

Perspectives of the implementation of intelligent transport systems in the Oryol urban agglomeration

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Abstract. In the presented work authors discuss and put under scrutiny perspectives of the implementation of intelligent transport systems (ITS) in urban agglomerations in the Russian Federation on the example of the Oryol urban agglomeration. The degree of readiness of the Oryol urban agglomeration for the implementation of intelligent transport systems was assessed by applying the following criteria: a) the state of traffic monitoring performance, b) the state of traffic management organization and road safety, c) the state of transport planning organization, d) the state of traffic administration, e) the degree of justification for the implementation (improvement) of ITS in the agglomeration, f) the level of development of ITS in the region, g) resource provision of ITS engineering systems.

1 Introduction

The society in its modern stage of development is characterized by the intention to apply information technologies in all spheres of life and economy. The transport sector, which in our country is characterized by constantly increasing motorization rate and rather slow pace of development of road infrastructure, is not an exception. The situation in big cities such as Moscow, St. Petersburg, Kazan, etc. where transport develops and ITS are being implemented may be regarded as fairly good. A slightly different state of things is observed in cities with a population of 300 to 500 thousand inhabitants. The main problem lies in the limited financial resources of these cities. [1, 2].

2 Material and methods

Within the framework of the federal project "System-wide measures for the development of road infrastructure" of the national project "Safe and High-Quality Roads", a target project "The implementation of the intelligent transport systems that provide the automation of

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traffic management processes in urban agglomerations and cities with a population of over 300 thousand inhabitants" is being carried out. [3]

The Oryol urban agglomeration, which includes the city of Oryol and the Oryol district, is in full compliance with the criteria of the federal project "System-wide measures for the development of road infrastructure" of the national project "Safe and High-Quality Roads", since the population of the city of Orel and the Oryol district, as of January 01, 2020, is 308838 and 68768 inhabitants respectively.

According to the Resolution of the Government of the Russian Federation of December 21, 2019 No. 1762 "On approval of the rules for the provision and distribution in 2020 - 2024 of interbudgetary transfers from the federal budget to the budgets of the federal subjects of the Russian Federation the implementation of intelligent transport systems providing the automation of traffic management processes in urban agglomerations and cities with a population of over 300 thousand inhabitants, within the framework of the federal project "System-wide measures for the development of road infrastructure" of the state programme of the Russian Federation "Development of the transport system", assessment of the readiness of regions for the implementation of ITS is performed according to several criteria. These are: a) the level of traffic monitoring works performance; b) the level of traffic management operations and road safety; c) the level of transport planning organization, d) the level of traffic administration, e) the degree of justification for the introduction / development of ITS in the agglomeration, f) the level of development of ITS in the region, g) resource provision of ITS engineering systems. [3]

3 Results and Discussion

A state-of-the-art intelligent transport system architecture comprising 9 mandatory modules and 13 mandatory subsystems, as well as 7 optional modules, and 22 optional subsystems is envisaged to be implemented in the Oryol urban agglomeration, as a part of the target project "The implementation of the intelligent transport systems that provide the automation of traffic management processes in urban agglomerations and cities with a population of over 300 thousand inhabitants". [4]

As a result of the analysis of the level of development of ITS of the Oryol urban agglomeration, it was discovered that on the territory of our region several ITS subsystems are implemented and have different levels of functioning, corresponding to the aforementioned reference architecture (Table 1).

Table 1. ITS subsystems implemented on the territory of the Oryol urban agglomeration

№	ITS subsystem	Level of functioning
		3
1	Road condition management subsystem	Ensures fast response of road maintenance services to deterioration of the operational parameters of the road surface
2	Subsystem for transport control and traffic rules compliance monitoring	Ensures data transfer to law enforcement agencies and ITS subsystems
3	Weather conditions monitoring subsystem	The subsystem operates in a predictive and forecasting mode
4	Subsystem for monitoring the condition of the road and road infrastructure	The subsystem is implemented and functions correctly
5	Subsystem for anti-icing maintenance management	The subsystem is implemented and functions correctly

End of Table 1

Nº	ITS subsystem	Level of functioning
1	2	3
6	Subsystem for dispatch control of road maintenance services	The subsystem is implemented and functions correctly
7	Subsystem for detection of dangerous goods	The subsystem is implemented and functions correctly

For the further development of the ITS of the Oryol urban agglomeration, a local project based on a step-by-step realization of the target project "The implementation of the intelligent transport systems that provide the automation of traffic management processes in urban agglomerations and cities with a population of over 300 thousand inhabitants" has been developed for the period 2020-2024. This local project envisages the creation of a "Unified Transport System Management Platform" (UTSMP), which plays a role of the main integration platform. Yet, it provides the analysis of data collected from all the existing internal subsystems as well as from other external information systems. Here it should be also mentioned that an important requirement for the implementation of the local project is the compliance of the physical and functional architecture of ITS of the Oryol urban agglomeration with the requirements of GOST R 56294-2014 "Intelligent transport systems. Requirements for the functional and physical architecture of intelligent transport systems ". [5, 6]

