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Supply chain management in industrial housing construction: specifics, problems, methods, performance indicators

Construction belongs to one of the resource-intensive sectors of the economy, which makes the problem of organizing the resource supply of construction production urgent. An analysis of foreign and domestic supply chain management practices has shown that logistics costs have a high share in the costs of organizations, regardless of their industry affiliation. The share of transportation costs is significant. Taking into account the dynamics of business environment, it is necessary to continuously improve the supply chain management mechanism, including taking into account regional and sectoral aspects of enterprises' activities. Considering the specifics of construction from the standpoint of resource provision, it can be concluded that logistical problems are increasing due to the lack of integration of construction participants, uneven consumption of certain types of resources, as well as the high impact on both supply processes and construction production, natural and climatic conditions. Each participant in the supply chain has risks and they affect the activities of all subjects of the chain, complicating management processes. The SCOR model, focused on the key business processes of the organization, has found wide application in supply chain management. The metrics proposed in the model have a hierarchical system and are focused on individual subsystems of the supply chain, management levels of control, and create an information basis for making effective management decisions. The authors propose a system of indicators reflecting the specifics of construction in relation to the subsystems of the SCOR model: supply reliability, resource efficiency, logistics cost management and efficiency of logistics asset management. The system can be effectively used in the organization of management accounting for cost centers, which reliably reflects the logistical costs of construction projects, processes, types of work, consumed resources, and resource suppliers. **Keywords:** industrial housing construction, supply chain management, construction specifics, management problems, features of logistics processes, supply chain management models, performance assessment indicators

The organization of the resource supply chain management system for construction projects makes it possible to significantly reduce construction production costs, reduce production losses and defects, avoid unnecessary labour costs and means of production, loss of working time, violation of construction deadlines. This will strengthen the market position of the construction company and ensure financial stability. The specifics of construction as an industry with a variety of relationships and factors determining them, a large number of participants in the construction process, form the main properties of the supply chain [1]:

- instability of sales for suppliers due to uneven consumption of a particular type of resources;
- difference between design solutions and the real situation on the construction site;
- insufficient integration of logistics processes, which can be enhanced if subcontractors and suppliers are involved in the early stages of the planning process for the construction of an object or a development complex.

These features reflect the specifics of construction as a type of activity. Additionally, the following construction features are highlighted, which determine the importance of logistics process management, in particular¹ [2]:

- territorial dispersion of construction facilities

included in the contractor's work programme, which increases transportation costs, which have a high share in the structure of logistics costs;

- long production period that does not have the cyclical nature inherent in other industries;
- limited building area, which determines the specifics of warehouse logistics;
- increase in the degree of individualization of the production process in housing construction significantly increases the range of resources consumed;
- subcontractors are involved who perform certain types of specialized work, which requires clear coordination of their activities;
- rental relations with suppliers of construction equipment for facilities are widely practiced and their maximum load is important;
- constantly increasing requirements for construction production, due to the need to shorten the construction period, increase the life cycle of the real estate object, reduce resource conservation both during the construction phase and operation of the object;
- high material consumption of construction determines the need to search for reserves to reduce material costs through procurement, warehouse and production logistics;

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1 Borisova L.A. The use of logistics in construction in a crisis. URL: <https://cyberleninka.ru/article/n/ispolzovanie-logistiki-v-stroitelstve-v-usloviyah-krizisa> (rus.).

- material flows are characterized by high risks, since discrete flows prevail in construction.

A properly organized supply chain management system allows for increased transparency and consistency of logistics processes, including material and financial flows, regardless of functional and corporate boundaries, and to create a single configuration. Each participant in the supply chain has business risks and they are projected onto the activities of all subjects of the chain, complicating management processes. The problems of a construction company also consist in the fact that, being a focal company in the supply chain, in fact, it is not the owner of logistics processes, but only a consumer. What problems are created in the way of improving management in the supply chain [1, 3]:

- high logistical costs, including through the transportation of construction materials, since manufacturers are usually geographically removed from construction sites;
- insufficient capacities of manufacturers of building materials, which cannot be rapidly increased due to increasing demand; as an example, the identified risks of implementing federal projects, when risks of providing construction materials arose during planned large-scale construction²;
- low quality of building materials, which leads to the need not only to increase the warranty reserves, but also to solve the problem of recycling the waste that has arisen;
- lack of balance in the composition and dynamics of the formation of various types of inventories;
- reduced labour productivity at the construction site, which leads to disruption of resource consumption schedules;
- problems of coordination of subcontractors' work schedules.

