Decision-Making Support System in the Risk Management of Logistics Infrastructure Projects

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Abstract*—The article is devoted to the role of modern technologies in the optimization of logistics processes in infrastructure projects. Such technologies and information systems for managing the organization's resources. It is analyzed how these technologies can be used to optimize and manage project risks. Specific challenges faced by project managers when organizing logistics processes in infrastructure projects are considered. A rationally formed logistics infrastructure and its effective management contributes to the benefits of all participants of the logistics chain based on their clear interaction, which in general allows to improve the quantitative and qualitative parameters of financial flows. The purpose of the article is to substantiate the essence of logistics infrastructure and define its components in the direction of ensuring effective management and providing integrated logistical support of the life cycle of infrastructure projects. The object of research is the processes of logistical support of the life cycle of infrastructure projects. The subject of research is the management of processes of integrated logistical support of the life cycle of infrastructure projects. In the course of scientific research, general scientific and special methods were used, including: methods of synthesis and analysis, induction and deduction, methods of statistical analysis. And also: a systematic approach, a terminological analysis to determine the essence of the logistics infrastructure, a project approach for technical and economic substantiation of the feasibility of using a software product based on information systems and BIM technologies, application of BIM technologies to optimize the life cycle management processes of construction objects, including logistical ones.

Keywords*—*infrastructure projects, logistics, information systems, flexible project management methodologies, Lean, organization resource management, life cycle

I. INTRODUCTION

Forced changes due to russia's armed military attack on Ukraine destroyed a significant part of the infrastructure, which in turn underwent a transformation of business processes related to logistics. This led to the need to adapt logistics and supply chains in various areas to today's realities.

Dozens of organizations have lost warehouses, hundreds of companies are still having to rebuild their supply chains, and many manufacturers are having to relocate production facilities and help relocate their workers and their families.

In general, according to various estimates, about 400,000 square meters of warehouse space was destroyed or damaged in the Kyiv region. This is 20% of the area of the entire Kyiv region. There are also significant losses in other regions of Ukraine.

II. ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

According to domestic researchers, logistics infrastructure is a set of technical and project-organizational elements, with the help of which all types of resource flows (material, financial, informational, labor, return) carry out cyclical movement with the greatest efficiency from the supplier of resources to the final customer [6].

The work of a large number of Ukrainian scientists was devoted to the issue of the logistical approach to management in Ukrainian realities. Most of them studied the logistics of mainly industrial and transport companies and the improvement of logistics processes during the construction of objects due to the use of technologies [7].

The concept of "infrastructure of logistics processes". Within its limits, it distinguishes external (highways, integrated logistics service centers, railways, airports, seaports and waterways, television information networks and facilities, auxiliary equipment for servicing linear and point facilities) and internal facilities (houses and warehouse facilities, internal roads, other localized equipment for moving resources and information) [3].

Inadequate estimation of volumes and quantities of products, over-execution or shortage in procurement, growth of logistics costs during transportation and storage lead to a significant increase in the total costs of construction and operation. Also, one of the key problems of infrastructure construction projects is ineffective management of the processes of design, construction, operation, etc [1]. This reduces labor productivity, forcing work to stop, requiring

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rework and disrupting established supply chains of materials, machinery, labor, etc.

For example, according to the concept of implementation of BIM in Ukraine, which is carried out with the support of the EU project "Assistance to Ukrainian authorities in improving the management of the infrastructure project cycle", the average deviation from the plan for the implementation of construction and infrastructure projects is estimated at 20 months, and cost overruns are on average 80% for all projects.

