RITM^3 as the Digital Platform for Traffic Management in Smart Cities

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Abstract. The paper reviews major problems of cities related to the management of transport flows; it looks at fundamental Russian legislative acts regulating the improvement of the urban transport management systems; briefly reviews information about the Adaptive Traffic Control Systems which are extensively used across the world cities and reflects on the capabilities of the Russian digital platform RITM^3 (Real time Integration Transport Measurements Modeling Management), which is the evolution of the TransInfo software developed by the St. Petersburg company SIMETRA (formerly "A+S Transproject"). Digital platform RITM^3 is designed for modeling traffic flows in cities and proactive traffic management in real time. The article also provides information about the experience of digital platform RITM^3 application in Moscow.

1 Introduction

Urbanization is one of the most important trends in the modern world. By 2050, the world's urban population is expected to grow by 2.5 billion, making up to 66% of the total world population [1]. If in 2015 there were 29 mega-cities in the world with population over 10 million people, it is expected that by 2030 there will be 12 more mega-cities [2].

In addition, there are challenges related to the transport connectivity between large urban areas in growing "polycentric megacities" [3], as well as between rural areas of developed and developing countries, given that the business activities are predominantly concentrated in urban areas [4], and interconnection between cities and suburban areas (in urban agglomerations).

Therefore, the development of modern cities, especially megacities and agglomerations, along with the benefits for population, bring various problems of economic, environmental, social and other areas. The overwhelming majority of problems of sustainable development of cities can be solved only by an integrated approach based on modern technologies. One of the most promising ways to achieve this is to apply the concept of "Smart City".

Within the framework of this concept, which is becoming increasingly popular, we can highlight the Smart Transport component, the purpose of which is to solve or at least mitigate problems related to the need of maintaining population mobility, finding the optimal balance between personal and public transport, between auto transport and other

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types of urban and suburban transport, reducing casualties from traffic accidents, reducing the negative impact on the environment, and so on.

Of course, solving problems requires overcoming various barriers to innovation. In particular, experts highlight the following types of barriers:

- technological barriers
- political and cultural barriers
- legal and institutional barriers
- financial barriers. [5]

As far as technological barriers are concerned, it can be said that this is the smallest "stumbling block", as the level of development of modern digital technologies makes it possible to assert that technologies have already become an integral part of any control system. A pressing objective in this area is the integration of various digital systems into a single space of decision-making support and real-time control, which will be discussed in more detail below.

Overcoming political and cultural barriers is a complex but achievable task. For instance, numbers of paid street parking areas and toll roads are growing across the world including Russia.

Legal and institutional barriers are largely understood and systematic work to improve transport management legislation is underway throughout the world, including Russia.

Consideration of financial barriers is not within the scope of this article. It should be noted though that there are ways to overcome them, and in Russia too, in particular, through the development of state-private partnership projects.

Modern methods of transport planning and automated or automatic traffic management are used more often in the cities for governance of transport and road traffic. This article will review the approaches towards resolving problems listed above and discuss available solutions including application of modern information and communication technologies for management of urban transport flows.

2 Methods

In this paper are used are used some government regulations of Russia, as well as contemporary scientific methodological literature related to the concepts of "sustainable development" (for example, [4], [6], "smart city" [7; 8 etc.], and are reviewed capabilities of computer aided systems for managing traffic flows in cities [9; 10, Chapter 6].

Data from the Federal State Statistics Service [11], other state organizations (General Administration for Traffic Safety, GIBDD) [12], data from analytical center of the Government of the Russian Federation [13] and other sources was used for producing this paper.

3 Results

3.1 Main Urban Problems in Russia

Russian experts estimate that inefficient and unsafe work of transport results in losses of up to 8-10% of the gross urban product of large cities and urban agglomerations annually. [10, Chapter 1.2. Problems of modern transport systems].

Inter alia, impact of the road transport on the environment and consequences of road accidents constitute the critical factors.

Road transport has a significant impact on the environmental pollution. This impact is felt by almost all residents of urban and rural settlements located along motorways. In

2008, road transport in Russia emitted more than 17 million tons of pollutants into atmosphere, which makes 46% of the total amount of emissions, including emission from the immobile sources [11]. At the same time, in recent years, the volume of emissions, and the share of road transport in pollution is only increasing.

Road traffic accident costs to society are also significant. Thus, in 2012 in Russia there were more than 200 thousand road traffic accidents, with almost 28 thousand dead and more than 250 thousand injured [12]. Road traffic accidents cause significant loss to the Russian economy amounting in recent years to about 2.5% of the gross domestic product of the country. [10, Chapter 1.2]

3.2 Government Regulations

The awareness of the necessity to improve transport management systems in Russian cities is recognized at the legislative level. For example, Federal Law No. 456-FZ of December 29, 2014 amended the Urban Planning Code to establish the requirements for development of Programmes of Integrated Development of Transport Infrastructure (PIDTIs) for settlements and urban districts. The regulation of PIDTIs was established a little later with the adoption of Decree of the Government of the Russian Federation No. 1440 of December 25, 2015. Also the Order of the Ministry of Transport of Russia No. 43 of March 17, 2015 " On Establishing Standards for Design of Road Traffic Projects and Traffic Circuits" regulating the development of relevant documents was approved.