According to the strategy for the development of the construction industry, the volume of housing commissioning by 2030 will amount to 120 million sq. m per year, including by increasing the share of industrial housing construction, which should amount to 75 % of the total construction volume (according to the baseline scenario) and at least 60 %, taking into account the impact of possible risks³. This requires solutions to improve the construction resource support system and improve the supply chain management system. In particular, the issues of the formation of a technological "chain" as a set of organizations involved in the production of components for the technological cycle of the final product, ordered in the performance of operations for processing raw materials, are considered.

The lean construction concept is focused on reducing all types of costs in the construction and operation of a finished facility by optimizing the interaction of all parts of the production process and optimizing their work. This will contribute to ensuring the planned increase in labour productivity in construction in 2035 by 117 % compared to 2021. However, there is also a feedback here: if for some reason, including the natural and climatic conditions of the construction of facilities, insufficiently developed road infrastructure, measures to increase labour productivity and reduce logistical costs cannot be implemented.

In construction practice, on highly organized and mechanized construction sites, when constructing large-panel buildings, labour

costs per 1 sq. m of the total area are reduced by almost 2 times compared with traditional construction methods, and up to 60 % of labour costs are transferred to factory conditions. The experience of construction in China shows how to solve the problems of industrialization of construction by improving the supply chain management system. In particular, modelling the organization of construction on the site, including the delivery of structures to the site and their installation [4, 5].

In industrial housing construction, a combined organizational form of production is used, which contributes to the development of concentration and specialization processes by equipping with modern equipment and using advanced technologies, more complete use of material resources. Combining several technologically interconnected industries with the construction stage at one house-building plant allows for continuity of production and financial processes. These organizations are characterized by efficient logistics, but there is a need for further development of resource and innovation potential in order to solve the problems of integration with sales logistics [6].

The introduction of information modelling technologies in the Russian construction industry is considered to be an innovative process, characterized by intersectoral interaction of participants in the investment and construction process to create a real construction object and its digital twin. At the same time, the model describes the entire life cycle of the object. In 2019, a concept was developed for the implementation of a life cycle management system for capital construction facilities using BIM technologies in building an information model of an object under construction⁴. The implementation of these measures makes it possible to create an integrated supply chain management system, which will make it possible in 2024 to increase construction efficiency, reduce the cost of projects, reduce construction time and the number of violations of deadlines.

In almost all countries, transport costs account for a significant share of logistics costs (up to 60 %). According to experts, due to logistical measures, it is possible to reduce the stock level by 30–50 %, reduce repeated warehouse transportation by 1.5–2 times, the cost of road transportation by 7–20 %, and rail transportation by 12 % [7].

At the current stage of development of the supply chain management system, the following measures can give results [8]:

- systematic planning of measures for the timely identification, prevention or reduction of risks;
- as part of the process approach, set standards for the basic indicators of each logistics process;
- structuring the system of basic indicators according to the management vertical;
- to set the maximum possible deviations of the actual values of the indicators from the planned value;
- to evaluate the effectiveness of each process in the supply chain.

An integrated logistics system assumes the maximum integration of such functions as transportation, warehousing, and inventory management at the level of their optimal size, including taking into

2 Results of monitoring of individual national projects (summarized). URL: <http://council.gov.ru/media/files/S9VoCEQB37XXxBQWGgP9LXecQFaJgdfy.pdf> (rus.).

3 Strategy for the development of the construction industry and housing and communal services of the Russian Federation for the period up to 2030 with a forecast up to 2035. Approved by the Decree of the Government of the Russian Federation 3268-r dated October 31, 2022. (rus.).

