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A SYSTEM MODEL OF DECISION-MAKING TRANSPORTATION PROCESS MANAGEMENT IN TRANSPORT INFRASTRUCTURE PROJECTS

Aspects of system analysis of the process of railway transportation management are considered in the work. Each of them is analyzed in detail and the role of each in managing the transportation process is determined. It was determined that the implementation of complex automated management systems led to the definition of a typical multi-level structure of the application system, which provides a combination of various management goals, however, the use of certain tools does not affect any of the aspects of the analysis.

System models of the decision-making process in transportation process management, each level of the analytical system of transportation process management, are presented. The functions and processes of each of these levels are analyzed in detail. With the help of system models developed in the work, the hierarchical principle of management of the transportation process is considered, which is based on detailing management actions and, at the same time, narrowing the number of basic management objects.

Keywords: *information base, management system, system model, system approach, analytical system, decomposition.*

Introduction. In order to determine the properties and parameters of the analytical system, which should ensure adequate management decision-making, it is necessary to conduct a systematic analysis of the process of managing railway transportation. At the same time, each of the aspects of system analysis is relevant:

- Elemental, which reveals the set of elements that make up the system.
- Structural, which examines the internal connections and relations between the elements that make up the system. Allows you to get an idea about the internal organization of the object under investigation.
- Functional, reveals the functions for which the investigated objects are created and exist.
- Targeted, determines the need to determine the goals that the system must achieve and their interconnections.
- Resourceful, identifies resources that provide a solution to the problem.
- Integrative, defines a set of quality indicators of the system, which ensures its integrity and, at the same time, its uniqueness.
- Historical, allows you to identify the conditions at the time of the object of research, the stages passed in the development of the object, the current state and prospects for further development.

The consideration of transportation management in a historical aspect indicates, first of all, that the structure of management changed due to the distribution of functions. Management levels were formed, each of which had its own management goal and, accordingly, a source of data. That is, the current structure of levels of management of the transportation process is a consequence of

evolutionary changes. Further changes in external factors should lead to corresponding changes in the management organization.

The functional aspect determines the completeness of the performance of transportation management functions, which are supplemented over time. For example, market conditions dictate the need to analyze relationships with customers transporting goods by rail [1].

The target aspect, which is closely related to the functional aspect, determines the goal of management. For multi-level management of the transportation process, such goals are different but harmonized with respect to the fulfillment of the goals of the higher level of the structure. For a corporation, this is usually a profit.

The resource and integration aspects of the system analysis of the railway transportation management process are specific. Traditionally, the management structure of the transportation process does not directly affect the overall quantitative and qualitative composition of resources - infrastructure facilities and rolling stock - that participate in the transportation process. Management in such conditions is carried out on allocated, in other words, limited resources. The same conditions of limited resources also limit the transportation process management system in the integration aspect. Because they do not provide integrity in the management of all resources.

The integration aspect of system analysis determines the boundaries of the system – in our case, the freight transportation management system. Returning to the given example, it is necessary to decide whether or not the function of increasing resources, which are participants in the transportation process, is included in the set of transportation process management functions [2].

It should be noted that all the listed aspects of the system analysis of the freight transportation management process do not depend on the use of certain automated management tools for this management. From the point of view of system analysis, the use of computer systems is reduced only to the way of performing certain functions of the system.

The purpose and tasks of the study. The purpose of the study is to develop a system model for decision-making in the transportation process with the aim of optimizing management actions at basic facilities and improving cargo data processing through an automated management system.

Research objectives: 1. To analyze the process of managing the transport process by evaluating the work. 2. To propose models of decision-making models that will provide the necessary information support for decision-making using data in the information base. 3. Using modern Case-technologies, present a system model for managing the transportation process in railway transport, which is based on the hierarchical principle of construction, which allows to optimize the obtaining of information about the cargo by the subjects of the management of the transportation process.

Research materials and methods. The process of managing freight transportation in railway transport is impossible without the use of automated systems, therefore the use of the information environment is an integral part of automation. In particular, accounting of the work of divisions and the entire railway, calculation of quantitative and qualitative indicators of the work of divisions and the entire railway as a whole, financial and accounting reporting, technological documents, settlement documents for services rendered, etc. takes place in the information base - the only automated system for managing cargo transportation of Ukrainian railway [3].

The system, which contains a huge amount of data about all operations with management objects, is an information system. System developers and operating practitioners emphasize in work [1, 8] the need to transform the information system into a decision support system by creating analytical servers.

