Information models for ensuring the sustainability of transport operations formation in the context of digitalization

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Abstract. The conditions for the formation of an information model for ensuring transport activities in the context of digitalization and the digital transformation of the transport industry are considered. It is shown that the development of information support will allow switching to transport from information systems that perform a passive function and information support for management, to active, predictive management systems based on increasing the degree of use of available information and its verification.

1 Introduction

There is active digital development and transformation of the transport industry in economy. In the transport strategy of the Russian Federation for 2030, approved by Decree of the Government of the Russian Federation dated November 27, 2021 No. 3363-r, special attention is paid to the use of digital technologies and digital transformation. The strategy addresses the issues of creating integrated transport services, digitalization of vehicles, transport infrastructure, the activities of government authorities, and transport security issues.

For example, towards passenger transportation there is the provision of comprehensive digital services in the context of "smart infrastructure" and "mobility as a service", for freight transportation - end-to-end digitalization of the transport chain and robotization of logistics operations, and in the context of state regulation of freight transportation - the introduction of end-to-end tariff regulation in "infrastructure tariff" format. The role of digital technologies is also high in ensuring the reduction of the negative impact of the transport complex on the environment in accordance with the principles of sustainable development.

Taking into account the fact that the directions of digital transformation cover the entire transport system as a whole, their consistent implementation, due to increasing volume of data acquisition and processing (big data in transport), should lead to rational planning and organization of transportation, ensuring a balance of interests of suppliers, consumers of

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transport services and state, which is entrusted with regulatory functions, and also lead to the management of social risks in transport.

Digital transformation is always based on data management [1], and for individual processes in transport, especially those related to transportation safety and new client services, real-time data management is necessary.

The level of digital coverage of elements of the transport industry today is heterogeneous in real situation. This is true both for individual modes of transport and for components of multimodal transport systems. According to industry expert estimates for the level of digitalization and digital transformation in Russia, types of transport today can be arranged as follows (from largest to smallest): air transport, railway transport, road (automobile) transport, water transport [2-5]. Separately, pipeline transport should be noted, the level of digitalization of which is quite high [6].

In the issue of data management in transport, the relevant problem is the received and processed data sets usage. According to experts from the Russian Export Center [7], the level of productive collected data usage in transport in 2018 in the context of multimodal international transport did not exceed 20-30%. According to more modern estimates, according to the analytical portal www.itsjournal.ru, we can talk about values of 40-45% in certain sections of multimodal transport systems. The demand for the development of technologies for processing and analyzing big data in transport increases every year.

By the systems approach, the transport system consists of elements that are interconnected in various relationships and connections that ensure its integral functioning. Increase in the volume of processed data allows for each element of the transport system to increase the degree of its integration into a unified transport system in the logic of ensuring the sustainability of supply chains [8]. In addition, in conjunction with the development of transport management processes, the required volumes of data make it possible to consider the use of “cyber-physical systems” for managing transport and logistics services [9]. In addition, the basis for the development of intelligent transport systems and a digital platform for the transport complex of the Russian Federation is being formed [10]. In the future, increasing the level of digitalization of transportation will make it possible to ensure the formation of intermodal smooth and seamless integration of transport, a description of which is given in [11]. Thus, the integration of processes in transport systems at the data level will increase the volume and quality of data, which, in turn, will be in demand for managing sustainable development processes [12]. Integration processes at the data level for such continuous socio-technical systems (which include transport), for which the criteria for sustainable development must be met, require the development of approaches to industry information modeling of transport objects and processes.

2 Transport sustainability information support

The transport system, like any system, responds to continuous changes in the external environment, changing its own processes accordingly. The factor of system stability under the influence of external disturbances for transport is quite critical, since as noted earlier, transport combines the characteristics of a production, technological and social system.

Being built into the economy, the transport component is in the loop of ensuring the industrial and social needs for high-quality transportation at the optimal cost, both from the position of the transport organization-carrier, by ensuring economic activity and the efficiency of the rolling stock, and the consumer of the transport service, as well as the state, the owner object of the corresponding transport infrastructure, etc.