The priority objective for Russia has been recognized as modernization of transport management system in agglomerations. The priority objective for Russia has been recognized as modernization of transport management system in agglomerations. This has been affirmed in the Priority Project "Safe and Quality Roads" (Project BQD, see [14]), which will be under implementation until 2025. The project involves 36 Russian agglomerations and has budget of 540 billion rubles.

The Russian standard "Smart City" was adopted in 2019. According to this standard, the major components of a Smart City are:

City government

1. Digital platform for involving citizens in solving urban development issues ("Active citizen").

2. The City Digital Twin.

3. Intelligent centre for urban management.

Smart Housing and Communal Services.

4. Implementation of smart metering of communal utilities.

5. Reduction of energy consumption by state and municipal organisations.

6. Computer aided systems for monitoring customers' requests and repairs of breakages and malfunctions .

7. Implementation of a digital model for the management of public utilities facilities.

8. Implementation of computer aided systems of building control: monitoring of noise, temperature, working order of lifts, fire safety systems and gas equipment .

9. Implementation systems for electronic voting in meetings of property owners.

Innovation for the urban environment

10. Energy- efficient urban lighting, including architectural and artistic highlighting.

11. Setting up automated control of road and communal equipment.

12. Implementation of a computer aided car sharing system.

13. Public Wi-Fi networks.

Smart urban transport

14. Implementation of automated photo and video registration of road traffic violations .

15. Creation of control system of city parking spaces.

16. Intelligent systems for management of public transport .

17. Intelligent traffic management systems.

18. Creating safe and comfortable spaces for awaiting public transport .

19. Implementation of control system of quality of roads.

Intelligent Public Safety Systems

20. Creation of intelligent video surveillance system.

21. Implementation of emergency warning systems for citizens 22. Intelligent management of fire safety systems in crowded areas.

Intelligent environmental safety systems

23. Automation of municipal solid waste management.

24. Online air quality control monitoring.

25. Online water quality monitoring system.

Communications network infrastructure

26. Creation of a unified urban infrastructure of communication networks.

Tourism and service

27. Electronic city maps for city residents and guests.

28. Creating complex information source for residents and guests of cities [15].

Among the items listed in the Standard a significant part (over one fifth) is unsurprisingly related to issues of transport, given the severity of problems associated with the management of urban transport.

3.3 Additional results: existing gaps in Russian definitions are identified

Despite the fact that the BQD priority project [14] is dedicated to the development of roads in agglomerations, there is no definition of the term "agglomeration" in the project passport itself. The paper [16] suggests the following definition of the term: "urban agglomeration is a territory with stable transport and cultural connections that dynamically changing depending on the level of development of a particular transport infrastructure".

The Russian standard "Smart City" [15] does not define the fundamental concept of "smart city". For the purposes of this paper the definition of the British standard PAS 180 is adopted. PAS 180 defines a smart city as the one where there is "effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens". [17]

3.4 Adaptive Traffic Control Systems

Upper level systems for Adaptive Traffic Control Systems are widely used in various countries in Europe, America and Asia. The most widely used in the world are:

- BALANCE (developed and maintained by the German company GEVAS Software, Germany), which is part of the PTV group),

- ITACA (Intelligent Traffic Area Control, University of Oviedo Spain),

- MOTION (Method for the Optimization of Traffic Signals In On-line Controlled Networks, implemented in Siemens SITRAFFIC product, Germany),

- OPAC (Optimized Policies for Adaptive Control, University of Massachusetts, USA),

- RHODES (Real-time Hierarchical Optimizing Distributed Effective System, University of Arizona, USA),

- SCOOT (Split Cycle Offset Optimization Technique), developed by the British research bureau TRRL, then implemented by Imtech Traffic & Infra (Gauda, Netherlands) and Siemens (Berlin and Munich, Germany),

- SCATS (Sydney Coordinated Adaptive Traffic System, developed by the Road and Traffic Authority of New South Wales, Australia),

- UTOPIA (Urban Traffic Optimization by Integrated Automation, developed by MIZAR (Turin, Italy), currently part of SWARCO Italy).

Most of these systems were developed back in the late 20th century, but have been modified and are still used in many cities around the world to this day. These systems include various functionalities and differ in terms of parameters such as traffic flow modeling capabilities, real-time traffic management approach (reactive or proactive) and other characteristics.

The notion "modeling" refers to the use of macroscopic, mesoscopic and microscopic models to assess traffic conditions, which are then used as input data to adjust the time signals. [9; 10, Chapter 6] for modeling traffic flows.

For modeling of transport flows models and algorithms from software products of PTV Group, Germany are usually applied.

