

Smart space solutions of pedestrian ways in public transport transit hubs

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Abstract. The article is devoted to the organization of architectural and planning solutions of pedestrian communications in the city transport and transfer nodes. An urban planning approach to the use of territories based on modern trends in the development of smart cities for their sustainable development is proposed. The structure of pedestrian communications on the basis of the developed classification is presented, as well as typical projects of transverse profiles taking into account the peculiarities of functioning and composition of the transport and transfer node. The results of the study can be used as recommendations in the implementation of planning projects for the territory of urban transport and transfer nodes. According to the received data, pedestrian flow data were grouped by axial length (l , m) and intensity of flow (q , m/min) by clustering method. As a result of mathematical calculation, 3 groups of data were obtained, each of which determines a unique zone of transport and transfer node, having special characteristics in radius, intensity of flow and relative density (D , sq.m/sq.m). From a practical point of view, the developed structure of walking paths together with the idea of zoning of the territory of the transport transit hub can be an excellent tool for the designer in the development of the Design of planning of the territory of the transport transit hub and selection of parameters of the cross profile of a specific section. The development of science-based approaches is necessary to develop the quality of urban space and to ensure the sustainable development of the urban hub.

1. Introduction

Modern trends in urban planning determine the need to develop smart cities. When it comes to smart land use, we imagine that a smart city consists of smart territories, areas that can be managed for their sustainable development and this should be done at the first stage of the life cycle of the territory - formation of its architectural and planning solution [1].

The object of the study was the territories of the transport transit hub, which with increased requirements to functionality, comfort and safety of the urban environment due to the high concentration of people and urban functions.

The world experience emphasizes the need to form smart territories in transport and transfer node, as they focus on a lot of transport and public infrastructure and there is a need to manage transport and pedestrian flows at the level of organization of the territory. The main method is the formation of structure and typology of transport transit hub objects [2,3]. The main users of the transport and transfer hub territory are people who either transfer between different modes of transport or gain access to the infrastructure elements of the transport transit hub. Figure 1 shows the variety of



different types of infrastructure of transport transit hub and the main task is to organize a pedestrian framework on the territory of transport transit hub. It will be subject to the following requirements:

- ensuring the required level of population mobility;
- provision of transfers within the intermodal transport system;
- access to every object of infrastructure[4];
- the shortest connection with minimal time;
- conditions for comfortable and safe movement for different groups of users;
- information and technical support of movements;
- economic efficiency of use by urban territories;
- Integration with the system of external footpaths from adjacent areas.

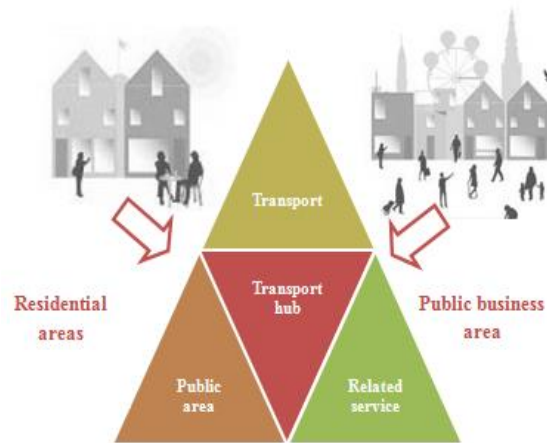


Figure 1. Composition of transport transit hub

The purpose of the article was to develop an urban planning approach to the organization of smart architectural and planning solutions of pedestrian communications in transport transit hub, which form the quality of urban space and ensure the sustainable development of the urban hub (Figure 2).

The smart territory of the transport transit hub is a territory that is organized on the basis of a smart system of pedestrian communications, which allows:

- controlling the processes of traffic and distribution of traffic and pedestrian flows to effectively perform the social function of transport transit hub;
- managing the efficient use of territories to increase the value of urban land;
- managing the function of creating an identical urban environment with the introduction of a single style of development and infrastructure, the introduction of natural elements, the formation of an urban landscape.