4 The concept of implementing a life cycle management system for capital construction facilities using BIM technologies. URL: <https://gge.ru/upload/iblock/93c/0/%20концепции%20внедрения%20системы%20управления%20жизненным%20циклом%20объектов%20капитального%20строительства%20с%20использованием%20BIM-технологий.pdf> (rus.).

account shortages, possible seasonal restrictions at the level of a specific facility and the organization as a whole. It also envisages logistical integration of supply and production, the possible orientation of the benchmarking of the logistics of a construction enterprise to the logistics systems of enterprises with assembly technologies.

In modern conditions, the tightening of requirements for the fulfillment of construction deadlines is an objective process, since it affects the economic sustainability of construction companies. At the same time, the fulfillment of contractual construction deadlines is hampered by the high-rise buildings, the high degree of equipment of facilities with engineering communications, and an extended group of construction participants [9].

In countries with advanced technologies of industrial housing construction, the method of organizing construction "installation from wheels" is used, when prefabricated structures are delivered to the construction site according to hourly or minute schedules, taking into account the technological sequence. On-site warehouses are created only for small components. Such a system has a positive effect on many indicators of the contractor organization: construction time is reduced, construction equipment is used more efficiently, and the safety of structures increases due to a decrease in the number of loading/unloading [9].

Logistics processes can be well organized in the context of the use of modular housing technology for the construction of certain types of facilities in conditions where mobility, speed of construction and relatively low cost are important. The key features are: ease of installation and dismantling of buildings, cost-effective transportation. In addition, finishing works can also be carried out at the plant, which reduces construction time and increases the speed of financial flows due to logistics [10].

There are proposals within the problematic field of logistics of the housing and construction complex to improve the system [11]:

- use of modular housing construction, which will ensure the rhythm of construction processes;
- improvement of technological production and supply processes based on digitalization;
- adaptation of the logistics system of the housing and construction complex to the conditions of the urban environment.

The SCOR model, developed for the purpose of more effective analysis, design and planning of supply chains, has found wide application in market practice. The supply chain operations model has been developed and is being developed as an inter-industry management standard. The model has developed more than 200 metrics that can be used in supply chain management^{5, 6}. In each of the company's areas of activity, key business processes are selected that must be performed at a high level, which will determine the effectiveness of the system as a whole. The model creates benchmarks, but the need to take into account industry specifics should be taken into account.

The assessment of the effectiveness of indicators of logistics business processes in supply chains is based on the use of indicators of the functioning of the first level of the model, i.e. on high-rank meters that can generalize a number of logistics processes. With regard to the specifics of the activities of construction contractors, we propose the following system of indicators that maximally cover supply chain management (Table).

The applied logistic indicators should correspond to the managerial level of control, create an information basis for making

Indicators for assessing the logistics processes of a construction organization

Subsystem of indicators of the SCOR model	Subsystem indicators
Reliability of delivery in the supply chain	1. The number of orders completed in violation of the delivery schedule (for each resource and supplier) for the period. 2. The share of orders completed in violation of the delivery schedule (for each resource and supplier) for the period, %. 3. The percentage of defective supplies (for each resource and supplier), for the period, %. 4. Downtime of crews at the construction site due to lack of resources, people/hour, for the period. 5. Downtime of construction equipment at the construction site due to lack of resources, machines/shifts, during the period
Resource efficiency of the logistics infrastructure	1. Productivity of warehouse lifting and transport equipment, volume of resources/hour. 2. The average percentage of loading of on-site warehouses, for the period, %. 3. The cost of storing a unit of resource (by type of resource), rub.
Costs associated with supply chain logistics operations	1. Total logistics costs per 1 sq. m of the total area of the construction site, rub/sq. m. 2. Total logistics costs to revenue from sales of construction products, rub. 3. Inventory turnover ratio (by type of resources). 4. Costs for the organization and execution of the order (by type of resources), rub. 5. The cost of managing returns/waste, rub. 6. Transportation costs per unit of resource (by type of resources). 7. Costs associated with a shortage of resources, per unit of resource (by type of resources), rub.
Efficiency of logistics asset management in the supply chain	1. Resource efficiency as the cost-effectiveness of the material resources of construction production. 2. Inventory turnover ratio (by type of resources). 3. Revenue from sales of construction products per 1 rub. material resources. 4. Cost-effectiveness of material resources, %

effective management decisions. At the same time, it is necessary to organize management accounting for cost centers, which allows you to reliably determine the logistical costs of construction projects, processes, types of work, and resources consumed.

