

# The emergence and development of transport hubs in Russia

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**Abstract.** The transport interchange hubs development (TIH) has recently become an important urban issue. In our country, this problem being quite new is determined by urban planning approaches aimed at solving it. The transport hub includes a complex of several transport modes performing operations for servicing transit, local and urban transportation of goods and passengers.

**Keywords.** The transport interchange hub, TIH, transport hub, transport infrastructure, transport and logistics cluster, industrial center, strategic objects.

## 1 Introduction

A transport interchange hub is a point where two or more types of transport docks, technological interaction of which is ensured by an appropriate set of devices and means, as well as organizational measures. A transport hub is considered as a complex system with different types of transport combined together with various technologies and with different vehicles and devices, which ensure convenient traffic and passenger flows movement.

Transport hubs are designed and built so that passengers can conveniently transfer. The system of covered walkways and galleries protect pedestrians from rain, cold and other adverse weather conditions.

In the UPT system (urban passenger transport) of a large city, especially when several types of public transport are available, the organization of passenger transfer largely determines the efficiency of the entire transport system. To solve this problem, transport hubs are being created in the city transport system.

In world practice, TIH is called the word «hub» or «transport hub». The term «hub» is taken from the English phrase «hub and spoke» – «axis and spokes». Initially, it began to be used to denote the organization of the air transportation system, in which, instead of traditional direct flights from point A to point B (Point-to-Point), a new transportation system using transfers (Hub-and-Spoke) began to operate. The first transport hub appeared in 1955 on the basis of Hartsfield-Jackson airport in Atlanta (USA), where air passengers were able to transfer from planes to commuter trains without leaving the airport complex. Since then, this model of organizing traffic flows has become more structured and has gained immense popularity around the world.

Later on, ground transport was included in the ‘hub and spoke’ system – buses, taxis and trains, and the term «hub» received a broad interpretation. It had been applied to transport hubs created on the basis of railway stations and bus stations. Today, a hub or transport hub

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is a public space that unites several terminals where passengers are transferred between various modes of transport, including aviation, rail and road.

The problems of transport infrastructure in the country especially in Moscow and the Moscow Region have become urgent in the last 15 years due to the steady increase of motorization level of the population, the growing demand for passenger and freight transportation, the active construction of large objects of mass attraction without adequate provision of the transport system, and etc. The inevitable consequences of these factors are not only a decrease in safety, efficiency of functioning of the areas of residence, but also an increase in outdated transport, deterioration in the quality of life of the population.

Considering the history of Moscow traffic jams, which have become a serious problem since the 90<sup>s</sup> of the XX century, it can be noted that the first congestion on the streets of the city occurred at the end of the XVI century, with the popularization of carriages. From that time until today, Moscow has repeatedly struggled with traffic jams, however, such a scale of disaster that we see today has never happened. In the 90<sup>s</sup> of the XX century personal cars became more accessible to a wide range of people, and urban passenger transport did not meet the needs of people. Many new areas were outside the metro service area, ground passenger car/electric transport ran irregularly, poorly communicating with other modes of transport. Commuter trains were not also mostly provided with communication with the metro, there were long waiting periods and there was no comfort for moving. There were many other problems that created an unattractive environment for using public transport, which encouraged people to travel around the city by private car on a daily basis. These problems persist to this day.

Studying the history of transport architecture in general, from the point of view of urban planning, it can be noted that such nodes have long existed and still exist. These are, for example, the same railway stations, metro stations with ground route passenger transport connected to them. At the moment, they are partially or completely in need of renovation, in order to meet the modern requirements for public transport. The existing transport hubs on the territory of Russian settlements do not meet modern requirements for ensuring comfort, safety and fast transfer from one type of transport to another. The existing planning solutions do not meet the ever-increasing volume of passenger traffic; the territories of transport hubs are oversaturated with spontaneous objects of trade, unauthorized parking of vehicles on the adjacent road network. Many of them lack municipal parking, intercept parking, and other important elements. Transport hubs are not adapted for the movement of low-mobility groups of the population [1, 2].

## 2 Materials and methods

TIH may include:

- stations of high-speed urban transport and stopping points of ground UPT (urban passenger transport);
- ways of passenger movement;
- ticket offices and other services;
- control and information support system;
- parking for taxis and bicycles;
- waiting areas and public spaces with trade services and catering establishments;
- intercepting parking lots and parking for personal vehicles.

There are different classifications of TIH:

- by type of transport: aviation (airports), railway (stations), sea (ports) and river (river stations and ports), automobile (bus stations), metro, tram (stops), bus (bus stations), etc.;
- by types of transportation: freight and passenger;
- complex: combining the above types of transport and functions;
- by type of organization: flat, multi-level, etc.;
- other classifications.