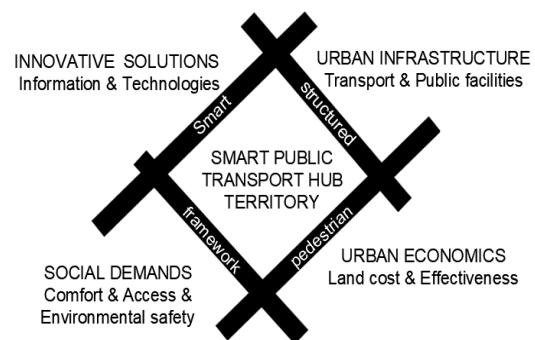


Figure 2. Urban planning approach to development of organization of smart architectural and planning solutions of pedestrian communications in transport transit hub

The object of the study was the city transport transit hub on the example of the city of Moscow [5]. The transport core consists of urban modes of transport - land modes, light and traditional metro, as well as other public functions: trade, social and public infrastructure. The study sought relationships between the territory's existing planning solutions and their spatial organization in 3 main areas:

- identification of the structure of pedestrian communications and their functional purpose[6];

- procedure of formation of transverse profiles of pedestrian communications;
- order of formation of urban identity of transport transit hub territories, which perform aesthetic function of city face

This path leads to the formation of a high-quality urban environment with identity and recognizable appearance and fully meets the requirements of sustainable development of the territories at the stage of urban planning [7].

2. Materials and methods

The work carried out in-depth surveys of the planning organization of the transport transit hub for the organization of pedestrian communications and their adaptation for low-mobility groups of the population, correspondence of human flow routes with these maps, removal of the time frame of stay on pedestrian communications in the transport transit hub [8, 9].

The results of in-kind surveys and theoretical surveys on the organization of pedestrian traffic made it possible to highlight the main specific conditions for the organization of pedestrian traffic in the transport transit hub, which have a direct or indirect impact on the planning of pedestrian communications.

The difference in types of pedestrian connections is due to the variety of infrastructure elements included in the transport transit hub. The method of survey of pedestrian communications of transport and transfer nodes was based on the data of theoretical surveys and analysis of existing experience of survey of pedestrian communications.

According to the received data, pedestrian flow data were grouped by axial length (l, m) and intensity of flow (q, m/min) by clustering method. As a result of mathematical calculation, 3 groups of data were obtained, each of which determines a unique zone of transport and transfer node, having special characteristics in radius, intensity of flow and relative density (D, sq.m/sq.m). Calculation results in the form of boundary characteristics of each zone are shown in figure 3[10].

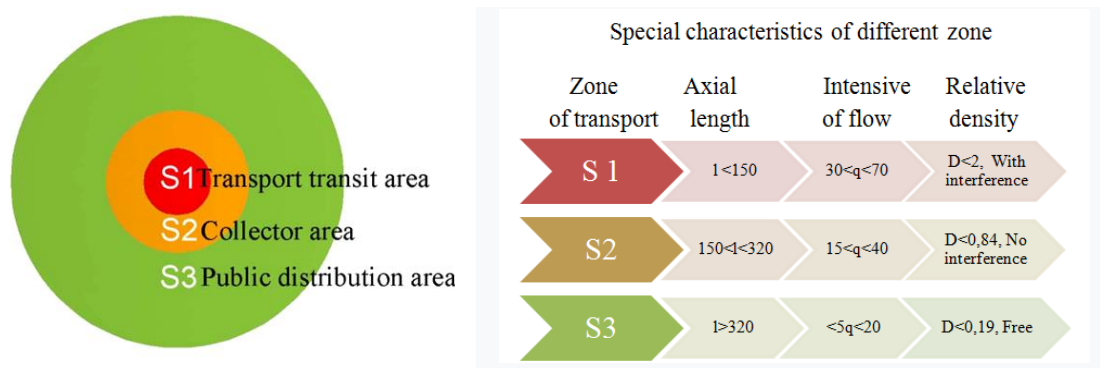


Figure 3. Zoning of transport transit hub territory according to classification

The first zone serves as a concentration of transport infrastructure and is designed to provide an approach to it and various types of transfer.

The second zone collects pedestrian flows from various objects of transport transit hub territory and adjacent areas for direct access to the transport zone.

The third zone is available for accommodation of public objects and territories with transport transit hub: administrative, social, commercial, natural, cultural, leisure and religious. They serve as public spaces and areas transit oriented development.