The cost of transport services in the typical conditions is calculated on the basis of cost-based pricing methods, the common feature of which is the addition of a certain premium to the cost of transportation, the value of which corresponds to the industry profit rate. The

amount of transportation costs, as a rule, is formed by cost elements and costing items based on the level of costs of previous years and adjustment factors that reflect the planned level of costs for the forecast period. At the same time, the costs usually take into account the necessary savings for the development of a motor transport organization. As shown in [13, 14], to ensure the sustainability of the transport system, voluminous factor information support is required, which will be reflected in providing the necessary level of management to ensure sustainability. From the point of view of external effects, for transport this is also the necessary information support for the formation of balanced tariffs for services.

In a comprehensive study of the transport system from the perspective of information modeling it is necessary to consider information models of the elements of its structure, characterize structure-forming properties and features based on a large amount of information (data).

There is several classes of information support (data flows) can be distinguished for a transport system:

- technical and operational performance indicators of rolling stock and infrastructure;
- telemetry of vehicles;
- operational information from transport terminals;
- information on price factors (tariffs) for transportation, market information;
- information received from technical complexes for monitoring the operation of transport infrastructure, transportation organization, transport terminals;
- information provided by adjacent entities of the transport system - transport terminals, warehouses;
- information about consumers.

To ensure sustainability within the framework of integrated transport systems and multimodal transportation, it is necessary to apply a combined approach to information support for transport operations, including the formation of prices for services as an economic entity that contains in aggregated form all possible factors of the operation of the transport system. Components of this combined approach to information support include:

- taking into account factual information without modifying it, eliminating distortions for the formation of high-quality information support for management;
- universality of procedures and processes for collecting information - obtaining information should be ensured within the framework of end-to-end universal procedures, and such procedures should be applicable to different components of transport systems;
- objectivity of the composition of information - based on social needs, information support should include components that allow the relevant processes to be assessed from different angles.

It is important to consider that the information model must include information processing components in accordance with business process diagrams. The normal scheme of transport business processes should not include components related to the attraction of excess resources for the provision of transport services, inefficient use of fixed production assets, as well as costs not related to transport services.

Now, when the level of efficiency of the transport system is influenced not only by economic, but also by political and organizational factors, the main tool for achieving a balanced state of transport operation is an information and economic justification for the composition, price and volume of services provided, as well as providing integration schemes for transport operation as between individual types of transportation, and within industries. Only in such conditions can we talk about ensuring the interests of market subjects: consumers of transport services, government regulators, transport organizations.

Another requirement for information support for sustainability in transport is to provide a detailed representation of the characteristics of processes, on the basis of which decisions

can be made on attracting resources (investments) for the development and modernization of the production base, as well as conditions for reimbursement of costs associated with the implementation of the production program of a transport organization with a given level of transportation quality.

Thus, information modeling in the context of the digital transformation of transport and the need to ensure its sustainability should also be associated with financial and economic activities. In this case, the functional components of the economic security of the transport system will be ensured.

3 Conceptual description of the information model for ensuring transport sustainability

Ensuring the operation of the transport system is possible only within the framework of dynamic information models that comprehensively describe the processes of change and development of systems.

It is necessary to take into account that the transport process does not modify the transported object. The cost of transportation (passenger, cargo) also has little connection with the cost of the object; it is only determined by the additional cost of social labor that must be incurred in order for the transportation to take place. Only the need to take into account the costs of social labor forces us to add the cost of transportation to the cost of the final product. From the point of view of ensuring sustainable development, the transport services sector itself cannot be a source of added value. Being necessary for the functioning of society, the transport sector must therefore function in conditions of limited growth in the cost of social labor for transportation, there must be a tendency to minimize the cost of increasing the price of the final product due to the transport component, and accordingly there must be a socially balanced model for providing transportation.

Within the logic of modern transport development, the transport system (or subsystem on a regional scale, at the meso level) should function in such a way as to maximize its efficiency only by increasing turnover and by the volume of high-quality transport services.