Several fundamental principles of the formation of TIHs in Russia can be formulated:

- the territory of the TIH should be considered as a single space, which is a complex urban structure;
- the development of TIH and the adjacent territory should initially be considered as a complex, development investment and urban planning project, implemented with the participation of the city and in the interests of citizens;
- the implementation of the project requires the participation of private business, the city and the state on mutually beneficial terms;
- when developing a project, it is necessary to assess in detail the commercial efficiency of the project, build a predictive business model, determine what costs will be borne by the project participants and how quickly these costs will pay off;
- it is also necessary to assess the accompanying social benefits from the implementation of the project (social effectiveness of the project) [3-5].

The main goal of the development of TIH in Russia is to increase passenger traffic and efficiency of transportation. The related tasks solved by TIH are to ensure their functionality, convenience of visitors and the possibility of intuitive orientation in space, application of innovations, ensuring efficiency, long service life, economy and profitability, safety of passengers and their smooth passage.

The algorithm for achieving the set goals is as follows:

- to develop an urban planning model that includes all types of transport;
- to determine the possibility of nodal points in the transport urban planning model;
- to carry out detailed planning zoning of the TIH territory and the surrounding area;
- to develop the architectural concept and model of TIH.

In Russia, there are two main directions for the development of the TIH system. The first is the organization of a flat transfer hub, which implies a comprehensive reconstruction of the transfer hub area [6, 7]. Reconstruction includes:

- creation of a functional planning scheme that allows separating multidirectional pedestrian flows, to avoid crossing traffic and pedestrian flows;
- reduction (or complete liquidation) of small retail trade objects in the node;
- streamlining the parking of individual vehicles in the hub;
- isolation of boarding aprons for ground passenger transport with canopies covering the aprons to protect passengers from atmospheric precipitation;
- arrangement of bicycle parking;
- provision of pedestrian and transport services, taking into account the capabilities of people with limited mobility, etc [8, 9].

The second direction in the development of the TIH system is the organization of a transfer complex (capital transport and transfer hub), a single engineering complex designed to provide the most comfortable conditions for transferring passengers while observing all technological requirements for the functioning of passenger transport systems. The transfer complex provides the spatial and functional interconnection of all TIH elements: vestibules of high-speed off-street transport stations; land passenger transport terminals; stop and reversal areas of public transport; parking lots for vehicles (including intercepting ones) [10, 11]. At the same time, passing passenger services are provided with social infrastructure facilities, etc [12].

The construction of the transfer complex, in contrast to the planar solution of the TIH, allows providing significant savings in the urban area due to the multi-level solution of the node. Intercepting parking is an integral part of the TIH, which allows car owners to leave their personal vehicles and change to public ones to continue the trip. In fact, at all stations of the Moscow metro, at the platforms of suburban electric trains, spontaneous and unauthorized "intercepting" parking lots have appeared and are operating. Parking at the TIH helps to improve the ecology of the city, reducing the amount of air polluting emissions from

intercepted vehicles. TIH as the center of the settlement system of local significance, in addition to performing the transport function, solves the problem of trade, household and leisure services for the population. Commercial objects of TIH will help to bring the purchase of everyday goods and provision of services as close as possible to the daily routes between home and work [13, 14]. At the same time, the reduction in regular shopping trips of citizens will also affect the unloading of streets and roads and will reduce the occupancy of public transport. Commercial and consumer services at TIH which do not interfere with the transport and interchange function of the hub contribute to the creation of significant amenities and time savings for most of the citizens.

The main benefits from the creation of TIHs are an increase in passenger traffic and an increase in the efficiency of transportation through the creation and use of common infrastructure and optimal passenger movement patterns. Indirect benefits from the creation of TIHs include increased fees and taxes [15]; creating a safe environment and eliminating the criminal environment; creation of convenience and comfort for passengers, etc.

## **3 Results**

### **3.1 Moscow experience**

The Moscow region is one of the most densely populated megalopolises in the world, which in itself is a huge transport hub on a national scale. All transport systems currently available in the world operate within the city and on its outskirts. The city is a conglomerate of administrative, political and economic functions. Numerous interregional and international routes of various types of transport links pass from and through it. Transport hubs of the capital type play the role of a center of gravity for a territory with a high population density. The function of the Moscow transport hubs is to link the metro, railway, MCC and ground transport into a single system. This will allow passengers not to waste time when transferring. The pilot project of a modern TIH was developed in 2005 on the basis of the Kaluzhskaya metro station (2005), where, in addition to the combined stops of public transport, parking lots and shopping and entertainment complexes with covered landing platforms appeared. In 2011, the Moscow authorities adopted a program for the creation of 273 transport hubs of various types, where special attention is paid to railway transfer hubs.

