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STRUCTURAL PECULIARITIES OF INTELLIGENT TRANSPORT SYSTEMS DEVELOPMENT IN THE RUSSIAN FEDERATION

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Abstract. The analytical material presented in the paper and practice-oriented proposals make it possible to improve the quality (accuracy) of traffic flow monitoring in the conditions of the street-road network, taking into account the functioning of the federal ITS management system. The research field of the article also includes the prediction of the accident rate of individual road sections (street and road network) through the analysis of parameters covering such important factors as: weather conditions, type and condition of the road and control devices, seasonal variations of traffic intensity, speed of the traffic flow, individual vehicle, etc. Based on the methodological features of transport monitoring presented in this article, the principles of innovative big data tools using the resources and capabilities of the neural network are proposed. According to the researchers, such tools are effective, and their widespread use at all levels of the transport sphere is a near-term prospect, which requires organizational and managerial decisions.

The paper also presents a methodological analysis of the existing approaches to structuring of intelligent transport systems, which are key indicators (criteria) of qualitative and effective development of all spheres of the economy at the level of the Russian Federation.

Keywords: Intelligent transport systems, neural networks, road traffic monitoring, federal ITS network, organization of road traffic, OD matrix, machine learning.

СТРУКТУРНЫЕ ОСОБЕННОСТИ РАЗВИТИЯ ИНТЕЛЛЕКТУАЛЬНЫХ ТРАНСПОРТНЫХ СИСТЕМ В РОССИЙСКОЙ ФЕДЕРАЦИИ

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Аннотация. Представленный в статье аналитический материал и практико-ориентированные предложения позволяют повысить качество (точность) мониторинга транспортных потоков в условиях улично-дорожной сети с учетом функционирования федеральной системы управления ИТС. В область исследования статьи также входит прогнозирование аварийности отдельных участков дорог (улично-дорожной сети) посредством анализа параметров, охватывающих такие важные факторы, как: погодные условия, тип и состояние дороги и управляющих устройств, сезонные колебания интенсивности движения, скорости транспортного потока, отдельного транспортного средства и др. На основе представленных в данной статье методологических особенностей мониторинга транспорта предлагаются принципы работы инновационных инструментов больших данных с использованием ресурсов и возможностей нейронной сети. По мнению исследователей, такие инструменты эффективны, а их широкое использование на всех уровнях транспортной сферы является ближайшей перспективой, требующей организационно-управленческих решений.

В статье также представлен методологический анализ существующих подходов к структурированию интеллектуальных транспортных систем, которые являются ключевыми показателями (критериями) качественного и эффективного развития всех сфер экономики на уровне Российской Федерации.

Ключевые слова: Интеллектуальные транспортные системы, нейронные сети, мониторинг дорожного движения, федеральная сеть ИТС, организация дорожного движения, матрица OD, машинное обучение.

Introduction. Traffic monitoring, subject to the functioning of the intelligent transport system, within the street and road network has a number of methodological features that determine its structural differences from other hypothetical options for this type of survey. The movement of transport within the street and road network has a number of differences that complicate it relative to the movement on the road network of federal, regional and municipal roads. In addition, as confirmed by Federal Russian Statistic Agency data, it is necessary to note the demographic factor, which is expressed in the fact that 74.8 % of the population live in urban areas, which makes certain adjustments to the methodology of organization of road traffic monitoring [1]. Such percentage distribution of population of the country is expressed in a large load on the street and road network of cities and urban agglomerations. According to researchers, these factors directly affect the results of road traffic monitoring; they are expressed in high intensity of the flow, increased load on the road and a wide range of flow composition, etc. In addition, traffic within the city and agglomerations is associated with a large number of risks and problems, including road traffic accidents (RTA), which cause damage to all road users, which negatively affects the economic aspect of mobility (Zyryanov V. V., Semchugova E. Yu., Skrynnik A. M.) [2].

Main part. The modern stage of society development, the peculiarities of the implementation of economic models and mechanisms have a pronounced trend of "compression" of space, which is manifested in an increase in population concentration and, as a consequence, economic activity in urban agglomerations. In this regard, the level of development of transport infrastructure, in the context of urban agglomerations, has a high degree of influence on the economic component of the city. Thus, there is a problem, the solutions to which are in the synergistic plane, combining production and economic, socio-infrastructural and regulatory spheres of activity. In view of the identified problem, current trends, the relevance of road traffic monitoring of the street and road network in the functioning of intelligent transport systems (ITS) seems high [3].

One of the key tasks of this article is to analyze the existing data flows and the formation of proposals for structuring, streamlining and unification of information flows in the context of improving the use of software for transport monitoring, in conditions of the street and road network. In addition, in the process of ongoing research work, it is necessary to create such a hierarchy of modules within the software, which will be adapted to the current technological capabilities, the features of modern information systems of effective transport monitoring, as well as provide the possibility of integration with smart city systems. This paper proposes one of the possible options for the structure of data flows, which can be used to create a tool for monitoring traffic within the street and road network of the urban agglomeration. Using such an approach, will make it possible to analyze big data online and to monitor traffic and predict the possibility of traffic congestion and accidents.