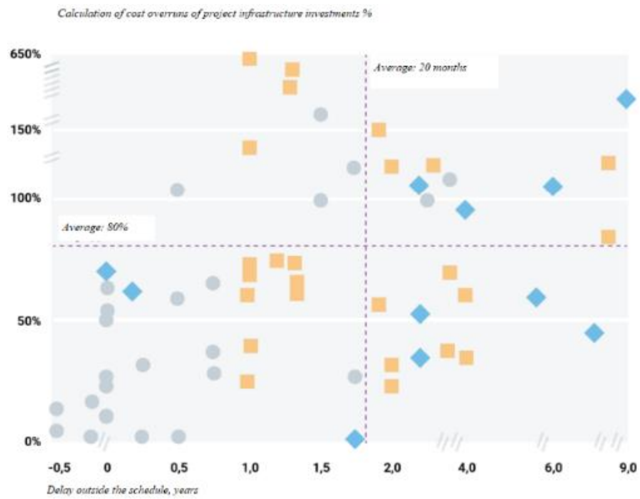

Fig. 1. Cost assessment of infrastructure projects

Separately, it should be noted the general lack of approaches to managing the life cycle of objects as a whole (in particular, life cycle assessment, operating costs, cost analysis, etc.) [7]. When in the investment and construction activities of the advanced countries of the world, structural changes are gradually taking place, the basis of which is a shift in focus from the design and construction process to the entire life cycle of the object, in Ukraine, at the moment, such systemic approaches are not observed, except for certain developments and proposals .

The slow pace of innovation in the construction industry is rather a consequence of a systematic lack of the necessary broad statistical, analytical, operational, economic, etc. data at almost all key stages and processes. Such a situation in the industry can generally be characterized as a certain "information vacuum", which prevents the industry (unlike others, for example, the engineering industry) to systematically accumulate and operate data during the life cycle of objects, creating a reliable analytical basis for decision-making.

Construction infrastructure programs and project portfolios rank almost at the bottom of the digitization index, and are characterized as a highly localized and fragmented sector that lags behind in most criteria. In addition, due to the use of traditional design methods, there is a rather serious problem of constant "loss" of data at each transition to the next stage of the object's life cycle. At this time, investments in information and communication technologies in construction are small compared to other industries.

The trend of increasing the need for effective management of construction project operation processes indicates the importance of logistics, especially the dominant role is observed in the field of procurement planning and execution, because they consist of such processes as ordering, receiving, transporting and storing material project resources.

Under the problematic situation of providing logistical support for the life cycle of objects in the construction infrastructure industry, there are violations in terms of putting construction objects into operation; violation of the planned budget for construction or its maintenance, inefficient use of material and labor resources and inefficient operation of the construction infrastructure project due to the lack of detailed information on the needs of current maintenance and repairs.

III. RESULTS OF RESEARCH

There is a ripe need to develop new approaches to designing information systems in the field of infrastructure. Adaptive approaches to the design of information systems in the management of large projects allow project offices to achieve the goals set by the customer and satisfy the needs of stakeholders. Infrastructure projects, such as the construction of dams, dams and hydroelectric power plants, are often carried out in difficult-to-reach mountainous areas or wetlands. This creates additional difficulties for the organization of logistics processes. Energy projects, especially related to the construction of power plants and substations, are characterized by large volumes of equipment, which often have non-standard sizes and weights. Delivery of such equipment requires careful planning and stakeholder coordination.

The specifics of the implementation of such infrastructure projects are strict deadlines. Any delay in the delivery of equipment can disrupt the construction schedule, so meeting deadlines is critical. Also high security requirements. Transportation of heavy and bulky equipment requires compliance with strict safety rules to prevent accidents.

Common challenges for both types of projects are unforeseen circumstances, changes in the project, large volumes of data and the need to process large volumes of information for decision-making, coordination of a large number of participants, which in turn determines the need to ensure effective interaction between stakeholders of infrastructure projects, programs and portfolios projects.

Construction infrastructure projects are characterized by a rather long supply chain, i.e. from the development of the project to its implementation and operation, which includes a significant number of small and medium-sized organizations, which leads to a partial loss of information (since it largely depends on the ability to accumulate, operate and exchange data , their quality and reliability).

The need for material resources, structures and products is determined by individual features of infrastructure projects, technology and construction organization. Procurement and supply of material resources must be carried out in strict accordance with technological requirements and reduce excess warehouse stocks to a minimum.

Warehouse logistics infrastructure is represented by warehouses, loading and unloading terminals, logistics centers. Their location, quantity, load level, product storage terms significantly affect the movement of logistics flows, including the speed of movement of financial resources.