The Ryazanskaya TIH, the largest transport hub in the capital, which will connect the Nizhegorodskaya MCC station, the Nizhegorodskaya Street metro station, suburban platforms and ground transport stops, will include a multi-tiered landscape park. It will become a buffer zone between residential areas and the TIH itself. A high-rise building with offices and apartments will be located nearby [16]. A three-level shopping center will appear under the Paveletsky railway station square, the reconstruction of which should be completed as early as next year. It will house restaurants, cafes and parking, and on the surface – a landscape park with a fountain, an open amphitheater and walking trails. All these facilities will also become a part of the Paveletsky TIH. The construction of transport hubs of such a format makes it possible to build not only business and shopping centers, but also entire residential complexes that do not put pressure on the infrastructure of old districts. For example, a public and business center City will be built as part of the City transport hub in the Presnensky district of Moscow according to the project of the German architectural bureau Helmut Jan JAHN architecture and the Russian company Pride. The project includes two towers of different floors (no more than 250 m high) on a single stylobate with underground parking. The complex will unite Delovoy Tsentr MCC station, Mezhdunarodnaya and Delovoy Tsentr metro stations and public transport stops.

### **3.2 Kazan experience**

An example of successful interaction of government agencies of the federal, regional and municipal levels is the transport hub «North Station» (another name – Kazan-2), opened on August 5, 2012 in preparation for the XXVII Summer Universiade. It integrates the flows of rail transport, intercity buses, metro and urban land transport. TIH passenger terminal with a total area of 7890 sq. m meets modern safety requirements. For the convenience of passengers, there are waiting rooms for 600 people (station) and 75 people (bus station), a combined checkout room, a left-luggage office, check-in and self-service terminals, cafes, toilets, a first-aid post and trade facilities [17]. TIH Kazan-2 receives an additional impetus for the development in connection with the design of the Moscow-Kazan high-speed rail line.

### **3.3 Novosibirsk experience**

In the Novosibirsk region of the West Siberian road, TIH «Seyatel» at the station of the same name was launched in summer 2015 by the joint efforts of local authorities and JSC «Russian Railways». In the immediate vicinity of the station, an automated intercepting parking lot for 134 parking spaces, bicycle parking, as well as a public transport stop and a turnaround for fixed-route taxis have been built. The territory adjacent to the station has been landscaped at the expense of the city budget. At the station itself, two landing platforms were reconstructed and a modern two-story station with a total area of 892 m<sup>2</sup>, with a capacity of 100 passengers [18]. On the ground floor of the building there is a waiting room with soft seats, bathrooms and a cafe for 12 people. To ensure safety and prevent ticketless passage from the side of the platform, turnstile complexes are installed, in the corner of the waiting room there is an elevator for disabled people. On the second floor there is a cash desk. In each of the four ticket offices, passengers can purchase travel documents not only in suburban, but also in long-distance traffic. With the help of three touchscreen information boards, anyone can independently familiarize themselves with the train schedule, as well as find out the timetable of intercity flights of the Novosibirsk bus station and Tolmachevo airport.

### **3.4 North Caucasian experience**

- A subprogram was developed to create a TIH in a specially protected ecological resort region of the Russian Federation - Caucasian Mineral Waters and adjacent territories. It was assumed that the creation of this program would allow cities to solve the problem of not only organizing a new street and road network, but also to carry out reconstruction and lay new engineering communications for the development of urban areas.

- To combine the railway communication with the Mineralnye Vody airport, a mechanism for connecting commuter trains to the airport building has been proposed, which will create more comfortable conditions for passengers in general.

- In the developed TIH projects, problems are identified and solutions are proposed for the transport accessibility of the complexes being created, which will prevent transport collapse near transport hubs.

- The commercial component has been taken into account, which will allow recouping the costs of creating a property complex in the near future.

## **4 Discussions**

TIH as the center of the settlement system of local significance, in addition to performing the transport function, solves the problem of trade, household and leisure services for the population [19]. Commercial objects of TIH will help to bring the purchase of everyday goods

and provision of services as close as possible to the daily routes between home and work. At the same time, the reduced regular shopping trips of citizens will also affect the unloading of streets and roads and will reduce the congestion of public transport. Commercial and consumer services in TIH, which do not interfere with the transport and interchange function of the hub, contribute to the creation of significant amenities and time savings for most of the citizens.

Each transport hub needs a separate project that takes into account the peculiarities of the historically developed transport hub. Each node is unique. In each transport hub it is necessary to ensure a complex interconnection of all the constituent elements of the transport infrastructure with the «fabric» of the city, with the urban environment. The volumetric-spatial solution must be inscribed in the existing and historical buildings. Part of the transport and communication spaces of the city requires the creation of a relatively small transport hub of local importance [20].

## 5 Conclusions

As a result of the design and construction review of transport interchange hubs in Russia, numerous problems are obvious. They are associated with:

- 1) linking various transport systems and their existing position in the urban environment;
- 2) a regulatory and legislative framework that is not ready to create this type of transport architecture, in the sense of the object, which demonstrates foreign design experience;
- 3) the need to regulate the design processes of nodes, taking into account their main purpose, from the point of view of the architecture of capital TIH facilities: it is required to create a methodology for the design of facilities, considering their focus, first of all (to service passengers, to create a comfortable environment, to ensure a convenient and fast transfer).

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