However, it is necessary to take into account that, when working out the principles of creating such systems, it is necessary to be guided by regulations and agreements, which can be expressed both in mandatory requirements, and in pre-structured action plan for a particular area of activity. In this context, we are interested in a set of regulatory documents.

Now the regulatory base of the ITS sphere is under formation, it is reflected in the fact that the Federal Law "On the national ITS network" is at the projecting stage. Meanwhile, it should be noted that there are other regulatory documents, which may contain the requirements and description of ITS: Federal Law of November 08, 2007 No. 257-FZ "On Roads and Road Activities in the Russian Federation", Federal Law No. 149-FZ of July 27, 2006 "On Information, Information Technologies and Information

Security" [4], as well as Federal Law [5], as well as federal legislation in the field of critical information infrastructure security, personal data and technical regulation.

Standardization in the field of intelligent transport systems is represented by the following state national standards:

– GOST R 56829-2015 "Intelligent transport systems. Terms and definitions", date of introduction 2016-06-01 [6];

– GOST R 56294-2014 "Intelligent transport systems. Requirements for functional and physical architectures of intelligent transport systems" [7];

– GOST R ISO 14813-1-2011 "Intelligent transport systems. Scheme of architecture of intelligent transport systems" [8];

– GOST R ISO 17438-1-2017 "Intelligent transport systems. Indoor navigation for personal and vehicle ITS station" [9];

– Draft state standard "Intelligent transport systems. Information security. Reliability of data exchange between the infrastructure and the vehicle" [10].

Analysis of the implementation of the approved program documents and the regulatory framework allows us to assert that today the development and determination of common approaches and methods of working with ITS in the field of transport monitoring is taking place not only at the level of the Russian Federation, but also at the level of the Eurasian Economic Union (EAEU) [11]. This approach, in which all member states of the union implement a unified policy in the creation and operation of ITS, develop common rules of operation — plays a defining role in the current geopolitical and economic conditions. However, it should be noted that at the moment, due to the individual characteristics and interests of each of the EAEU member states, progress in the implementation of a common policy in the field of ITS is not equal [12].

This is reflected in the fact that there are certain differences in the levels of implementation of a unified policy in the field of ITS:

– A common understanding and definition of the term "ITS" has been developed only in the Russian Federation, the Republic of Belarus and Kazakhstan.

– Normative legal acts regulating the ITS sphere have been developed only in the Russian Federation, Kazakhstan, at the same time it should be noted that in the Republic of Belarus this stage of development is in the process of formation.

– The presence of a single coordinating body for the development and implementation of ITS in the member states of the Union. In this aspect the situation remains the same. In the Russian Federation, the Republic of Belarus and Kazakhstan these bodies have either been formed or are in the process of formation. It should be noted that in Belarus there is a coordinating body, the powers of which are limited only in terms of public roads. In Russia there is another feature, characterized by the fact that there are several bodies that can implement ITS policy, while in Kazakhstan this stage is 100 % implemented, as there is ITS RK.

– The organizational structure of ITS among the EAEU member states is implemented only in the Russian Federation and Kazakhstan, in the Republic of Belarus this stage is under development, while the integration of science in ITS is implemented only in the Russian Federation.

– Integration of the private sector has the highest degree of implementation among the member countries of the Union; the only state that has not yet implemented this stage is the Kyrgyz Republic.

– Standardization, a key aspect that allows developing a unified approach to this area at the country level, has been implemented only in the Russian Federation and the Republic of Kazakhstan.

Such aspects as the availability of the market of ITS services and communications, environmental safety, ITS for the needs of national security are either not implemented or are in the initial stages of implementation.

The above features of uneven development and experience in the implementation of ITS contribute to the formation, as well as the adjustment of the general trend of development and structuring of the Russian transport system, in particular, the sphere of ITS in the Russian Federation.

The analysis of the strategy for the development of the national transport system of Russia, shows that the implementation of the national ITS network project, which will be «a geographically distributed system consisting of interconnected elements of information and technological, organizational, methodological, personnel, legal and regulatory and technical nature", implies an enhanced geoinformation structuring, but the unification of data flows is not one of the directions of this network development [13].

Despite the fact that this approach in structuring the entire ITS network in the territory of the Russian Federation is holistic and legally supported, there is another approach proposed by the state company «Avtodor», involving the creation of the Federal ITS management system, which will include regional level systems, municipal level subsystems, data transmission network, data collection system, and security system, in accordance with GOST R 56294-2014 [14]. The federal ITS management system implies both geoinformation structuring and data unification, which makes this system more geoinformation-oriented.

