Electronic scientific and practical journal

INTELLECTUALIZATION OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

#1 (2020)
May '20

WWW.SMART-SCM.ORG
ISSN 2708-3195
DOI.ORG/10.46783/SMART-SCM/2020-1

ISSN 2708-3195
9 772708 319005

Electronic scientific and practical collection
INTELLECTUALIZATION OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Electronic scientific and practical publication in economic sciences

ISSN 2708-3195
DOI: https://doi.org/10.46783/smart-scm/2020-1

Released 6 times a year

№ 1 (2020)
May 2020

Kyiv - 2020

The electronic scientific and practical journal is registered in international scientometric data bases, repositories and search engines. The main characteristic of the edition is the index of scientometric data bases, which reflects the importance and effectiveness of scientific publications using indicators such as quotation index, h-index and factor impact (the number of quotations within two years after publishing).

In 2020, the International Center for Periodicals (ISSN International Center, Paris) included the Electronic Scientific and Practical Edition "Intellectualization of Supply Chain Management" in the international register of periodicals and provided it with a numerical code of international identification: ISSN 2708-3195 (Online).

Recommended for distribution on the Internet by the teaching staff of the Department of Logistics of NAU (№ 3 from February 3, 2020). Produced 6 times a year. References to publications are required. The view of the editors does not always coincide with the view of the authors.

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DOI: https://doi.org/10.46783/smart-scm/2020-1
e-mail: support@smart-scm.org

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INTRODUCTION

We are happy to invite you to get acquainted with the first issue of the new scientific and practical publication "Intellectualization of Logistics and Supply Chain Management".

We strongly believe that the launch of this magazine indicates the objective need to rethink a wide range of issues related to the development of theory and practice in logistics and supply chain management, awareness of the need to unite the scientific community and logistics practitioners, dissemination of modern knowledge and best practices for innovative development of the logistics services market.

The first issue of the magazine is published at a difficult time. The global coronavirus pandemic and the deep economic crisis have significantly worsened business activity in the world. Currently, global supply chains are collapsing, international trade is declining, and competition between global and regional logistics operators is intensifying. The most common thesis is that the world will never be the same again. Industry experts predict the emergence of new, more flexible and adaptive supply chain management strategies and approaches to logistics business process management. The trend towards collaborations, cooperation and unification of services is emerging, comprehensive proposals for clients are being developed. There is increasing talk about the need to build bimodal supply chains, which involves the development of different decision-making scenarios: the traditional approach - cost-effective efficiency, low risk, high predictability; a new approach "second mode" - rapid recognition of opportunities, adaptability, willingness to solve unexpected problems and look for new opportunities.

Radical transformations of the global and national markets for logistics services require appropriate scientific support. Logistics science has a special role to play in this process. Initiating the emergence of a new journal, we decided to focus on its coverage of problematic aspects of the formation and development of logistics systems at the micro, mezo and macro levels, supply chain management, digitization of logistics, methods and tools for optimizing processes in logistics and supply chains, sociopsychology relations and network interaction of enterprises using cloud technologies, artificial intelligence, e-learning, neural business process management systems, etc.

Therefore, we invite scientists, researchers and business representatives, as well as our colleagues from abroad, to cooperate and present the results of scientific research, to discus and debate on them, to work together to develop the scientific theory of logistics and promote mutual intellectual enrichment.

We hope that the new scientific publication will become a theoretical guide for young researchers and representatives of other fields.

HRYHORAK Mariia
Chief Editor

The electronic scientifically and practical journal
"INTELLECTUALIZATION OF LOGISTICS AND SUPPLY CHAIN MANAGEMENT",
ISSN 2708-3195

17-25
v.1 (2020)
https://smart-scm.org

UDC 65.014.1
DOI: https://doi.org/10.46783/smart-scm/2020-1-2
JEL Classification: C 51; F 15; L 11.
Received: 10 April 2020

