (AHP), pairwise comparison | Weight coefficients for each indicator | Reflects the significance of indicators in the overall assessment |
| 6 | Calculation of partial indices for each indicator group. | Weighted normalized data | Weighted sum method | Partial indices for operational, financial, adaptive, informational, and service dimensions | Ensures transparency of intermediate results |
| 7 | Aggregation of partial indices into the integrated Flexibility and Adaptability Index (FAI). | Partial indices and weights | Weighted integration | Integral value of logistics system flexibility and adaptability | Provides a single quantitative result |
| 8 | Interpretation of the obtained FAI value according to defined levels. | FAI numerical result | Comparative scale (low, medium, sufficient, high) | Qualitative classification of flexibility and adaptability level | Facilitates managerial understanding of diagnostic results |
| 9 | Comparison of the enterprise results with benchmark or previous periods. | Historical and comparative data | Benchmarking, dynamic analysis | Identification of deviations and trends | Supports continuous improvement of logistics performance |
| 10 | Formulation of conclusions and recommendations for system improvement. | Integrated and comparative results | Analytical synthesis, expert interpretation | Set of practical measures to enhance flexibility and adaptability | Provides a basis for managerial decisions and strategic planning |

The practical verification of the proposed approach has shown that it can be adapted for enterprises of various scales and types within the transport and logistics sector. It supports the evaluation of logistics systems both in normal and crisis conditions, ensuring that managers obtain clear, structured information for planning and control. For Ukrainian logistics and transport companies, the methodology is particularly valuable as it helps maintain system resilience, optimize resource use, and ensure operational sustainability during the recovery period after large-scale disruptions.

## MAIN RESULTS AND CONCLUSIONS

The application of the proposed methodological approach provides enterprises with a practical tool for diagnosing the flexibility and adaptability of their logistics systems in unstable conditions. The developed system of indicators and the ten-step algorithm ensure a comprehensive assessment of logistics performance from operational, financial, adaptive, informational, and service perspectives. The integration of normalized and weighted indicators into the Flexibility and Adaptability Index (FAI) allows the enterprise to obtain a single quantitative measure of system resilience and responsiveness. The approach makes it possible to identify weak areas of logistics processes and develop targeted measures for improvement. The obtained results can be used for benchmarking, internal comparisons between departments, and tracking the dynamics of logistics flexibility over time. The methodology is easily integrated into the enterprise's management system and can be applied periodically, ensuring continuous monitoring of logistics adaptability. For Ukrainian transport and logistics enterprises, its use is especially relevant for maintaining stability and competitiveness during crisis and post-crisis recovery.

The study confirms that flexibility and adaptability are key characteristics of modern logistics systems that determine their efficiency under uncertainty. The proposed theoretical and methodological approach integrates different functional dimensions of logistics into a unified evaluation framework, combining analytical rigor with practical applicability. Its implementation allows enterprises to measure, interpret, and enhance the adaptability of logistics operations, ensuring resilience, sustainable performance, and competitiveness in dynamic environments.

## REFERENCES

1. Bowersox, D. J., & Closs, D. J. (1996). *Logistical Management: The Integrated Supply Chain Process.* New York: McGraw-Hill, 730 p. 2. Stock, J. R., & Lambert, D. M. (2001). *Strategic Logistics Management* (4th ed.). New York: McGraw-Hill/Irwin, 872 p. 3. Harrison, A., & Van Hoek, R. (2008). *Logistics Management and Strategy: Competing Through the Supply Chain.* Edinburgh: Pearson Education, 316 p. 4. Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *The International Journal of Logistics Management*, 15(2), 1–14. 5. Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research*, 58(10), 2904–2915. 6. Chornopyska, N. V. (2008). Methodological approaches to assessing the logistics activity of an enterprise. *Bulletin of Lviv Polytechnic National University. Logistics*, 623, 265–271. 7. Chukhrai, N. I. (2009). Evaluation of supply chain functioning: essence and conceptual approaches. *Bulletin of Lviv Polytechnic National University*, 647, 276–285. 8. Karyi, O. I. (2004). [Information support of enterprise logistics cost management. Extended abstract of Candidate's thesis. Lviv: Lvivska politekhnika, 22 p. 9. Khvyshchun, N. V. (2011). Logistics components of increasing enterprise competitiveness. *Logistics: Theory and Practice*, 1, 126–134. 10. Shytykova, L. V., & Akhinko, Ya. R. (2024). Modeling the logistics activity of an enterprise to increase innovation potential and competitiveness. *Change Management and Innovation*, 10, 38–41. 11. Zaverbnyi, A., Dvulit, Z., & Vuiek, Kh. (2022). Features of logistics chains formation during the war and in the post-war period. *Economy and Society*, 43–44. 12. Kaliuzhna, N. H., & Sheremet, A. S. (2022). Logistics system of Ukraine: current problems and recovery priorities. *Business Inform*, 4, 90–96. 13. Kulakova, S. Yu., Kalembet, A. V., & Podkopova, D. Ye. (2023). Peculiarities of logistics costs formation of enterprises under martial law. *Financial and Credit Systems: Development Prospects*, 1(8), 22–29. 14. Peshko, M., & Zaverbnyi, A. (2022). Problems and prospects of supply chains transformation to minimize losses during the war. *Economy and Society*, 44. 15. Tsymbalistova, O. A., Kharchenko, M. V., & Chernikhova, O. S. (2022). Improvement of logistics enterprises functioning under martial law in Ukraine. *Academic Visions*, 14. 16. Christopher, M. (2016). *Logistics and Supply Chain Management* (5th ed.). London: Pearson, 310 p.