Assessment of the level of performance of traffic monitoring operations must be carried out in accordance with the Order of the Ministry of Transport of Russia dated April 18, 2019 No. 114 "On approval of the road traffic monitoring procedure". [7] Currently, there is no traffic monitoring system being implemented in the Oryol urban agglomeration. Hence, traffic-related data is not transmitted to the analytical transport regulation system (ATRS). As a consequence, the criterion characterizing the level of performance of traffic monitoring operations has a value of zero.

The level of traffic organization and safety is characterized by the list of indicators of the efficiency of traffic organization averaged over the urban agglomeration in accordance with the Decree of the Government of the Russian Federation of November 16, 2018 No. 1379 "On approval of the Procedure for determining and analyzing the main parameters of road traffic" [8]:

- average delay;
- time index;
- the level of service of road traffic in the urban agglomeration;
- congestion indicator for urban agglomeration roads;
- buffer index, averaged over the urban agglomeration;
- information on the number of traffic monitoring points and sections;
- information on the share of roads in the network of the urban agglomeration, which have the level of service corresponding to categories E and F.

Considering the fact that presently a traffic monitoring system is not implemented in the Oryol urban agglomeration, the information presented in Table 2 below is based on calculations obtained from a specially created transport model.

The average level of service of road traffic in the Oryol urban agglomeration may be regarded as sufficient (C category); nevertheless, 25% of all the roads and streets have critical level-of-service values and are attributed to categories E and F.

Table 2. Indicators characterizing the level of traffic organization and traffic safety in the Oryol urban agglomeration

Nº	Indicator	Indicator value
1	Average delay, hours/veh per day	0,02
2	Time index, units	1,17
3	Level of service of road traffic, %	C (53%) (with an average speed on the network equal to 31,8 km/h)
4	Congestion indicator, units	0,125
5	Buffer index, averaged over the urban agglomeration, units	0,17
6	Information on the number of traffic monitoring points and sections, units	25
7	Share of roads in the network of the urban agglomeration, which have the level of service corresponding to categories E and F, %	25
8	Number of deaths in road accidents, per 100000 inhabitants	8,21

In accordance with the "Methodological recommendations for the development of transport planning documents for the federal subjects of the Russian Federation", approved by the protocol from the meeting of the working group of the project committee on the national project "Safe and high-quality roads" on August 12, 2019 No. IA-63, transport planning documents for the urban agglomeration are the following ones:

- programmes for integrated development of transport infrastructure (PIDTI);
- integrated schemes of public transport services (ISPT);
- integrated traffic management schemes (ITMS).

The local ITS project of the Oryol urban agglomeration provides information on the currently existing transport planning documents in the urban agglomeration. There is no PIDTI developed for the entire agglomeration, but the city of Oryol, which constitutes 50% of the total number of municipalities, already has such a programme in place.

Integrated schemes of public transport services (ISPT) as well as integrated traffic management schemes (ITMS) for the Oryol urban agglomeration are not yet developed either. However, there are integrated traffic management schemes (ITMS) deployed in Oryol and Oryol district. Traffic management project (TMP) was conceived only the city of Oryol. Thus, we can conclude that the value of the criterion characterizing the level of transport planning of the Oryol urban agglomeration has a value of 50% in accordance with "Methods for assessing and ranking local projects in order to implement the intelligent transport systems that provide the automation of traffic management processes in urban agglomerations and cities with a population of over 300 thousand inhabitants within the framework of the federal project "System-wide measures for the development of road infrastructure" and the national project "Safe and High-Quality Roads" [9]. Transport planning documents of the Oryol urban agglomeration indicate a number of measures aimed at the development of ITS in the region. For instance, ITMS of the city of Oryol projects a creation of a wireless automated traffic management system (ATMS) as well as design and construction of the ATMS center, which characterizes the degree of justification for the introduction / development of ITS in the agglomeration. [10]

In the local ITS project of the Oryol urban agglomeration as the "Executive bodies authorized to manage traffic" indicated are the following entities:

- Department of construction, energy, housing, communal services, transport and road infrastructure of the Oryol region;
- Department of municipal services and transport of the Administration of the city of Oryol.

In particular, the Department of construction, energy, housing, communal services, transport and road infrastructure of the Oryol region is responsible for "road activities in relation to highways of regional and intermunicipal importance and the implementation of measures to ensure road safety on them, including the organization of the functioning of paid or free parking lots (parking spaces)". [11] The Department of municipal services and transport of the Administration of the city of Oryol in its turn holds responsibility over the "organization of road activities in relation to roads and streets of local importance within the boundaries of the urban district and ensuring road safety on them, including the creation and maintenance of parking lots (parking spaces)". [12] Thus, it can be noted that in the Oryol urban agglomeration there are two separate executive bodies authorized to manage traffic that differ in terms of territory allocation.