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INTEGRATED LOGISTICS SUPPORT FOR THE LIFE CYCLE OF BUILDING OBJECTS

Volodymir Marchuk, Henryk Dźwigoł. «Integrated logistics support for the life cycle of building objects». *The role of integrated logistical support in the after-sales stages of the life cycle of construction sites is considered. It is shown that the effective management and operation of buildings and structures, their engineering equipment, is impossible without the analysis of logistical support, which is carried out at the design stage and is refined at the following stages of the life cycle of construction objects on the basis of accounting and analysis of operational information on the management of technical condition of construction. An information model of integrated logistic support for the life cycle of construction structures has been developed. It is shown that the core of the information model is an integrated information environment that contains information about the construction object, resources and processes, ensures that the data involved in the life cycle of the entity is stored and accessible. Data is added to the information environment by all participants throughout the lifecycle of the objects, allowing you to receive and analyze up-to-date project documentation and visualizations at any time. The stages of the life cycle of construction objects in an integrated information environment are analyzed.*

Keywords*:* integrated logistical support, life cycle of a construction object, BIM technologies, information model, logistic analysis.

Володимир Марчук, Henryk Dźwigoł. «Інтегрована логістична підтримка життєвого циклу об'єктів будівництва». *Розглянуто роль інтегрованої логістичної підтримки на після продажних стадіях життєвого циклу об'єктів будівництва. Показано, що ефективне управління і експлуатація будівель і споруд, їх інженерне оснащення, неможлива без проведення аналізу логістичної підтримки, яка здійснюється на стадії проектування і уточняється на наступних стадіях життєвого циклу будівельних об'єктів на підставі обліку та аналізу експлуатаційної інформації з управління технічним станом об'єктів будівництва. Розроблена інформаційна модель інтегрованої логістичної підтримки життєвого циклу будівельних споруд. Показано, що ядром інформаційної моделі є інтегроване інформаційне середовище, яке містить відомості про об'єкт будівництва, ресурси і процеси, забезпечує збереження і доступність даних тим суб'єктам, що беруть участь у життєвому циклу об'єкту. Дані додаються в інформаційне середовище усіма* *учасниками протягом всього життєвого циклу об'єктів, що дозволяє в будь-який момент часу отримувати актуальну проектну документацію і візуалізації, а також її аналізувати. Проаналізовано стадії життєвого циклу об'єктів будівництва в інтегрованому інформаційному середовищі.*

Ключові слова: інтегрована логістична підтримка, життєвий цикл будівельного об'єкту, BIM-технології, інформаційна модель, логістичний аналіз.

Владимир Марчук, Henryk Dźwigoł. «Интегрированная логистическая поддержка жизненного цикла объектов строительства». *Рассмотрены роль интегрированной логистической поддержки на после продажных стадиях жизненного цикла объектов строительства. Показано, что эффективное управление и эксплуатация зданий и сооружений, их инженерное оснащение, невозможно без проведения анализа логистической поддержки, осуществляемой на стадии проектирования и уточняется на последующих стадиях жизненного цикла строительных объектов на основании учета и анализа эксплуатационной информации по управлению техническим состоянием объектов строительства. Разработанная информационная модель интегрированной логистической поддержки жизненного цикла строительных сооружений. Показано, что ядром информационной модели является интегрированное информационное пространство, которое содержит сведения об объекте строительства, ресурсы и процессы, обеспечивает сохранение и доступность данных тем субъектам, которые принимают участие в жизненном цикле объекта. Данные добавляются в информационную среду всеми участниками в течение всего жизненного цикла объектов, что позволяет в любой момент времени получать актуальную проектную документацию и визуализации, а также ее анализировать. Проанализированы стадии жизненного цикла объектов строительства в интегрированном информационном пространстве.*

Ключевые слова*: интегрированная логистическая поддержка, жизненный цикл строительного объекта, BIM-технологии, информационная модель, логистический анализ.*

Research Justification. Today, the construction projects' life cycle processes are undergoing major changes related to the rapid development of innovative technologies that allow to optimize the processes of buildings and structures' design, construction and operation, to solve complex problems of construction project management, to provide information support among all participants in the life cycle. The life cycle of construction sites is inextricably linked to the logistical support for managing the business processes of design, supply, construction, transportation, warehousing and after sale of facilities. This reinforces the need to develop and implement logistical approaches to managing the business processes of construction sites at all stages of the life cycle.

Publications review and analyzing unresolved issues. To date, the formation of logistic activity of construction industry enterprises and their participation in the life cycle of construction objects is characterized by the presence of unjustified high logistics costs, direct material and financial losses, which lead to instability of their financial volatility. Especially for the stage of the construction facilities operation, which is the longest stage in the life cycle, and can last up to 50 years or more, and the costs may exceed five to seven times the nominal value of initial investment and three times the cost of construction [1].

