PROSPECTS OF INTERMODAL TRANSPORT SERVICE SYSTEM

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ABSTRACT

The article is devoted to the problems of development of intermodal transport system of large cities and agglomerations. The results of surveys regarding evaluation and identification of the prospects of transport service are presented. The model of the developed system allows to visually show the state of the urban transport network. Approbation of the proposed model in Moscow agglomeration makes it possible to assess the existing and develop a promising program for development of passenger intermodal transport, which corresponds to the modern quality of transport services for the population of the metropolis.

Keywords: intermodal transport system, metropolis, passenger transport, individual transport, transport and transfer hub, «intercepting» parking.

Background. *Evolutionary development of cities and their transformation into an agglomeration is associated with the process of complicating transport links on their territory, which entails unavoidable changes in the organization of the public transportation system. Modern urban trends determine the high level of requirements imposed both on coherence of urban areas and on the quality of transport services for passengers. Scientific researches in the field of planning of transport systems of urbanized territories are directed from this point of view to find solutions concerning adapting existing methods of transport services to certain urban development conditions, which goal is to ensure its qualitative development [1].*

One of the most promising areas of scientific research is the process of developing a city intermodal system as a qualitatively new stage in the organization of transport services for the population. The term intermodal means such a system in which the coordinated work of all modes of transport is realized, which guarantees the minimum difficulty of making a combined trip for inhabitants of the metropolitan area [2]. Moreover, when planning such a system, it is necessary to have clear ideas about the nature of the interrelationships between the mobility of the population and the capabilities of the existing transport system in order to avoid unreasonable decisions on its development. In this aspect, the intermodal system has a great potential in comparison with the unimodal one.

Objective. *The objective of the authors is to consider prospects of intermodal transport service system.*

Methods. *The author uses general scientific methods, comparative analysis, analytical method.*

Results. *The international term «intermodality» is widely used in planning transport services for large cities and agglomerations. Priority tasks of transport planning are not only the development of transport infrastructure that provides the possibility of carrying out combined trips of the population, but also the formation of consumer loyalty to trips of this kind. Part of the policy of access control to the main street network, which is actively used in the US [3], is the development of a system of «intercept» parking facilities, formed along the lines of high-speed passenger transport. Thus, car owners are provided with an alternative in the form of intermodal transportation such as «personal car – passenger transport», making a one-model trip on a private car. This practice is also being implemented in the major cities of Europe. The systems of «intercepting» parking are efficiently operating in the world's largest capitals and cities – Munich, Stockholm, Amsterdam, Paris, Madrid, Brussels, many others [4, 5]. The combination of several modes of transport in one trip is widely developed in urbanized areas, the transport framework of which constitutes one or several types of high-speed transport modes – high-speed bus lines (Curitiba, Brazil), urban and regional railway (for example, the lands of Germany), underground or systems of light rail transport existing in most world capitals. Japan has an advanced experience in the design of passenger transport transit hub, presenting examples of high-quality public spaces organized at the intersection of various modes of transport [6].*

Analysis of foreign sources of scientific research shows that special attention is paid to the development of effective intermodal transport systems that meet the requirements of the modern concept of sustainable development [7]. The main goal of the development is the search for a theoretical basis for making practical design decisions, based on the application of methods of system analysis [8], as well as mathematical and computer modeling. The development of methods for estimating and forecasting various parameters that determine the work of individual elements of the intermodal system determines its correspondence with the principle of the trinity of the concept of sustainable development of urbanized territories:

– development of the social sphere of transport services for the population, aimed not only at meeting the demand for transport services, but also ensuring their quality for various groups of the population. One of the most promising areas is the formation of an inclusive public environment [9];

– the solution of environmental issues related to the preservation of the environment and the reduction of the technogenic impact on the environment [10];

– the influence of the development of the transport system on the economic development of the city as a consequence of improving the conditions of population mobility and access to its territories [8].