Decision-making regarding object management is based on the paradigm of choosing a certain strategy based on data about the state of the object and its target function [4-6].

The general technological process of preparing a decision in the management of the transportation process consists of the following actions, which can be represented using a system model in the form of a context diagram of IDEF0 process modeling in Fig. 1:

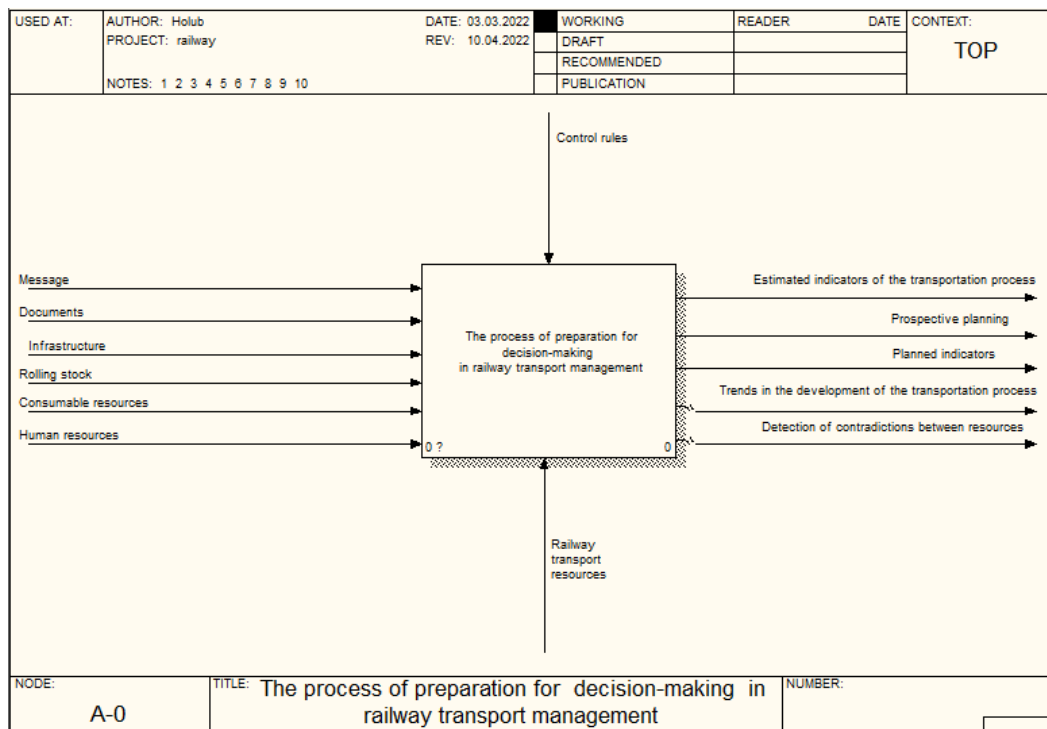


Fig. 1. A system model of the decision-making preparation process in transportation process management

The system model of the decomposition of the decision-making process in railway transport management in Fig. 2, which is depicted in the form of a decomposition diagram of the IDEF0 notation, reflects the modeling of the technological process of railway transport management, which includes:

1. Registration (measurement) of transportation process parameters.
2. Logical control of input measurement data, which consists of procedures for checking the correctness of measurement, categorization of measurement parameters, correction or rejection of incorrect measurement data.
3. Logical control of environment data. Environment data consists of the following measurement elements: infrastructure (immovable objects); objects of rolling stock (locomotives, wagons); expendable resources; human resources [7, 10].
4. Calculation of operational indicators. Such indicators are elementary events or operations of the transportation process, on the basis of which it is possible to analyze this process.
5. Storage of actual operational data in the data warehouse. The data warehouse is required to accumulate indicators of the transportation process for past periods and is a source of data for further analysis. This provides an opportunity to determine the long-term dependence of the transport process parameters on time and/or the interdependence of these parameters.
6. Access to the storage of operational data. Automatic or automated analytical calculations are performed with the data that is the content of the data warehouse. To do this, calculation programs must establish access to data storage.

