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Urban Transportation Systems in Large Cities: Issues of Efficiency

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ABSTRACT

Yu. V. Trofimenko, M. R. Yakimov. Monograph «Transport planning: formation of efficient transport systems of large cities». 2nd ed., rev. and enl. Perm, RADAR agency, 2022, 536 p. ISBN 978-5-6048401-0-8.

The article is a review of the monograph «Transport planning: formation of efficient transport systems in large cities», prepared by well-known Russian transport scientists Yu. V. Trofimenko and M. R. Yakimov. The monograph summarises and systematises extensive material on topical problems of functioning of the transport systems of large cities. The book also reflects modern approaches to transport planning and organisation of traffic in cities, methods for assessing quality of functioning of urban transport systems, issues of modelling and optimising design solutions for organising transport services for the population, as well as modern approaches to building transport management systems in territorial entities.

Keywords: urban transport, transportation system, transport planning, modelling of transport flows, efficiency of urban transport systems.

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The full text of the review article in Russian is published in the first part of the issue.
Полный текст статьи-рецензии на русском языке публикуется в первой части данного выпуска.

The issues of theory and practice of planning the transport systems of large cities became relevant long before the start of the period of rapid motorisation. By the second half of the last century, several scientific schools on organisation of urban transport systems had been formed in the Soviet Union. Prominent representatives of these schools (for example, G. A. Golts [1], V. N. Obraztsov [4], A. A. Polyakov [6], D. S. Samoilov [7], V. V. Silyanov [8], M. S. Fishelson [10], etc.) were known far beyond national borders, and their conceptual approaches and methodological developments were widely recognised in the world scientific community and were used in planning the transport of modern megacities that were emerging at that time.

Today, in the conditions of intensive motorisation and the rapid growth in the size and number of cities, the relevance of research on modern problems of development of transport systems of various territorial socio-economic entities and development of innovative planning solutions for them increases significantly [3, 9–15]. Efficient, reliable and safe functioning of urban transport systems is one of the main conditions for sustainable development, formation of a comfortable and safe environment for the prosperous life of citizens. Therefore, the monograph under review, dedicated to creation of such conditions, is very relevant.

It is worth noting that the monograph is reprinted for the second time, although such seriality is not typical for scientific works. However, modern transport systems are so unstable in their development that actualisation of theoretical concepts and methodological tools is justified for this area, taking into account industry transformations. The preface to the second edition states that in recent years there have been significant «changes in the field of transport planning, transport construction, organisation and management of traffic». Therefore, the authors decided to update the original edition. The work identifies five key tasks, the consistent solution of which ensures development of relevant and reasonable measures to improve the overall efficiency of the transport system of a large city:

1) Formation of approaches and methods for analysing the functioning of urban transport systems in general and in individual territories.

2) Development of a system for monitoring the state and modes of operation of the city's transport system.

3) Creation of a system for predicting the state of functioning of the city's transport system in space and time. Analysis of the efficiency of functioning of urban transport systems.

4) Creation of tools for development and selection of measures for formation of an effective transport system of the city.

5) Development of principles for managing the city's transport system under the current restrictions.

The totality of these decisions forms a new methodological approach of development of the transport system of a large city, which focuses on qualitative efficiency criteria. With the traditional approach, the problems of the efficiency of functioning of transport systems of various taxonomic levels are solved at the expense of infrastructural support. Therefore, the expectations of users and the topics of many researchers often focus on creation and development of road transport and service infrastructure. According to the authors, new and improved road transport infrastructure facilities in the future will still be filled with vehicles of both personal owners and commercial carriers, and traffic conditions on the road network of cities, despite significant infrastructure costs, will still not receive quality improvement. The paper notes that building up infrastructure does not solve the problem of road congestion, and increasing network capacity is unable to eliminate congestion, since a private car will always be more preferable than public transport. The authors see a way out of this situation in the use of «effective tools for developing effective management decisions in order to improve the quality of life in cities».