Taking into account all possible types of warehouse logistics infrastructure will allow tracking the trajectories of financial flows, analyzing them, planning, which determines the development of programs for geographic location and determining the optimal number of warehouses. Taking into account in the management of financial flows the internal and external components of the logistics infrastructure is mandatory in order to ensure the improvement of their parameters.

TABLE I.. COMPARISON OFPROJECTS MANAGEMENT METHODOLOGIES FROM THE POINT OF VIEW OF STANDARTS

Characteristic	**Waterfall model**	**Agile**	**Scrum**
Development cycle	Linear	Iterative and incremental	Iterative and incremental
Planning	Detailed at the beginning of the project	Flexible, focus on the current iteration	Sprints (short iterations)
The role of the client	Less involvement	Active participation in the development process	Active participation in the development process
Documents	Detailed documentation at all stages	Minimal documentation, focus on working product	Minimal documentation, focus on working product
Standards	PMBOK (mainly)	PMBOK, BABOK, SWEBOK	PMBOK, BABOK, SWEBOK

Knowledge of PMBOK, BABOK and SWEBOK is the foundation for a successful project manager. By combining this knowledge, you will be able to effectively manage projects of varying complexity and ensure high quality results.

TABLE II. INTEGRATION OF KNOWLEDGE INTO THE PROJECT LIFE CYCLE

Project phase	**PMBOK**	**BABOK**	**SWEBOK**
Initiation	Definition of the goal, creation of the project charter	Analysis of business needs, definition of requirements	Assessment of technical feasibility
Planning	Project plan development, resource assessment	Development of data models, processes	Development planning, testing
Implementation	Team management, quality control and archiving	Management of requirements changes	Coding, testing
Completion	Obtaining formal approval and archiving	Checking the compliance of the system with the requirement	Adoption of the system

The concept of Lean organization management involves the continuous elimination of all types of losses with the sole purpose of maximizing business optimization and the best customer satisfaction. It is based on the production system of the Japanese company Toyota, thanks to which the car concern came out of the post-war crisis and became a successful organization on a global scale.

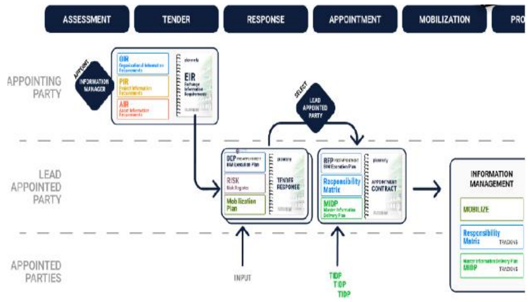

Fig. 2. Workflow for BIM logistics infrastructure projects

It is no coincidence that the professional standard of business analysts, the BABOK Guide, has included Lean and 6 Sigma methods in the most frequently used process analysis techniques.

Unlike a typical quality management system, which declaratively describes what needs to be done, but does not say how, lean manufacturing principles tell in detail how to reduce losses or eliminate them altogether. In particular, the method of mapping flows of value creation regulates step by step how to create a VSM, and the 5S system is generally a simple and cheap way of rational organization of the work space.

Also, an important property of the Lean concept is the versatility of its methods, which can be used as effective management of a factory or other industrial enterprise. These approaches are well suited to the IT industry as well. For example, of the 12 principles of the Agile Manifesto, almost half completely repeat the ideas of Lean. This is particularly evident in the DevOps philosophy, which aims to accelerate the development and operation of software by means of automating repetitive processes and managing infrastructure as code.

It is worth noting that, like any management approach, Lean is primarily not about technologies and tools, but about changing business processes and human thinking. This is what combines lean manufacturing and digitalization.

Systemic organizations manage to respond in a balanced and urgent manner to changing working conditions and new external influences. For project teams using information systems WMS and TMS-solutions, moving the warehouse is not a difficult task. For example, an object with an area of 50,000 square meters can be transported to a new location in a few days, if there is a suitable warehouse, as well as the availability of the necessary amount of transport and human resources.

The company's portfolio includes solutions that allow not only high-quality and quick launch of new facilities, but also quick reconfiguration of existing ones, adapting them to new realities. Experience in reorganization and reengineering of processes to restore and optimize warehouse logistics management is becoming relevant.