In construction, a properly organized supply chain gives a significant economic effect, since even minor supply disruptions lead to downtime, violation of the work schedule, increase in

5 SCOR — supply chain model. URL: [http://Downloads/L10+SCOR model+supply chain+%20\(4\).pdf](http://Downloads/L10+SCOR model+supply chain+%20(4).pdf)

6 The Apics Scor model and its main processes. URL: [cor-model.pdf](#)



► construction time, increase in the cost of construction and violation of contractual obligations.

The planning of logistics activities should be comprehensive and systematic, reflecting the dynamics of the market of resources for construction. The correct organization of the supply chain management system of material resources allows you to significantly reduce the costs of construction production, reduce production losses and defects, avoid unnecessary labour costs and means of production, loss of working time, and violation of construction deadlines. This will strengthen the competitive position of the construction company and ensure financial stability.

REFERENCES

1. Lapidus A.A., Safaryan G.B. *The role of supply chain management in construction. Technology and Organization of Construction Production*. 2018; 1:28-31.
2. Pasyada I.N. *Features of construction logistics in projects of integrated development and development of territories. Vestnik of Rostov State Economic University*. 2017; 3(59):63-69. (rus.).
3. Berezhnaya G.G. *The essence and types of risks in the supply chains of organizations of the construction complex. Bulletin of BSTU named after V.G. Shukhov*. 2019; 3:5-11. (rus.).

4. Gurinovich V.Yu., Leonovich S.N., Pozdnyakov D.A. *Trends and directions of development of industrial housing construction in the world and domestic practice of housing construction. Vestnik of Polotsk State University. Part F. Constructions. Applied Sciences*. 2023; 1:10-18. DOI: 10.52928/2070-1683-2023-33-1-10-18 (rus.).
5. Gurinovich V.Yu. *A comprehensive study of the development of industrial housing construction. Science and Technology*. 2022; 5:397-409. DOI: 10.21122/2227-1031-2022-21-5-397-409 (rus.).
6. Azhimov T.Z. *Management of the resource and innovative potential of industrial housing construction enterprises : dissertation of the Candidate of Technical Sciences*. Moscow, MGSU, 2022; 180. (rus.).
7. Pletneva N.G. *Features of organizational logistics in construction. Theory and Practice of Management*. 2019; 7:75-79.
8. Golovin S.V., Lutsenko M.S., Fadina A.S. *Modern aspects of supply chain management at an industrial enterprise. Modern Economy: Problems and Solutions*. 2020; 12(132):58-73. DOI: 10.17308/meps.2020.12/2491 (rus.).
9. Davletov I.H. *Prospects for the development of industrial housing construction. Bulletin of Science and Practice*. 2021; 7(6):324-328. DOI: 10.33619/2414-2948/67/35 (rus.).
10. Pakhomova L.A., Oleinik P.P. *Comfortable housing of the new industrial generation. Construction Production*. 2020; 2:23-29. DOI: 10.54950/26585340_2020_2_23 (rus.).
11. Bashidze R.R. *The problematic field of logistics of the construction and housing complex. Economics and Management: Scientific and Practical Journal*. 2022; 1(163):82-86. DOI: 10.34773/EU.2022.1.15 (rus.).

Управление цепями поставок в индустриальном домостроении: специфика, проблемы, методы, показатели эффективности

Строительство относится к одной из ресурсоемких отраслей экономики, что делает актуальной проблему организации ресурсообеспечения строительного производства. Анализ зарубежной и отечественной практики управления цепями поставок показал, что логистические издержки имеют высокую долю в затратах организаций независимо от их отраслевой принадлежности. Существенна доля транспортных расходов. С учетом динамики бизнес-среды необходимо постоянное совершенствование механизма управления цепями поставок, в том числе с учетом региональных и отраслевых аспектов деятельности предприятий.