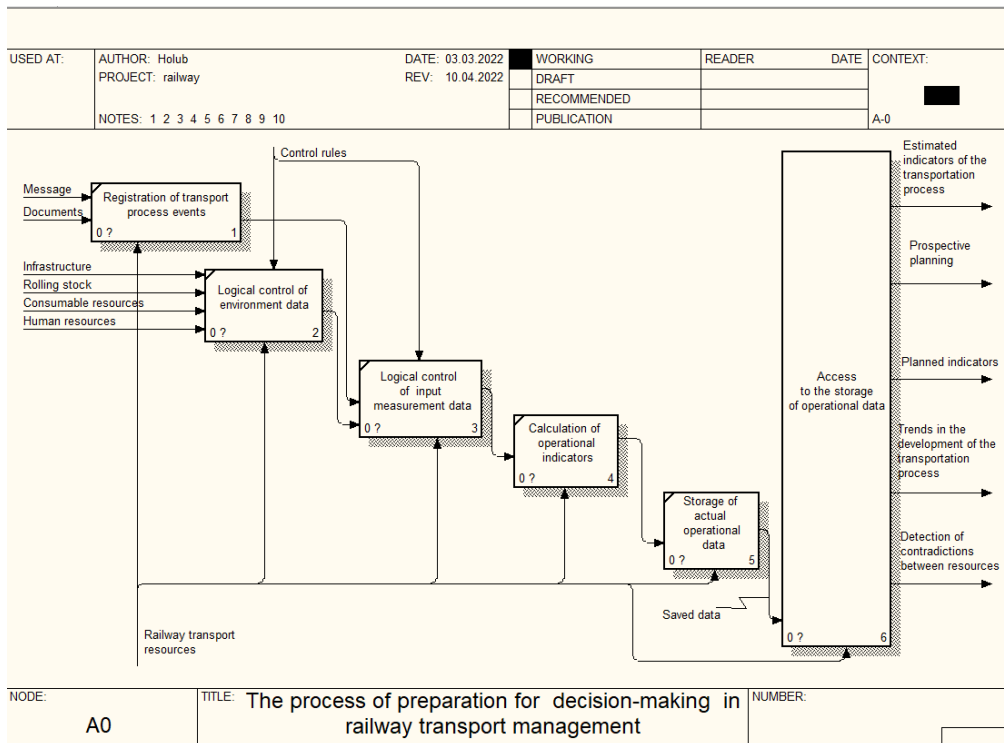


Fig. 2. A system model of the decomposition of the decision-making process in railway transport management

The next stage of modeling the processes of managing the transportation process presents a diagram describing the process of access to the storage of operational data in Fig. 3

The diagram shows the system model of the description of the process of access to the storage of operational data: assessment of the transportation process; forecasting parameters of the transport process; planning and calculation of normative values; definition of functional and correlational dependencies; simulation of critical situations.

The analytical decision-making system in the management of the transportation process aims to provide evaluation information about the completed transportation process in comparison with the planned indicators and indicators of past periods. The history of the completed transportation process allows you to determine trends for the future. Including predicting critical situations [8, 11].

The output of the decision-making preparation process is:

- Estimated indicators of the transportation process that has already taken place;
- Trends (tendencies) in the development of the transportation process;
- Modeling of critical situations – identifying contradictions between required and existing resources;
- Formation of planned (normative) indicators.

Decision-making is carried out within the system's responsibility and competence. In view of this, the main points of responsibility of the transportation service of the Ukraine railway are:

- Organization of operational work of railways of Ukraine;
- Transportation process management;
- Regulation of resources in the field of organization and provision of the transportation process.

In Fig. 4 presents the model of factors and directions of the analytical system of decision-making in the management of the transportation process, which determines the formulation of the concept of the analytical system [9, 17]. Namely, a certain way of understanding, interpretation of any phenomena,

processes, objects, a basic point of view, a guiding idea for their illumination, a leading direction, a constructive principle of various types of activity.