The low expected socio-economic efficiency from implementation of projects for development of the road transport infrastructure of cities is often due to simplified forecasts of the transport behaviour of numerous participants in everyday mobility (users of public transport, owners of personal vehicles, subjects of commercial transport activities), which create the main load on the urban road network and route lines of all types of public transport. It is not yet possible to achieve a high quality of forecasts for distribution of transport flows for the purposes of infrastructure planning due to the complexity of the facility. Millions of residents of large cities travel every day with personal or public transport. Moreover, each transport user tries to choose the best option for all his trips, taking into account numerous factors and features. The totality of millions of locally optimal solutions cannot provide the best option for operation of the transport system, since there are no universal means yet to influence the choice of travel parameters for each and every individual road user.

In the theory of transport systems, two conceptual approaches are used to assess distribution of transport flows over the road network: descriptive and normative (e. g.: [2, 5, 9]). With a descriptive distribution, transport flows freely between sections of the road network until a balance is reached according to the established optimisation criteria (usually the average speed). Therefore, if a new road appears in the city or the old one is improved, which will allow traffic participants to improve their performance (get to the right place faster), then flows from adjacent segments will flow to such sections of the network. Such dynamics will continue until free resources of new sites are exhausted. Such phenomena are often observed in large cities during rush hours, when information about traffic jams and possible ways to avoid them (for example, from navigation systems) becomes available to car drivers, they begin to massively change travel routes, which ultimately leads to traffic jams at the sections of the bypass route. The normative distribution of the transport flow is characterised by a clear coordination of the actions of all traffic participants from a single control center (for example, organisation of traffic on the railway network). Transport systems with normative distribution (management) are more stable, but their management requires significant resources to ensure continuous coordination of flows based on information from all traffic participants about the parameters of their planned trips (volumes, timing, directions). Therefore, development of progressive ways to improve the efficiency of functioning of transport systems of large cities through organisational

and managerial rather than infrastructural solutions is an important area of modern research.

According to the established tradition, the authors begin their research with terminological generalisations in the subject area. Interpretations of many terms, such as «transport flow intensity», «capacity», «transport correspondence», «transport system stability» and others, are given in the usual sense. At the same time, the paper presents several concepts, the content characteristics of which attract attention. For example, two terms similar in semantics are given – «means of transportation» and «vehicles». According to the authors, means of transportation are «moving and immovable objects combined into technical systems by means of transport (transport systems)». At the same time, the composition of such objects is not explicitly disclosed. At the same time, according to the authors vehicles are «mobile means of transportation designed to move passengers, cargo and equipment in space». Since the paper does not divide means of transportation into mobile and fixed or other means, but only states that such means consist of movable and fixed objects, here readers may have a logical question whether vehicles are an integral part of «means of transportation» or is it a variation of them. A similar situation is typical for the concept of «transport infrastructure», under which the authors propose to consider fixed means of transportation that ensure functioning of various transport systems. In other words, the above definitions of the terms «means of transportation», «vehicles» and «transport infrastructure» do not allow establishing an exhaustive list of objects included in the category «means of transportation».

The proposal of the authors to consider the terms «systems of transport» and «transport systems» as different system categories is also noteworthy. Moreover, the content of the term «transport system» is innovative to a certain extent – «a natural and technical system formed as a result of meeting human transport needs, includes means of transportation, transportation facilities, and the environment». Among other things, this definition contains a thesis that, in our opinion, underestimates the active purposeful and creative role of society in creation of such natural and technical formations. There are also a number of debatable terms and their definitions in the work. However, we believe that it will be interesting for readers to consider the definitions proposed by the authors and compare them with definitions of similar terms from other sources.

The undoubted advantage of the monograph is the given extensive review of scientific research on a wide range of issues of organisation and functioning of urban transport systems. In particular, the authors described the content of the works of many domestic and foreign researchers on the problems of urban transport planning, designing the road network, determining the technical parameters of main roads, managing transport flows, mathematical modelling of transport flows, forecasting the transport demand of the population, etc. The work contains numerous information about historical aspects of development of urban transport systems, the influence of mentality, culture and traditions of individual peoples on planning decisions and configuration of transport networks of settlements. For obvious reasons, generalising such a body of scientific knowledge is not easy. Therefore, some review information has the character of metadata, rather than productive scientific criticism, the results of which are always of value for setting new scientific problems and improving methodological approaches.