Based on the analysis of existing experiences, we formulate the main tasks of forming an intermodal transport service system:

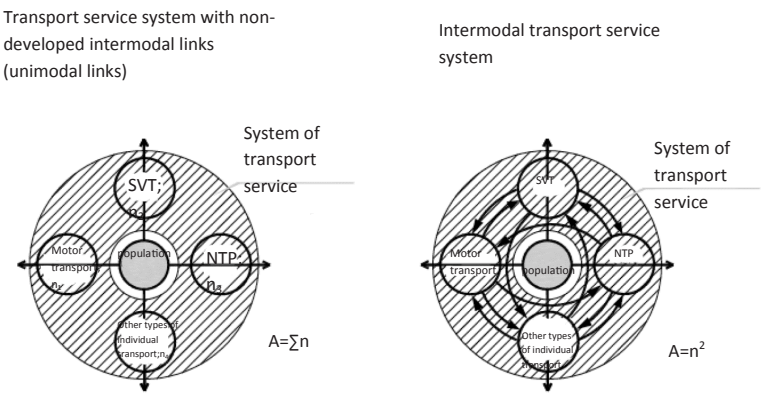
- *achievement of high quality of the proposed transport services in accordance with world standards;*
- *ensuring the required level of urban mobility by meeting the population's demand for transport services;*
- *sustainable development of the transport system and urbanized areas.*

Pic. 1 presents graphical models of unimodal and intermodal transport service systems obtained on the basis of a system analysis of the state of existing

Table 1

Summary table of internetwork communication links in the intermodal transport service system

Communication link	TIH elements	Requirements to the planning decision [17–19]
«district – SVT» «district – NPT»	fronts of embarkation – disembarkation; pedestrian crossings; cash desks; halls and zones of active waiting; passive waiting zones; distribution level; technological premises.	Shortest and free approach to stations and stopping points; Design parameters of pedestrian communications; observance of visibility conditions and barrier-free approach; Recommendations on landscaping and architectural and planning decisions of the zone of influence of the station; Information support; Requirements for an inclusive environment.
«SVT – NPT» «NPT – SVT»		Interchange by the shortest distance not more than 150 m; Measures to protect against atmospheric precipitation; Information support; Requirements for an inclusive environment.
«district – motor transport» «district – non-motorized (other) transport»	not carried out in TIH	–
«Motor transport – SVT» / «Motor transport – NTP» / «SVT – motor transport» / «NTP – motor transport»	«Interception» parking; pedestrian communications; cash desks / related services	Planning and organizational measures to minimize the time for approaching the parking lot; Information Support; The shortest distance from the entrance to the station of passenger transport is not more than 300 m; Planning activities to ensure the safety of parking and movement of pedestrians on its territory; Recommendations for improvement, visual inclusion in the image of TIH; Measures to reduce the impact on the environment; Requirements for an inclusive environment
«Non-motorized transport – SVT»/ «Non-motorized transport – NTP»/ «SVT –non-motorized transport»/ «NTP –non-motorized transport» «non-motorized transport – motor transport»/ «non-motorized transport – motor transport»	«Interception» parking; pedestrian communications; cash desks / related services	Safety requirements for approaching the parking lot; Allocated parking spaces, storage devices; Information Support; Measures to ensure the safety of parking and the movement of pedestrians through its territory.



Pic. 1. Variants of organization of transport services for the population.

Table 2

Summary table of intra-network communication links in the intermodal transport service system

Intra-network communication link	TIH elements	Requirements to the planning solution [17–19]
«SVT – SVT» «NPT – NPT»	Pedestrian crossings; Protection against atmospheric precipitation; Cash desks, waiting areas, information support; Technological premises; Passive waiting zones.	Interchange by the shortest distance not more than 150 m; Information Support; Measures to protect against atmospheric precipitation; Information Support; Requirements for an inclusive environment.
«Motor transport – motor transport»	«Interception» parking, Parking areas of commercial vehicles; Embarkation / disembarkation zone, Pedestrian communications	Planning solution of the zone for carrying out an interchange between cars; Information Support.

transport systems [11]. Models differ in the number of passenger connections that can be used by the population to travel. The number of links in the organization of the intermodal system increases in proportion to the square of the number of modes of transport that make up the system. At the same time, the goal is to reflect the complexity of the interconnections in a similar organization of transport services.

The combination of two links and more is a way of making an intermodal travel with the possibility of an organized transfer from one mode of transport to another. The junction point in which the interaction of various modes of transport and the population occurs is the transport interchange hub [11].

Currently, Moscow is implementing programs to build TIH both in the city and in Moscow region [12]. Intensive land development of Moscow agglomeration stimulates the corresponding development of the transport service system.