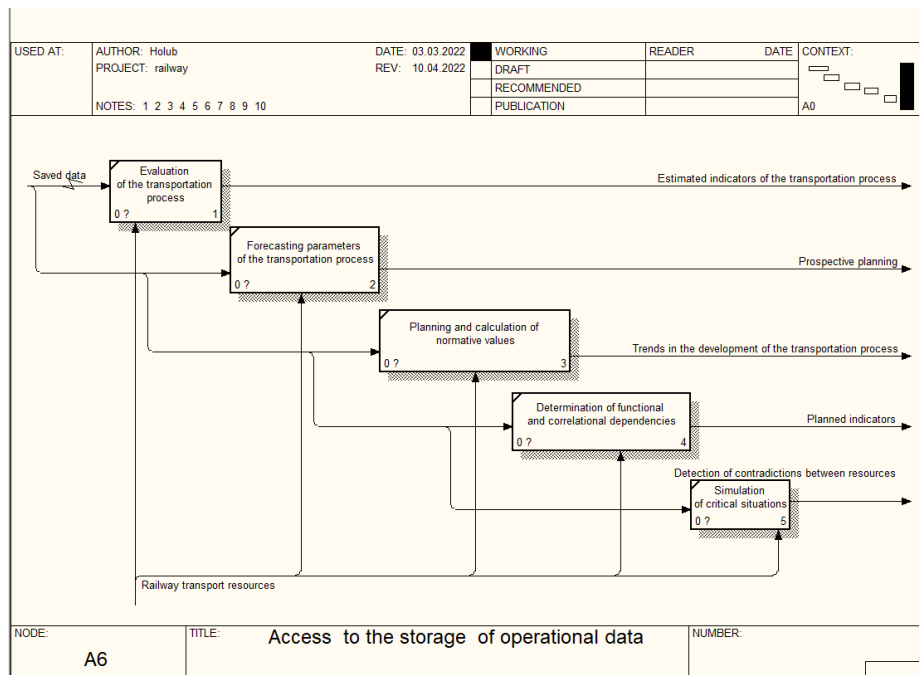


Fig. 3. System model for describing access to the operational data repository

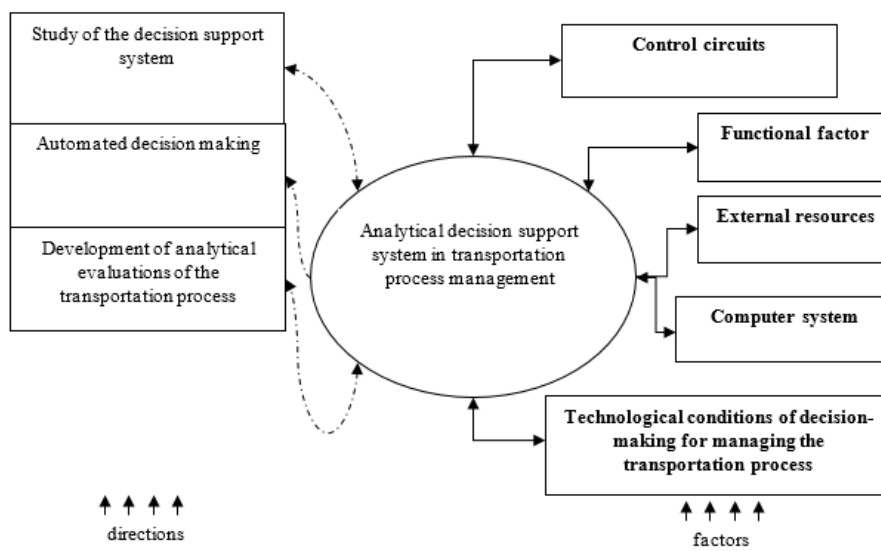


Fig. 4. Model of factors and directions of the analytical decision-making system in the management of the transportation process

The model includes the main factors and directions, which are the basis of the synthesis of the analytical decision-making system in the management of the transportation process.

The factor of technological conditions of decision-making highlights the fact that decision-making, that is, choosing the right option for further actions [12], can be equally the result of retrospective data analysis, and decision-making in real time, based on current data.

The factor of the management level (contour) correlates with the factor of technological decision-making conditions. If at the level of strategic management cargo is considered as a certain volume to be moved, then operational management considers cargo as the contents of wagons and the subject of loading and unloading operations. If the strategic level of management is based on the analysis of retrospective data and data from compatible areas, then the operational level is guided by the corresponding plan and the data of the execution of this plan, which must come in real time.

Therefore, the system analysis of the management of the transportation process defines three levels or management contours:

Strategic management –formation of standards and basic indicators of the transportation process, necessary for the creation of plans, traffic schedules, and other long-term plans.

Tactical management – creation of normative medium-term plans, traffic schedules and other plans that regulate the transportation process.

Operational management –linking normative plans to the real situation with applications for transportation, as well as short-term plans and their implementation taking into account the current state of the infrastructure [13].

Since the task of transportation is integral, the contours of strategic, tactical and operational management unite all links of management - from general to local.