It becomes evident that modern innovative tools need to be used to reduce the logistical costs of the construction life cycle. Today's tool is BIM (Building Information Modeling), an information modeling and lifecycle support for construction projects. BIM technologies are treated as the development of Continuous Acquisition and Life Cycle Support (CALS) technologies for construction projects. CALS technologies combine the principles and technologies of product's life cycle information support at all its stages, and an integrated information environment utilization, based on the open architecture usage, international standards, database management, electronic exchange of data between participants of the life cycle within their powers [2].

BIM technologies allow to combine information already owned by the organization with the new knowledge that emerges in the company when moving to BIM. It provides data exchange between existing enterprise systems and the BIM model. The information model becomes a data provider for procurement systems, scheduling, project management, internal ERP and other enterprise systems. BIM modeling for building objects offers the following main benefits that an organization receives, namely [10]:

- virtual model of the building;
- individual parameters of the object;
- quality project documentation;
- the ability to quickly identify inaccuracies and errors in projects, as well as their immediate elimination;
- experimental methods of object examination under given different conditions;
- management and control of the object at all stages of the life cycle;
- concurrent information model use of a building or structure by several contracting organizations to perform their work;
- possibility of repair works, reconstruction of objects in accordance with operational requirements.

BIM technology demonstrates the ability to achieve high speed and quality of design and construction work, as well as significant cost savings.

Although the concept of BIM technology is relatively recent and constantly evolving, today it is a comparatively new type for buildings and structures 3D design. Unlike CAD, where systems based on simple lines and shapes are represented, BIM measurements of a building and all kinds of systems are made in the form of data based on a single digital model, which includes three-dimensional objects whose characteristics and purpose are integrated synchronized [3].

Specialists of different companies and organizations (design, construction, operation) within the scope of their powers take part in the construction object's life cycle. Each participant in the life cycle introduces its conditions, changes and details in the information model of the building, which avoids gross mistakes during construction, reducing costs during operation. As a result, in the virtual model, in addition to the basic elements, a large number of objects (library elements) are created and supplemented. Thus, "archives" with various variants of building elements appear [4].

Basic information model formation allows to perform a preliminary logistic analysis of indicators, during which user can evaluate alternative measures to improve the performance and efficiency of the building. A virtual model of a construction object associated with an information database, in which each element of the model is assigned additional attributes.

The advantages of the virtual model include the consideration of all details, finished elements and nuances, clear structural and economic calculations, the materials library formation and analysis of the buildings behavior in emergencies [5]. Such libraries can contribute to the development of an accessible environment, since the basic elements have certain parameters and form. The model of such elements already contains technological nuances, details and other necessary information. At the project stage there will be no errors when creating ramps and other special elements, as it could be used the finished elements, adapted to the situation.

An integral part of a building information model is its Building Energy Modeling (BEM), which is widely used worldwide in the design of public and residential buildings [6, 7]. Currently, there are a large number of software systems for energy modeling that can be used to solve a wide range of project tasks, as follows: development and selection of measures to improve the energy efficiency of buildings; estimation of recoupment of energy saving measures; selection of the optimal tariff for energy resources; determination of the operational cost (annual cost of energy) of the building; provide accurate values from solar radiation, including for modern buildings with complex architectural forms.

Implementation of BIM technologies is explained by the benefits from the use of this technology at different stages of the life cycle of a construction object, the submission of electronic documentation, simplification and reduction of construction costs, reconstruction, major repairs, increased control and supervision of construction, the ability to manage the project life cycle construction prior to its decommissioning. Thus, since 2016, the UK government [8], one of the leading countries in the use of BIM technologies, has mandated the use of BIM models, with the mandatory inclusion of digital data required for the operation phase of the building.

Effective management and operation of buildings and structures, their engineering equipment, is impossible without carrying out the analysis of logistical support at the design stage and their refinement at the next stages of the construction objects life cycle which is based on accounting and analysis of operational information for the technical condition control of the construction objects. Logistical support is not limited to the LC (life cycle) phase, as has been reported in many publications. Its mission is much broader, it affects all stages of the LC and aims to reduce logistics costs in the after-sales stages.