But it is worth noting that such approaches are most effective when opening new directions, covering new regions, where the key factor is the speed of entering the market. Also, the purchase of logistics services will be appropriate if there is a lack of professional personnel at the initial stage, and in cases of difficulties with the administration of processes.

TABLE III. POSSIBILITIES OF LOGISTICS INFRASTRUCTURE PROJECTS

Possibilities for setting up warehouse logistics in new conditions.	Characteristic
Decentralization of commodity flows	Logistics chains with a high level of centralization of supply have been severely affected. Such networks are now taking measures to decentralize commodity flows. All networks have to act on a case-by-case basis and pay significant attention to day-to-day operational issues to sustain operations and try to plan for next steps.
Forecasting systems	System management of strategically important resources can also be included here. Such a systematic approach in the current situation allows for more accurate planning of logistics and optimization of growing logistics costs.
Logistics consulting	In the absence of automated warehouse process management systems and employees capable of carrying out changes of such a scale, the purchase of logistics services may be a very possible way out for the company. This step can not only reduce the risks for the company's survival, but also help it to ensure the movement of product flows for as long as possible.

Solutions for warehouse automation, including voice technologies, ensure optimal productivity of the warehouse complex at lower costs.

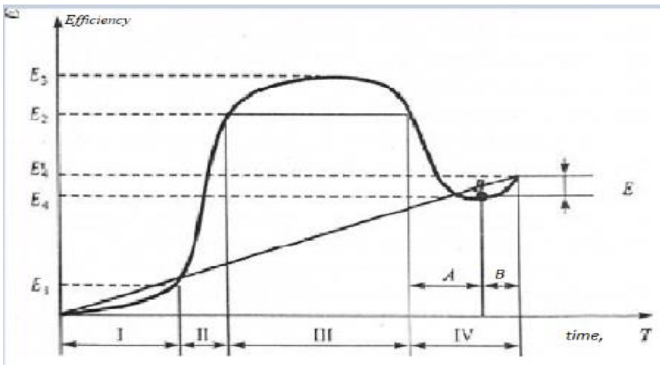

Fig. 3. An analog model of the life cycle of a logistics infrastructure project

Through the prism of the life cycle, the efficiency of logistics systems can mostly be characterized by two peculiar evolutionary cycles, each of which is well approximated by an S-shaped curve.

In the life cycle of a logistics system, four stages should be distinguished to characterize its current efficiency. The first cycle covers the origin, development and maturity of the logistics system. The second cycle includes a change in the life cycle of the logistics system from the beginning of the recession to liquidation. These cycles correspond to quantitative, and in some cases, qualitative changes in the parameters of the logistics system.

The first stage (I) is the origin and formation of the logistics system. It is characterized by relatively insignificant efficiency of E and relatively low rates of its growth (weak rise of the curve).

The second stage (II) is a rapid increase in efficiency. The return, that is, the current efficiency, is increased here due to the removal of restrictions on the coordination of subsystems of the logistics system and their functions.

The third stage (III) is a period of stability. It is characterized by practically the highest indicators of the efficiency of the logistics system, the immutability (constancy) of its initial parameters, a low probability of failures, high indicators of survivability and sensitivity to changes in the market situation, etc.

Stage four (IV). It includes two sections - A and B. Section A is the stage of efficiency decline, at which there are "alarm signals" about the loss of the achieved values and the remaining parameters of the logistics system.

Section B - efficiency gain. The rate of growth of ΔE in this period is insignificant and is connected, rather, with the curtailment of the activities of the logistics system.

IV. CONCLUSION

Having reviewed and analyzed decision support systems based on the method of precedents, the reader will be able to better understand their potential and applicability in the modern world, and will also have the opportunity to use this method to achieve better results in their own activities.

Thanks to the use of the developed model, it is possible to reduce the time for planning the project and drawing up technical documentation due to the use of precedents from this project. In the course of the work, the process of planning a software project was investigated and it was shown that the use of precedents makes it possible to increase the efficiency of planning and implementation of software projects based on the use of known practices by executors.

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