The functional factor is the limitation that determines the permissible limits, rules and methods of managing the transportation process. This factor also determines the rules of interaction with suppliers of resources that provide the transportation process - track, locomotive, wagon services and a number of others. Separately, it is necessary to highlight the interaction with the commercial service, which determines the volume, points of departure and destination, the nature of the cargo to be transported. These data are the starting point for planning the transportation process.

Another limiting factor is resources - human, rolling stock, infrastructure that ensures the transportation process.

A factor such as a computer system that provides decision support includes the architecture of the computer system, the software that corresponds to the chosen architecture, and the hardware that allows the corresponding process to be provided.

The railway transport process management system includes [11, 14]:

- Transportation planning and technical standardization
- Traffic schedule and train formation plan
- Operational planning of train and freight work
- Operational regulation and dispatch control.

The management system is based on the following hierarchy of goals:

- The cargo transportation plan, which determines the entire operational activity of the railway during the year. The plan has indicators: shipment of goods in tons by the most important types of goods; average daily load in tons and wagons; the number of ton-kilometers by types of traction; reception and delivery of goods in tons at railway junctions.

- Quarterly plan. Establishes the size of cargo shipment in general by the railway network and each by month, types of cargo.

- The monthly plan includes the load volume in tons and wagons on the network, railways, stations and shippers.

- Detailed transportation plan. It is compiled on the roads according to a single form using cargo codes, cargo receivers and stations. The expanded plan contains data on the dispatch of all wagons per day and separately by the most important items of cargo [15].

Organization of train traffic. It provides for the routing of transportation from loading points, the formation of routes at technical stations in accordance with the annual train formation plan.

Operational planning of train and freight work ensures the implementation of the transportation plan, train schedule and technical standards in the specific conditions of the next day and shift.

There is a widespread scheme of interaction of applied systems to transform primary data about events on a real object into evaluation information about its functioning. Such a scheme implements the process of solving business analytics problems: converting primary data about the state of production facilities into information about the progress of the production process and its assessment.

Thus, the creation of an applied level of transportation process management is a prerequisite for determining issues of preparation for decision-making in the management of the transportation process [16]. Applications of this level should formally monitor the business process of transportation management of the Ukraine railway as a whole, consisting of elements of the processes of managing the railway, directorate, station, stations of various types. In other words, without an implemented level of resource management, no automated decision-making is possible. Analytical procedures on events are possible only in the sense of comparing current registered events with planned normative indicators. To increase the credibility of the economic justification of operating costs, it is necessary to conduct their analysis by economic sectors, types of transportation, cost elements and their connections with the production process.

Conclusion. With the help of the formed decision-making models, it is possible to select and evaluate transportation process management systems that will best meet the needs of a specific entity. with the help of the unified automated system of management of cargo transportation.

In the proposed system models of management of the transportation process, a hierarchical management principle is assumed. This principle is based on detailing management actions and, at the same time, narrowing the number of basic management objects - rolling stock objects. At the same time, all levels of management are forced to participate in operational management. This provision is confirmed both by management practice and by the probable nature of planned and normative indicators. Given a single number for a significant period of time, such an indicator presupposes a certain regulation in order to achieve it.

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СИСТЕМНА МОДЕЛЬ ПРИЙНЯТТЯ РІШЕНЬ УПРАВЛІННЯ ПЕРЕВІЗНИМ ПРОЦЕСОМ В ПРОЄКТАХ ІНФРАСТРУКТУРИ ТРАНСПОРТУ

В роботі розглянуті аспекти системного аналізу процесу управління перевезеннями на залізничному транспорті. Детально проаналізовано кожний з них і визначено роль кожного при управлінні перевізним процесом. Визначено, що впровадження комплексних автоматизованих систем управління привело до визначення типової багаторівневої структури прикладної системи, що забезпечує поєднання різних цілей управління, проте використання тих чи інших засобів не впливає на жодний з аспектів аналізу.

Представлено системні моделі, процесу підготовки прийняття рішення в управлінні перевізним процесом, кожного рівня аналітичної системи управління перевізним процесом. Детально проаналізовані функції та процеси кожного з цих рівнів. За допомогою системних моделей, які розроблені в роботі, розглядається ієрархічний принцип управління перевізним процесом, який базується на деталізації управлінських дій та, одночасно, звуження кількості базових об'єктів управління.

Ключові слова: інформаційна база, система управління, системна модель, системний підхід, аналітична система, декомпозиція.