Problem statement. The purpose of the study is to analyze integrated logistics support for construction sites, which is a set of management measures aimed at reducing logistics costs at the after sales stages of the life cycle.

Results of the study and their analysis. Integrated logistical support is a set of management measures aimed at reducing logistics costs at the after-sales stages of the life cycle of construction sites.

It is carried out at all stages of the life cycle from the initial idea of the owner to the management, operation, maintenance and repair of objects and its subsequent decommissioning (dismantling). This involves the collection and comprehensive processing of all information about the object of construction (design, technological, operational, economic and other).

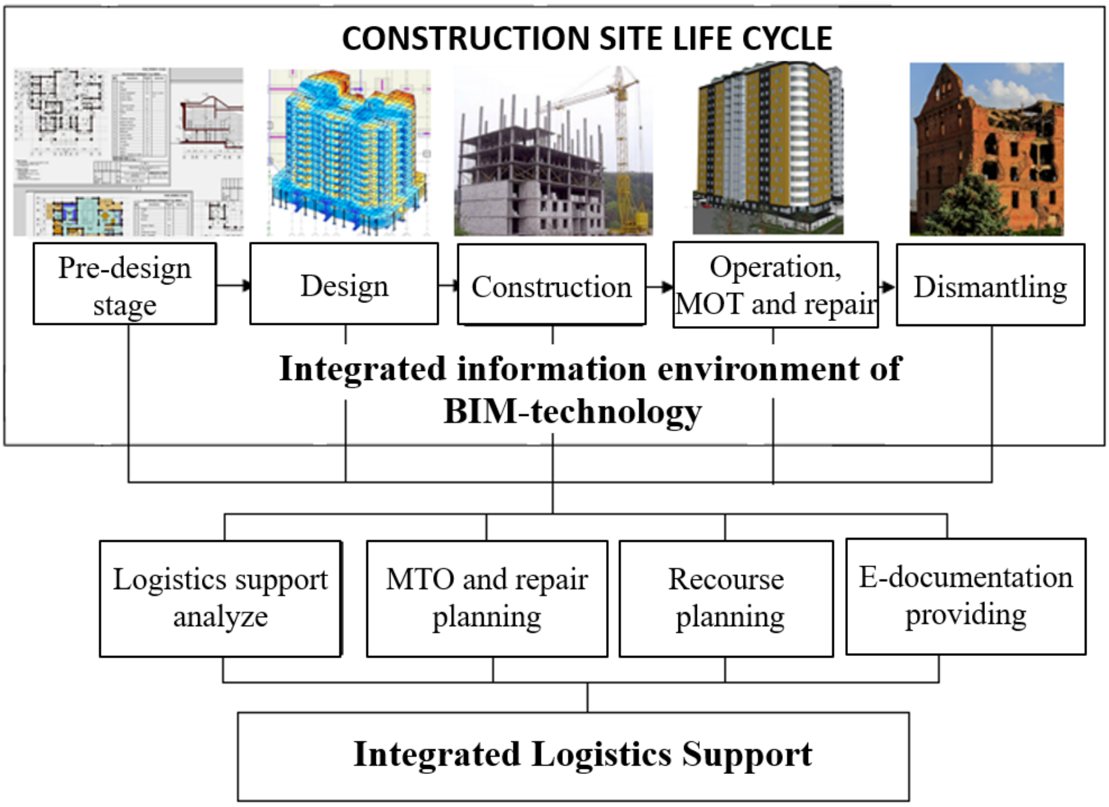

Figure 1. Information model of integrated logistics support for the construction sites life cycle

The level of detail is ensured by the fact that each life cycle participant, within his or her mandate, has access to the information about the object, which forms the fundamental basis for all decisions throughout the life cycle of the object.

The paper presents an information model of integrated logistics support for the life cycle of construction objects (Fig. 1), which is based on the conceptual model CALS [2]. The core of the information model is an integrated information environment that contains information about the construction object, resources and processes, ensures the storage and availability of data to those who involved in the life cycle of the object.

The data is added to the information environment by all participants throughout the life cycle of the objects, which allows to receive and analyze current project documentation and visualizations at any time. This is necessary for planning and managing business processes, designing, purchasing materials, coordinating work in different areas of the project, installation work, construction, operation, maintenance and repair.