Thus, transport monitoring, under conditions of both the national ITS network and the Federal ITS management system, taking into account the implementation within the street and road network, according to the researchers is not only an excellent tool for creating, adapting or changing the transport infrastructure, but also is a link between the authorities, responsible services authorized to perform control and supervisory actions in the transport sphere (State Inspectorate of Road Safety of the Ministry of Internal Affairs According to researchers, a large number of processes depend on the efficiency of these systems, for example, ensuring the daily pendulum migration (work – home – work, effective transportation of passengers of public transport, as well as cargo, within the boundaries of the agglomeration). In addition, a system providing accurate transport monitoring data for a single city, agglomeration or region would be useful for all stakeholders and authorized persons. Moreover, from the point of view of the business climate, the application of a unified approach will provide additional benefits in the form of improved quality of interaction, both at the B2C, B2B, and B2G levels. The unified parameters and structured interaction in the context of the received parameters will allow to design, develop and build other spheres within the agglomeration more effectively. In our opinion, the structuring and unification of data in the transport sphere should also affect the monitoring component. Such an approach to the strategy of transport development is based on a comprehensive analysis of the current state and problems of transport system development in close connection with the general directions and scope of socio-economic development of the country, as well as with global strategic trends in the economy.

The implementation of comprehensive access to accurate, standardized information, both for the authorities, responsible services and inspections authorized to carry out control and supervisory actions in the field of transport (State Inspectorate for Road Safety of the Ministry of Internal Affairs, Federal Service for Supervision of Transport), and for the public and the industrial complex is one of the key pillars of the current transport system, which should ensure the focus of all stakeholders' efforts when developing transport

An example of the implementation of such industry interaction can be the system of control of road funds (SCRF), implemented by the FAU "ROSDORNII". This software is more of a structured database to which all parties involved in road activities have access. In all sections of this system there is

a delineation of authority and functionality, but at the same time, within the road sector this system provides all parties with structured, unified information.

Thus, the task of implementing a unified IS that allows real-time automated monitoring of road traffic in urban agglomerations, with the condition of the possibility of coordination of interaction, has a high degree of relevance, which is confirmed by the need to develop the concept of implementation of intelligent transport systems in urban agglomerations.

When creating such information platforms, it is necessary to take into account certain criteria for structuring and filling the data, which will allow the user to have the opportunity to get the most complete and structured information for decision-making: the state and load of the street and road network (in real time), current data on the results of continuous monitoring of traffic. It should be noted that the data to be presented to the user should be unified, as well as have a low error margin, as it plays an important role when analyzing the main traffic parameters. Integration with the existing departmental information systems, as well as with the "smart city" systems, is one of the key aspects of the ITS system implementation in the agglomeration. At the same time, it is necessary to provide either full or partial access to the system data for all user groups (individuals, businesses and government agencies, etc.).

Application of actual programming tools in the field of transport, in particular transport monitoring in urban agglomerations, taking into account the application of neural networks and integration modules, which will allow establishing interaction at different levels of government and different business areas, implies the application of «smart city» principles. The application of such principles in the development of ITS of the city will make it possible to implement mechanisms for prompt collection, processing and provision of data, both for public authorities and other interested parties. Obtaining up-to-date and structured information will make it possible to make more effective, timely and complex decisions on the operation of city infrastructure facilities, as well as on the development of the agglomeration (city).

In the context of the current stage of transport system development, the relevance of the use of innovative programming tools increases, while the level of effectiveness of such tools is extremely high in the development of transport systems of urban agglomerations. In the context of the technical aspect of traffic monitoring it is necessary to ensure the efficient operation both from the standpoint of structuring and presentation of data through the interface and secure and reliable connection.

Conclusion. The approach presented in the work allows improving the efficiency of transport monitoring, predicting the accident rate of individual road sections through the analysis of parameters covering such important factors as: weather conditions, type and condition of the road and control devices, seasonal variations in traffic intensity, speed of the vehicle and individual vehicle. The speed of the system, provided by the unification and structured information flows, allows for effective and timely decisions aimed at reducing the time per trip, reducing the level of accidents, reducing the load on the road network.

In our opinion, improving the efficiency of the use of the street and road network and road safety using innovative techniques and programming tools is an integral part of the vector of transport infrastructure development. Continuous improvement of intelligent transport systems and the expansion of the list of functions implemented by them will reduce the risks arising in the process of road traffic to a minimum. With the increasing number of vehicles, people, the constant increase in the number of kilometers of street and road networks, federal, regional, inter-municipal, local public roads, with the ever-increasing amount of data, it is necessary to structure and analyze large amounts of data. Such circumstances imply the involvement of a large amount of computing power, as well as equipment that will allow the monitoring of road traffic, in order to assess the existing risks. Big data, neural networks,

machine learning — these programming tools allow optimizing both the load on the equipment, reducing the time of information processing, respectively, reducing costs and increasing the speed of public authorities. The use of modern tools of big data and machine learning is the toolkit that will need to be operated in the near future at the level of the entire transport sector.

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