A significant drawback in the administration of road traffic in the Oryol urban agglomeration is the lack of regulations for interagency cooperation in the field of traffic organization and safety. [13]

Moreover, in the region there is no centralized controlling body in the field of traffic management. The only system that monitors traffic is "Automated recording of administrative offenses" (IS "ARAO"), which applies photo and video recording technologies. It is designed to collect, record, systematize, retrieve, aggregate, store and use data on administrative offenses related to the road traffic. [14-16]

IS "ARAO" is a distributed automated information system and it consists of 12 automated workstations (AWS) for preliminary information processing, one automated workstation for the ViPNet administrator, one automated workstation for transferring photo-video recording materials, and one server for photo-video recording based on the SuseLinux 12.3 operation system.

Logically, automated workstations are divided into 2 groups:

- AWP for automatic recording of administrative offenses related to violation of the speed limit (5 places);
- AWS for automatic recording of administrative offenses related to driving on a red traffic light (6 places).

The system of photo and video recording includes 92 stationary traffic control complexes located in the city of Oryol and in Oryol region, as well as the equipment of the photo and video recording center located on the territory of the Main Directorate for Traffic Safety in the Oryol region, which includes 12 automated workstations, 1 data processing server and other related equipment. All equipment operates correctly and is in good technical condition.

The 92 stationary traffic control complexes are represented by the following types:

- 87 stationary complexes APK "Potok-PDD";
- 4 stationary complexes "Strelka-ST";
- 1 stationary complex "Kordon"

Having regard to the guidelines from [9], resource provision of ITS engineering systems of the Oryol urban agglomeration is assessed according to the following criteria:

- presence of regional (municipal) data processing centers (DPC);
- presence of regional (municipal) central control points (CCP);
- availability of data transmission networks that meet the requirements of the ITS concept of urban agglomeration.

For the effective and proper functioning of the ITS of the Oryol urban agglomeration, it is necessary to create a regional data center, since at the moment it doesn't exist. It is also essential to put into operation a regional CCP.

The infrastructure of data transmission networks of the Oryol urban agglomeration, which meets the requirements of the ITS concept, is ensured by communication networks

of large federal telecom operators: PJSC Rostelecom, PJSC Megafon, PJSC MTS, PJSC Vymplekom, LLC T2 Mobile and a number of small regional and local telecom operators.

The domain architecture of the ITS of the Oryol urban agglomeration developed in a local project is aimed at dealing with the following tasks [17]:

- increasing the level of road safety, developing effective solutions in order to prevent road accidents and minimize the negative consequences of accidents that occurred;
- optimization of traffic conditions on the roads of the urban agglomeration to increase their throughput and reduce the risk of road accidents.

The implementation of ITS in the Oryol urban agglomeration is aimed at improving the management and safety of road traffic (Table 3).

Table 3. Estimated values of traffic management and road safety indicators in the Oryol urban agglomeration

№	Indicator	Years				
		2020	2021	2022	2023	2024
1	Average vehicle speed, km/h	33	36	39	42	45
2	Average delay, hours/veh per day	0,02	0,199	0,0197	0,0196	0,0194
3	Congestion indicator, units	0,125	0,123	0,12	0,118	0,116
4	Number of road accidents	427	350	300	250	200
5	Number of deaths in road accidents	31	20	15	10	5

4 Conclusion

To conclude, we can say that there is a number of ITS elements that are already implemented, however data processing center (DPC) and central control point (CCP) are not yet in place. The level of traffic management needs to be improved, as there are sections of the road network with a critical level of service. All this indicates on the need to develop the region's ITS within the framework and with a support of the national project "Safe and High-Quality Roads". As it was discussed above, the local project "Intelligent transport system of the Oryol urban agglomeration" was developed, presenting and elaborating the measures for the development of ITS in the region. This local project was highly appreciated by the commission responsible for ranking applications for the provision of interbudgetary transfers to the federal subjects of the Russian Federation for the implementation of intelligent transport systems that provide the automation of traffic management processes in urban agglomerations and cities with a population of over 300 thousand inhabitants within the framework of the bigger federal project "System-wide measures for the development of road infrastructure" of the state programme of the Russian Federation "Development of the Transport Systems". The commission included representatives of the Federal Road Agency "Rosavtodor" and the Federal State-owned Company "Roads of Russia". By the decision of this commission No. IK-4pr dated July 5, 2020, the application of the Oryol urban agglomeration took the seventh place in the rating of applications for the implementation of regional ITS.

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