Integrated logistics support is one of the key concepts of the information model. It includes: logistical support analysis (logistic analysis), maintenance and repair planning, resource management, electronic maintenance and repair documentation. Logistic support analysis is carried out at all stages of the life cycle and is performed to ensure the necessary level of reliability of construction sites, as well as to establish requirements for: construction of construction facilities, placement of engineering and technical communications subject to regular maintenance, replacement and repair; technical systems and equipment; qualifications of service personnel; nomenclature, quantity and quality of resources (spare parts, supplies, etc.).

In the analysis of logistical support, an information flow is formed regarding the nomenclature and the required amount of resources to carry out and support the maintenance and repair of construction objects. Logistic support analysis aims to reduce costs over the life cycle of construction projects.

The planning of maintenance and repair of objects is carried out at the design stage and is specified during the production and operation of the product.

In the integrated information environment of the information model, the life cycle stages of the construction objects are implemented, such as pre-design stage, design, construction, after sales (operation, maintenance and repair), dismantling of the objects function.

Pre-design stage is the initial stage at which ideas about the future object are formed. At this stage, the analysis and selection of the most appropriate solutions are performed, also it is needed to determine the functional purpose of the construction object, its appearance and other aspects. The result of the pre-design stage is a sketch of the object containing the basic technical solutions that are needed to formulate a technical specification for the next stages of the life cycle. The sketch project allows to obtain a more complete and comprehensive assessment of the planned object and to identify immediately possible problems and shortcomings, which in the short term shortens the project development time at the design stage.

At the design stage, engineering and technical solutions are being developed, the reliability of structures and the possibility of their realization are determined. At this stage, one of the basic principles of integrated logistical support for CALS technology is being implemented - the principle of parallel engineering, which involves the execution of development and design processes while simulating the processes of building and operation of construction sites. Recommendations are being made for design changes to improve the maintenance of construction sites through functional analysis, as well as to analyze the construction of sites to test for spatial collisions, which eliminates most of the alterations in the construction process and avoids critical situations, that may occur during operation. On the basis of this information, they determine the need for resources, calculate the estimated cost of construction, prepare specifications for materials and equipment, elaborate units and specify other points.

The result of the design is a complete set of design documentation required for the installation and construction work. Most of the documentation is formed on the basis of an information model that reflects all the technical solutions needed to perform the construction work. Engineering systems and individual engineering elements reflect the calculated figures for the decisions taken (energy costs, pressure losses, electrical characteristics, etc.).

At the construction stage, building and assembly works are carried out in accordance with the basic set of working drawings (architectural model, model of engineering systems, model of structures, master plan) with obligatory control over the construction process (quality of the works performed, compliance of the completed construction works with the working documentation, adherence to the calendar). With the help of visual planning and control, users could monitor the actual condition of construction objects, the flow of cash flows, moreover the necessary management information is obtained in real time, which helps not only to avoid mistakes in budgeting, but also allows to accomplish the set tasks precisely in time and with the slightest differences in estimates.

At the after-sales stage, the use of the results of logistic support analysis allows the owner to simulate different modes of operation of the object in the information model, to choose the best option based on the site needs, and to reduce the total cost of ownership. The safety of the construction sites during operation is ensured by the maintenance, periodic inspections and control tests, as well as checks of the foundation condition, building structures and systems of engineering and technical support through the implementation of routine preventive, routine repairs, sanitary maintenance of structures. All parameters, as well as the characteristics of building structures and systems of engineering and technical support, obtained during operation are recorded in the passport of the building, as well as recorded and stored in a single information model.

Thus, in addition to the obvious cost savings, it is possible to extend the life of the joint operation of construction sites due to the fact that all necessary information on the maintenance and repair of engineering and other equipment will be stored in a single model that can be accessed by life cycle participants within their authority, and timely repairs and maintenance minimize the likelihood of emergencies.

Conclusions. Integrated logistical support is one of the key concepts of the information model, which is a set of management measures aimed at reducing the costs of after-sales stages of construction objects life cycle. The main process of integrated logistical support is logistic analysis, which, in addition to the obvious cost savings, allows to extend the life of construction objects by using data of a single model and the possibility of access within the authority to all participants in the life cycle. The information obtained helps to reduce the occurrence of emergencies, reduce the number of errors, improve communication between project participants, reduce the use of resources and improve the quality of the construction object.

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