An important research part of the work is devoted to methods and technologies for the analysis of urban areas in the context of peculiarities of formation of transport demand. Based on the study of the nature of land use and development of urban areas by objects of origin and absorption of trips with transport, the authors substantiated methods for estimating the volume and other characteristics of the population's transport mobility and distribution of traffic in interdistrict communications, taking into account the configuration of the road network. Studies on the main regularities of formation of transport flows are supplemented by examples of functioning of the transport systems of cities that faced the problems of rapid motorisation much earlier than large Russian cities.

On the basis of a significant amount of collected and analysed theoretical and factual materials, the authors involuntarily set themselves research tasks that are quite broad in scope, which might be narrowed without prejudice to the goals of the work. For example, in the section devoted to modelling the transport systems of cities, the authors note that their study was not focused on modelling all system objects in general, but only on aspects of the impact of urban road networks on the efficiency of movement. As a target indicator of functioning of the transport system, the minimum weighted average time for implementation of an origin-destination trip by all traffic participants was determined, taking into account the average speed and distance of the trip by all modes of transport, while meeting the restrictions on consumed resources, transport supply and demand. The optimal solution obtained in this way is, in essence, one of the options (according to the proposed criterion, the best one) for distribution of population movements along the road network. At the same time, we allow for a reasonable question, how such a distribution of passengers and transport (which in essence tends to be reduced to a normative, prescribed distribution) can be implemented in practice. As noted above, this will require the use of proven means of regulating user preferences for the choice of mode of travelling, while such tools are only being developed. Among these tools is the technology of organising the service «mobility as a service». However, the potential of this technology in regulating the travel of the population in large cities has not yet been fully explored. As noted above, if planned distribution of flows over the network is not accompanied by control actions (normative distribution), then the efficiency of infrastructure projects will decrease. Therefore, in practice, situations are often observed when individual design solutions are finalised, so to speak, «in manual mode», after commissioning of infrastructure facilities and analysis of the actual distribution of flows.

The final section of the monograph provides guidelines for development of new approaches and principles for managing the transport systems of large cities under the current restrictions. These recommendations are based on the authors' model of the transport system of a large city (discussed above) as part of the road transport complex,

road users and the environment. The authors divided the complex of problems of development and management of such complex natural and technical system formations into objective and subjective ones. Objective problems include changes in motorisation of the population, labour productivity, origin-destination routes of the population of cities, road construction, etc. Subjective problems include imperfection of the system for organising and managing development of the road transport complex, the insufficient legislative framework in the field of managing the transport system of the city, and the insufficient information management decisions, shortcomings in financing development of means of organising and managing traffic, etc. The approach is of large interest and can be further developed by revealing in more detail the features of application of this classification in the concept of managing the transport system of a large city proposed by the authors. Based on the analysis of the features of legislative and legal regulation of various aspects of transport systems management, the authors proposed the concept of distribution of powers in the field of urban management, presented options for building such a management system.

In general, the monograph is a complete scientific work, in which, without loss of generality, the city, its territory and the transport system functioning on it, are considered from the standpoint of the impact on quality of life of citisens. The monograph attempts to link the characteristics of quality of life of the population with the level of development of urban transport systems, and on this basis original tools for development and adoption of managerial decisions in this area are proposed. In general, the monograph «Transport planning: formation of efficient transport systems in large cities» is characterised by scientific novelty and practical value. Like any creative work, the monograph cannot be deprived of constructive criticism. However, all the above remarks are of a debatable nature, since they relate to completely new authors' approaches of improving the efficiency of the transport systems of large cities. Therefore, familiarisation with the monograph of a wide range of readers will contribute to a constructive discussion in the professional community of urgent problems in development of transport systems in large cities and development of innovative solutions to improve the efficiency of transport services for the urban population.

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