Starting from the early 10s of the twenty-first century the Russian digital platform RITM3, compatible with software products PTV and with functionality for both traffic modeling and adaptive traffic management, is utilized.

3.5 Russian digital platforms RITM^3 - Real time Integration Transport Measurements Modeling Management

In Russia in 2012 St. Petersburg company "A+S Transproject" (currently - SIMETRA) developed a static multimodal transport model of Moscow and Moscow region. This model was handed over to the Department of Transport and Road Infrastructure Development as a tool to assist in making decisions related to management of urban transport complex.

Later, based on the static transport model and live stream of data on traffic situations and road users obtained from different sources (telematic data, transport detectors data, data on repair works and other events), a dynamic transport model of Moscow transport hub, able to forecast a 45 minutes time horizon transport situation was developed.

For managing transport flows a special domestic software and an integrated digital platform for managing traffic in megapolises TransInfo were developed for application by the Traffic Organization Centers (TOC), Transport Planning Centers and dispatcher services of Moscow [18].

At present the second generation of this software is utilized – a digital platform RITM^3 (RITM^3: Solutions in transport sector. Monitoring. Planning. Management. https://ritm3.ru/en), which is the set of tool for creating and using ITMS (Integrated Traffic Management Scheme) and PIDTI (Programs of Integrated Development of Transport Infrastructure) for Russian cities and cities of other countries.

RITM^3 is a fully-fledged digital platform, which applies cartographic and GIS-technologies for modeling transport network and issuing recommendations within the framework of ITMS (Integrated Traffic Management Scheme). In addition to GIS and ITMS-online, the RITM^3 system includes other modules and solutions, such as "Situation Center", "Monitoring and dispatching", "Modeling of transport flows", as well as individual solutions for measuring traffic density and monitoring traffic routes and stops.

The digital platform makes extensive use of visualization tools (see, illustration below).

Fig. 1. Example of data visualization in the form of cartograms, graphs and charts, Source:
https://apluss.ru/news/modul_ksodd_onlayn_ritm3__tsifrovoy_plan_razvitiya_transportnoy_infrastru
ktury_goroda_ili_regiona

The projects for developing ITMS based on the RITM[3] system are implemented not only in Moscow, but also in Orenburg, Grozny, Chelyabinsk and Almaty, the capital of Kazakhstan.

3.6 Results of using RITM[3]

The experience of using RITM[3] in the Russian capital is the most indicative. As a result, Moscow has achieved an increase in average speed and a decrease in the level of traffic accidents. The results of 2015 demonstrated an increase in average speed (by 12%) with a decrease in the level of accidents (by 30%) and mortality (by 25%) in Moscow, and in 2016 Moscow was awarded the international award ITF Transport Awards in the category "For special achievements in transport". The jury members noted the improvement of the road situation in the Russian capital and a comprehensive approach to solving problems.

In 2017, the information-analytical system for managing the transport complex, developed on the basis of the digital platform RITM[3], was recognized as "The best information-analytical solution for a "smart city" in the competition "The best information-analytical tools in 2017", which was organized by experts of the Analytical Center under the Government of the Russian Federation [13].

The RITM[3] digital platform is used by the Center for Road Traffic Organization of the Moscow Government and for the duration of several years of being in operation the platform demonstrated its effectiveness as the main tool for managing the city transport system. In particular, it is RITM[3] that makes it possible to manage the traffic flows of a megapolises in real time using a dynamic transport model.

The dynamic transport model allows for the calculation and visualization of short-term forecasts of the transport situation (up to 45 minutes) based on several "what if..."

scenarios. The results of such modeling make it possible to foresee the consequences of decisions that may negatively affect transport situations and significantly improve the quality of decisions for optimizing the loading of the roads with traffic flows.

4 Discussion and Conclusion

It seems that it is RITM[3] that allows to combine the existing systems of the city into a single digital space for effective management of the urban transport system in an ever-changing transport situation and create a "digital doppelganger" of the city transport system.

The use of the Russian digital platform for the Russian agglomerations and other cities, as well as for cities from the former Soviet republics, in particular, Kazakhstan, Belarus, Moldova, will make it possible to carry out real import substitution and to create "smart transport" systems within the framework of "smart city" concept.

The conclusion can be made that yet another technological barrier for creating a digital economy in the area of transport management has been overcome in principle. At present, not so much technical, financial or social obstacles come to the fore, but problems of organizational and personnel support character.

For improving functioning of transport systems in cities it is necessary to solve a number of complex tasks, which primarily concern the organization of interaction between different stakeholders (developers, public authorities, investors, population, etc.) during goal setting and planning of projects for developing of transport infrastructure and traffic flow management.

Another important issue is to train transport planning specialists to utilize modern methods and tools of modeling and management in their work.

Although the conditions for solving these tasks in Russia are not as favourable as in the countries which embarked on the path of improving transport systems in cities earlier, nevertheless, through joint efforts of various stakeholders in Russia these objectives are gradually moving from the stage of discussion to the stage of solution.

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