Based on the developed zoning, the structure of pedestrian communications has been proposed (Figure 4), which allows for several important aspects:

1. Pedestrian traffic control for safety, comfort and easy orientation
2. Quality of access to transport services

3. Access to associated services without compromising the main transit function.

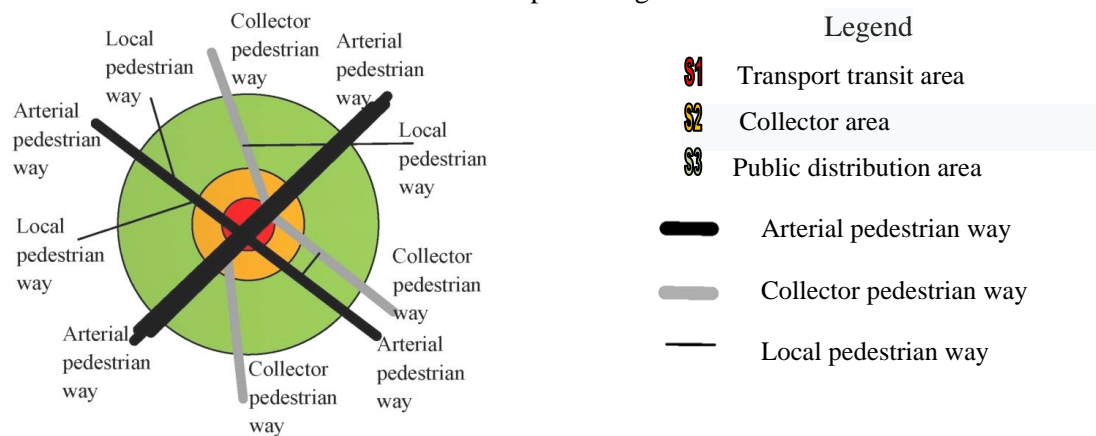


Figure 4. Structure of pedestrian communications in the transport transit hub

There are 3 categories of walking paths, each of which provides access to the corresponding area, as described in the table 1.

Table 1. Description of the structure of footpaths in transport transit hub

Hub zone	territory	Pedestrian way category	Function
Transport area zone		Arterial pedestrian ways	Access to different modes of transport, intermodal transfer, travel services
Collector Area		Collector pedestrian ways	Provision of collection of pedestrian flows from the territory of transport transit hub, external areas, infrastructure facilities of transport transit hub, such as parking lots, buildings and public areas
Public distribution area		Local pedestrian ways	Provision of access to public buildings and squares on the territory of transport transit hub from external areas and from passenger transport. They play the role of public space

3. The study of the structure of pedestrian communication elements in transport transit hub

The principles of zoning the territory of transport transit hub and the operation of pedestrian communications according to the structure were considered for urban transport transit hub located inside the city, where different types of urban passenger transport intersect. Such hubs are centers of public life in which many urban infrastructures are concentrated.

Table 2. Parameters of widths of pedestrian communication elements by types

	Arterial pedestrian way	Collector pedestrian way	Local pedestrian way
Transit lane	2m	2m	1,5 m
Frontage zone	-	1-1,5 m	-
Buffer zone	1m	1m	-
Bike lane	1,2m	1,5 m	1,5 m
Furniture zone/landscape	-	1 m	1 m
Boarding front lane	2 m-4m	-	-

The practical task of implementing the theoretical results of the study was to develop the order of calculation of the width of the transverse profile for each type of communication based on their function. Table 2 shows the initial parameters of each element of pedestrian communications.

The calculation was carried out by adding the widths of all elements of the transverse profile, which should be part of the transport transit hub on a specific section and presented for the transport transit hub Vladykino (Figure 5).

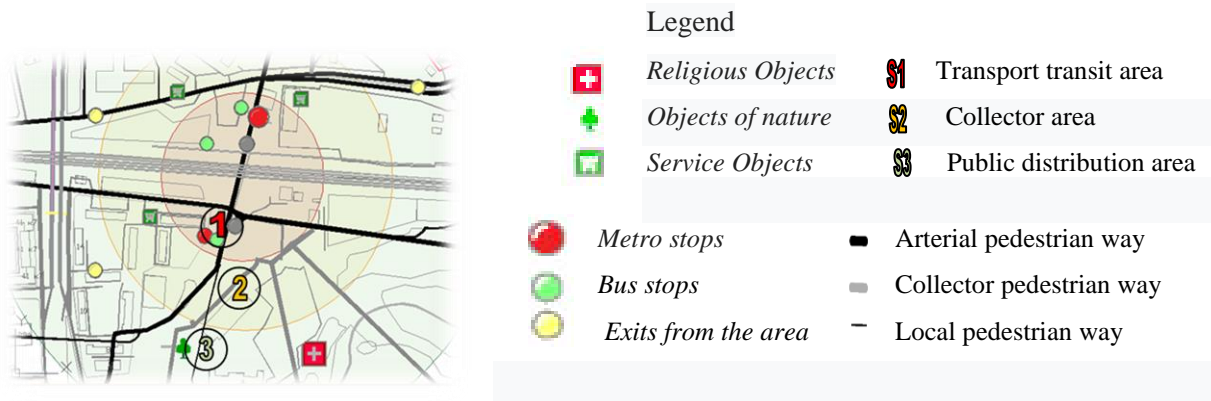


Figure 5. Transport transit hub Vladykino with applied structure and 3 sections

The *Artery pedestrian way* connects transport facilities: waiting areas, landings and landings. The main requirement of the planning solution is to ensure security, by taking into account the width of communications, to organize sufficient widths for access to transport facilities of different categories of citizens (Figure 6).