One of the main prerequisites determining the need for development of an intermodal system is defined by the existing parameters of labor migration of the population, the length and duration of which stimulate the population to search for the most optimal ways of making combined trips in terms of time and money. According to research, the length of labor pendulum trips from the Moscow region to the urban core is about 30 km, and 14.5 km is the average length of travel around Moscow [13].

The expected effect of the formation of an intermodal system on the territory of the Moscow agglomeration should provide [12, 14, 15]:

– normative accessibility of territories, ranging from 40 minutes for the territory of Moscow to 2 hours for the peripheral areas of the Moscow agglomeration;

– reduction of the load on the street-road network due to the formation of consumer loyalty among car owners for the use of passenger transport in the formation of a system of «intercepting» parking;

– improvement of conditions of transportation in passenger transport and optimization of their work during integration into a single transport system;

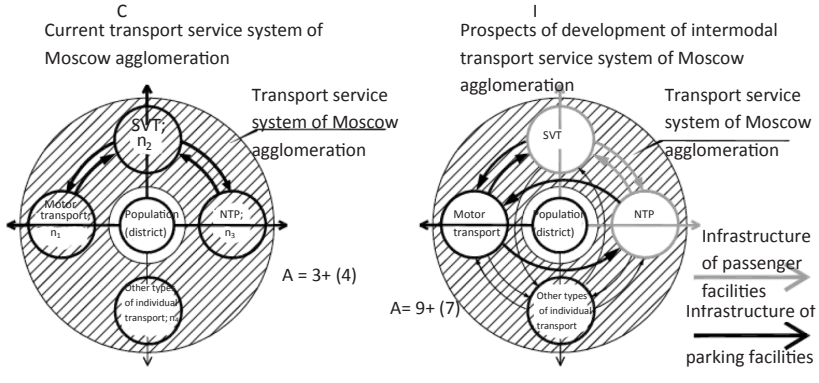
– development of territories located in the zone of pedestrian access from interchange stations – implementation of the principles of «Transit oriented development» [11];

– improvement of transport services for «problematic» areas, including the «New Moscow» district;

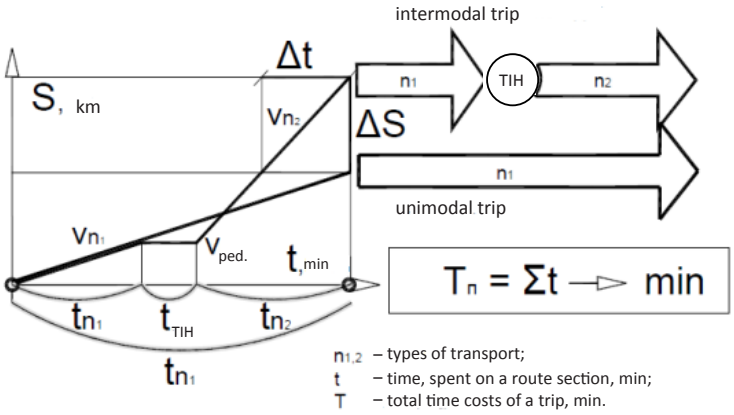
– improvement of transport links between Moscow and Moscow region for the purpose of joint social and economic development.

Thus, using the potential of the intermodal system to provide transport services to remote areas from the city center is becoming one of the main tasks of sustainable development of urbanized territories.

The existing state of the unified transport system in Moscow and the region is described by model C in Pic. 2. It is a transition state from a unimodal to an intermodal system, but with insufficiently developed connections between different modes of transport. The most well-formed are the connections between ground and extra-modal modes of transport – interchange between them, as well as an intranet interchange, is the most intensive in terms of passenger traffic, but often does not meet the requirements for the quality level of the transport infrastructure. At the stage of



Pic. 2. The system of transport services of the Moscow agglomeration: C – existing state; I – prospects for development.



Pic. 3. Advantages of developing an intermodal system for the territory of the Moscow agglomeration.

formation, there is a system of «intercepting» parking facilities that provide communications of individual transport with passenger types. Other types of motorized and non-motorized individual transport (motorcycle and bicycle transport), which share in urban mobility tend to grow, are shown as a separate block in the scheme, especially in the warm season.

In general terms, the formula describing the existing situation looks like this: four main types of unimodal links and four inter-species intermodal links that are under development.