Рассматривая специфику строительства с позиций ресурсного обеспечения, можно сделать вывод, что логистические проблемы возрастают из-за недостаточной интегрированности участников строительства, неравномерности потребления отдельных видов ресурсов, а также высокого влияния и на процессы поставок, и на строительное производство природно-климатических условий. Каждый участник цепи поставок имеет риски, и они влияют на деятельность всех субъектов цепи, усложняя процессы управления.

В управлении цепями поставок нашла широкое применение SCOR-модель, ориентированная на ключевые бизнес-процессы организации. Предлагаемые в модели метрики имеют иерархическую систему и ориентированы на отдельные подсистемы цепи поставок, управленческие уровни контроля, создают информационную основу для принятия эффективных управленческих решений. Авторами предлагается система показателей, отражающих специфику строительства, применительно к подсистемам SCOR-модели: надежность поставок, ресурсоотдача, управление логистическими затратами и эффективность управления логистическими активами. Система может эффективно применяться при организации управленческого учета по центрам затрат, достоверно отражающего логистические затраты по объектам строительства, процессам, видам работ, потребляемым ресурсам, поставщикам ресурсов.

Ключевые слова: индустриальное домостроение, управление цепями поставок, учет специфики строительства, проблемы управления, особенности логистических процессов, модели управления цепями поставок, показатели оценки эффективности

СПИСОК ИСТОЧНИКОВ

1. Лапидус А.А., Сафарян Г.Б. *Роль управления цепями поставок в строительстве // Технология и организация строительного производства*. 2018. № 1. С. 28–31.
2. Пасяда И.Н. *Особенности строительной логистики в проектах комплексного освоения и развития территорий // Вестник Ростовского государственного экономического университета*. 2017. № 3 (59). С. 63–69.
3. Бережная Г.Г. *Сущность и виды рисков в цепях поставок организаций строительного комплекса // Вестник БГТУ им. В.Г. Шухова*. 2019. № 3. С. 5–11.
4. Гуринович В.Ю., Леонович С.Н., Поздняков Д.А. *Тенденции и направления развития индустриального домостроения в мировой и отечественной практике жилищного строительства // Вестник Полоцкого государственного университета. Серия F. Строительство. Прикладные науки*. 2023. № 1. С. 10–18. DOI: 10.52928/2070-1683-2023-33-1-10-18
5. Гуринович В.Ю. *Комплексное исследование развития индустриального домостроения // Наука и техника*. 2022. № 5. С. 397–409. DOI: 10.21122/2227-1031-2022-21-5-397-409
6. Ажимов Т.З. *Управление ресурсно-инновационным потенциалом предприятий индустриального домостроения : дис. ... канд. экон. наук*. М. : МГСУ. 2022. 180 с.
7. Плетнева Н.Г. *Особенности организационного обеспечения логистики в строительстве // Теория и практика управления*. 2019. Вып. 7. С. 75–79.
8. Головин С.В., Луценко М.С., Факина А.С. *Современные аспекты управления цепями поставок на промышленном предприятии // Современная экономика: проблемы и решения*. 2020. № 12 (132). С. 58–73. DOI: 10.17308/meps.2020.12/2491
9. Давлетов И.Х. *Перспективы развития индустриального строительства жилья // Бюллетень науки и практики*. 2021. Т. 7. № 6. С. 324–328. DOI: 10.33619/2414-2948/67/35
10. Пахомова Л.А., Олейник П.П. *Комфортное жилье нового индустриального поколения // Строительное производство*. 2020. № 2. С. 23–29. DOI: 10.54950/26585340_2020_2_23
11. Башидзе Р.Р. *Проблемное поле логистики строительного жилищного комплекса // Экономика и управление: научно-практический журнал*. 2022. № 1 (163). С. 82–86. DOI: 10.34773/EU.2022.1.15

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