Figure 6. Artery pedestrian way in transport transit hub Vladykino (1)



Figure 7. Collector pedestrian way in transport transit hub Vladykino (2)

Collector pedestrian way is designed to connect transport elements of TPU and elements of accompanying service: purchase of tickets, shopping centers, places of reception of various goods and services. The main requirements of the planning solution are the possibility of access of different categories of citizens for unimpeded receipt of goods and services taking into account comfortable movement (Figure 7).

Local pedestrian way connects transport facilities with public spaces such as: sports facilities, parks, religious and cultural facilities. The main condition of the planning solution is comfort of movement, accounting for spaces for rest and information support for choosing the right direction (Figure 8).

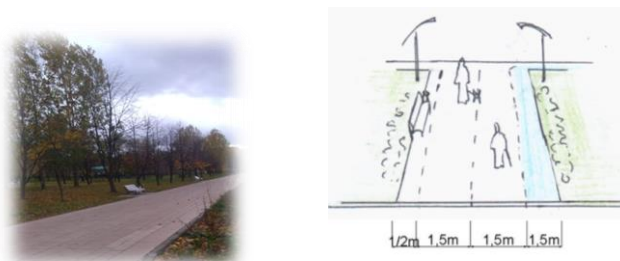


Figure 8. Local pedestrian way in transport transit hub Vladykino (3)

4. Conclusion

For Russia, the construction of the structure of pedestrian tracks is a new knowledge. A high-quality urban environment is a high-quality basis for the introduction of smart technologies that allow managing the life of the city. The scientific novelty of the results consists in the development of a new method of forming the structure of pedestrian paths for the management of pedestrian flows on the territory of transport transit hub, which allows taking a systematic approach to the use of territories. The study revealed dependencies between the established nature of the distribution of pedestrian flows in transport transit hub and the planning solution of pedestrian tracks. From a practical point of view, the developed structure of walking paths together with the idea of zoning of the territory of the transport transit hub can be an excellent tool for the designer in the development of the Design of planning of the territory of the transport transit hub and selection of parameters of the cross profile of a specific section.

The territory of transport transit hub in Russia is currently one of the most interesting for research, especially in terms of the formation of a smart environment. The development of science-based approaches is necessary to develop the quality of urban space and to ensure the sustainable development of the urban hub.

Acknowledgments

This study was performed with the financial support of the RF Ministry of Education and Science, President Grant #NSh-3492.2018.8

References

- [1] Sherbina E V, Danilina N V and Vlasov D N 2015 City planning issues for sustainable development *International Journal of Applied Engineering Research* **10** 43131-43138
- [2] Heddebaut O and Di Ciommo F *Eur Transp Res Rev* 2018 **10** <https://doi.org/10.1007/s12544-017-0283-3>
- [3] Abeer M and Fatima I 2014 From Typology Concept to Smart Transportation Hub *Procedia - Social and Behavioral Sciences* **153** 531 – 541
- [4] Shirley H 2003 *Accessibility design guidelines City of Toronto*, available at: www.toronto.ca/diversity/accessibilityplan
- [5] Vlasov D N and Shagimuratova A V 2015 Ocenka planirovochnogo razvitija transportno-peresadochnich yzlov sheleznodorozhnogo transporta *Urban dising* **5** (39) 31-36
- [6] Vuchic V R 2011 Transportation Engineering and planning *Urban Public Transportation Systems* **I** 576

- [7] Finogenov A I and Popov A V 2019 Concept of planning development of coastal resort settlements under conditions of complex relief *Journal of Environmental Management and Tourism* **10 1** 135-139
- [8] Helbing D and Molnár P 1995 Social force model for pedestrian dynamics *Physical Review E* **51** 4282–4286
- [9] South Carolina department of transportation 2008 *Access and roadside management standards*
- [10] Samoshin D A 2008 Parameters of pedestrian flow for modeling purposes *Proceedings of the Third International Conference on Pedestrian and Evacuation Dynamics* (University of Wuppertal, Germany)