Prospects for development of the intermodal transport service system of Moscow agglomeration are determined by the model I (Pic. 2), which includes four types of transport: ground (NTP) and passenger rapid transit (SVT), individual private and commercial vehicles, as well as seasonal motorized and non-motorized types (mopeds, bicycles, scooters, etc.). Their interaction on the territory of TIH should be ensured by the presence of an appropriate infrastructure [16], connected in a single whole by pedestrian communications:

• infrastructure of passenger transport is represented by equipped embarkation – disembarkation fronts, distribution level with accommodation of transport and related services, waiting rooms, cash offices, technological premises;

• infrastructure of parking facilities is represented by parking lots of various types with the parking spaces provided for each of the modes of transport, including bicycle parking, parking for moto transport, places for storage of small non-motorized vehicles; its role is played by «intercepting» parking lots, short-term parking, parking lots for embarking and disembarking of passengers, commercial and municipal parking for public needs.

Table 1 is a summary table of communication links that provide the conditions for interchange and TIH elements necessary for its implementation, as well as key planning requirements for its quality.

In general, the formula for a prospective transport service system can be presented as nine basic links between modes of transport, which account for the largest passenger load. The transport infrastructure providing the functioning of these links is the core of TIH. There are also five links of less developed, seasonal types of individual transport, the infrastructure for which should also be placed in the structure of TIH in the form of separate elements.

Besides, it is necessary to allocate intranetwork connections – interchange between different routes of the same transport. Particularly common are interchanges within the passenger transport system. However, at the present time, the popularity is gaining also the interchange from personal to commercial individual transport, concluded in the voluntary association of several car owners to make a trip on one car in case of coincidence of their route. This phenomenon is called: «carpooling» in case the interchange is carried into the car and «vanpooling», if the interchange takes place in the minivan. It is widely distributed in the US and, according to experts [16, 18], has a future in Russia. Types of intranet interchanges and the infrastructure providing their implementation are presented in Table 2.

Each of the links pertaining to the trip and carried out in the TIH is presented with a set of requirements, the implementation of which must occur first at the stage of development of the Project for its planning and, and then directly at the stage of organization and management of the hub. Key requirements include:

• minimum time spent on interchange, which determines its difficulty;

• comfort of waiting conditions, traffic with the participation of pedestrians, low mobility groups;

• safety of functioning of TIH and its separate elements, structures, communications, observance of environment ecology, etc.

Such requirements will determine the quality of the entire system of transport services and the urban environment in general [7].

Two closely interrelated goals for the development of the intermodal system should be singled out, aimed at solving two basic tasks of urban transport planning (Pic. 3):

1. Improving the conditions for accessibility of urban areas, which is determined by the possibility of combining different modes of transport, using the potential of the speed regime, which allows to move to longer distances over the same period of time compared to a unimodal trip.

2. Improving the conditions for mobility of the population, determined by the lower difficulty of traveling to the same distance when choosing a combined trip as a mode of transportation. A striking example here can be a comparison of the time spent on the same centripetal trip with work objectives: the time spent on driving on a personal car over an overworked in the morning hours of the road network can be 2–3 times the time required for a combined trip using underground.

The main difficulty in forming an intermodal transport service system is large financial and

organizational costs at each stage of its planning and design. The issues of finding optimums between the volumes of construction of the transport infrastructure, its quality and the cost of implementing projects, in this aspect, form an area of promising interdisciplinary transport, economic, social research.

Conclusion. *In conclusion, we will outline the main promising directions for organization of an intermodal transport service system for both the Moscow agglomeration and major cities with similar development trends:*

– priority development of all passenger transport systems;

– creation and implementation of innovative forms of transport services for the population;

– improving the quality of service and accessibility of public transportation services;

– management of access to the street-road network of agglomerations and cities, approaching their centers for the population of, including due to high-speed traffic;

– interaction between different types of passenger transport;

– increasing the attractiveness of passenger transport of general use in comparison with a private car;

– taking into account the economic, social and environmental components of the organization and functioning of the transport system as factors that shape its sustainability and long-term;

– coordination of the activities of federal and municipal authorities, private investors, scientific and design institutes and other possible participants in the process of developing and implementing transport strategies, managing the facilities of the transport complex, developing and improving the transport services of the population.

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