An imbalance in the operation of the transport system can occur in cases where the order of distribution of the surplus product is poorly consistent with the incentives inherent, for example, in the transportation tariff. In order for the rate of profit, as the basis for measuring the level of participation of transport in economic processes, to be objectively justified, it is necessary to create a balanced information support for the formation of economic conditions for organizing transportation (in particular, tariffs for transport services).

An essential element of a dynamic transport model should be an indicator of investment in the production process.

The enlarged structure of the information model for ensuring the sustainability of transport can be represented by the following composition of elements:

- an element that collectively reflects the information support of a transport organization to ensure the operation of labor processes and the payment of the required and balanced amount of wages - information support for the wage intensity of transport services (Ise);
- an element that collectively reflects information support for the processes of meeting the needs of a transport organization for material resources, as well as providing for general economic processes that depend on the scale of the organization’s production activities - information support for material intensity (IMe);
- an element that collectively reflects information support for the needs of a transport organization in the costs of restoring production assets, as well as restoring the

passive part of fixed assets (buildings, structures, equipment, technological transport, etc.) - information support for depreciation (IAM);

– an element that collectively reflects the information support for the formation of conditions for compensation for the expanded reproduction of the enterprise's funds, the formation of the organization's profit factors, ensuring the investment component, ensuring the social function - information support for profit (IPR).

When forming information models in transport, it is necessary to take into account factors that appear in real time. Such models form an end-to-end information space, allow for the production and management of information tools, and build an effective decision support system in transport.

In the process of forming a decision support model, it is necessary to establish the function of the system of results obtained from information sources, the execution of decisions made, and also to evaluate their mutual influence. The information system and the need for it have a significant impact on the decision-making process.

4 Conslusion

The level of increasing practical use of big data in transport will make it possible to form situational management and flexibly respond to the dynamics of the transport market, and apply informed operational management decisions. The development of data processing infrastructure will make it possible to move from information systems that perform a passive function and information support for management to active, predictive management systems based on increasing the degree of use of available information and its verification. Solving such a problem requires creating conditions for targeted, practice-oriented data processing in transport, which requires the formation of information models of components and individual segments of transport systems, which would fundamentally provide the possibility of interfacing and key communication of data arising in different parts of transport systems, in including multimodal.

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References

1. Gölzer Philipp, Albrecht Fritzsche, Production Planning & Control **28(16)**, 1332-1343 (2017)
2. M.I. Malyshev, N.A. Filippova, Information technologies and innovations in transport, 62-68 (2020)
3. O.V. Susloparova, D.S. Modina, Innovative development of the economy: trends and prospects, 148-158 (2019)
4. T.E. Evtodieva, Transport and logistics of sustainable development of territories, business, state (growth drivers, trends and barriers), 126-129 (2023)
5. N.A. Zhuravleva, Journal of science, practice, economics, 19-22 (2019)
6. T.V. Chekushina, G.Kh. Shafeeva. *Innovative technologies in the construction and operation of pipeline transport* (Universum: technical sciences, 2023), pp. 36-38
7. A. Kirillova, Intelligent transport systems of Russia, 42-44 (2018)
8. Stroumpoulis Asterios, Evangelia Kopanaki, Sustainability **14(8)**, 30 (2022)
9. A.V. Dmitriev, Izvestia St. Petersburg State Economic University, 163-170 (2020)

10. N. Ivanova, Transport Business of Russia **1**, 71-75 (2020)
11. B.M. Lapidus, L.V. Lapidus, Bulletin of Moscow University. Series 6. Economics, 45-64 (2017)
12. Nilashi, Mehrbakhsh et al., Harvard Data Science Review **5(3)**, 26 (2023)
13. E.V. Tabachnikova, Economy of the North-West: problems and development prospects, 116-123 (2022)
14. I.L. Golyand, K.A. Mukhina, K.N. Zakharin, J.A. Hegai, Ensuring Sustainable Development of the Regional Passenger Transport Systems on the Basis of Economically Sound Tariffs for Transportation Services (a Case Study of Krasnoyarsk Krai), 462-465 (2017)