Architectural and City-Planning Appearance of Multifunctional Transport and Transfer Units as Exemplified by Moscow

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Abstract. When developing multifunctional passenger traffic systems, two functions must be considered: that of a transfer hub and a commercial facility. Multifunctional transfer systems (90\% of the facilities examined) are constructed in two stages. Firstly, the transfer hub gets built and commissioned. It facilitates comfortable passenger transfer and service between different means of transport. The average land area proportion of a transfer hub (TH) in a land-use project (LUP) amounts to 35-55\%. The commercial space takes up about 45-65\% of the entire LUP area. Transfer hubs (100\%) comprise buildings and other constructions that serve various purposes, which manifests their multifunctional system properties. Parking lot design should become an integral part of developing TH units not included in the commercial part of the facility. Developing such facilities is a multi-stage process engaging specialists from various and vast areas. This type of dominant facilities are important to cities in terms of both transportation and architecture or city-building, and thus they require an individual approach to their development and construction.

1. Introduction
This article studies architectural and city-building solutions used in modern transfer hubs (TH) that comprise both the passenger transfer unit (TU) and other functions. Therefore, such facilities become multifunctional. The purpose of this paper is the analysis of the architectural and city-building appearance of multifunctional transfer units. The authors also identify the specific features typical of modern TH.

2. Relevance
The construction of permanent PTHs started in 2011. A tender was run for the development of a new development program for the Moscow Transportation Hub. It called for a layout project for a new type of passenger transfer unit. This project stipulated for the construction of large-scale units with two areas: public (serving the PTH function directly), and commercial (catering and trade facilities, offices, hotels, etc). It also recommended to build intercepting parking lots in the vicinity of the PTHs [1].

Between 2016-2020, 252 passenger transfer units were scheduled for construction in Moscow, along with other permanent structures within local transport infrastructure, including 92 single-storey
(flatwork) and 163 permanent buildings. In the region, 390 PTHs were recommended for construction [2]. New PTUs were scattered around Moscow and its vicinities (Figure 1). Apart from the transportation concept and solving passenger and transport problems, new PTUs influence the city-building situation and the appearance of the entire city. Figure 1 shows the location of PTHs examined in this article.

![Figure 1. PTH location diagram for Moscow. (PTH numbers are in line with Figure 2).](image)

The purpose of the research is solving the following problems and answering questions:
- What is the land area occupied by a passenger transfer unit in a land-use project (LUP);
- What proportion of a passenger transfer unit within an LUP is occupied by a transfer hub, and what proportion, in its turn, is occupied by commercial facilities;
- What are the proportions of interregional, regional and local PTUs under construction;
- What is the status of PTUs today and what are the projected construction completion dates;
- What are the functions of modern PTUs;
- What architectural solutions are used for the interiors and facades of PTUs.

3. Research significance
The objective of this article is to identify the typical features of new multifunctional units, whose main function is that of a transfer hub, based on the analysis of the facilities that are either currently being designed or under construction in Moscow and its vicinities (2019-2023).
4. Theory

The **research object** of the article - modern multifunctional passenger transfer units. The **subject of the research** - architectural and city-building solutions used in such facilities built in Moscow and its vicinities.

Define the differences between PTHs and PTUs according to their purposes.

**Passenger transfer hub (PTH)** is a nodal element of the public transport network in city-planning. It is used for passenger transfer between various means of transport in different combinations, and the provision of social infrastructure services to passengers [3], [4].

**Passenger transfer unit (PTU)** is a combination of passenger transfer hub elements with social, service, and entertainment infrastructure to provide comfortable transfer conditions and various services to passengers and visitors [5].

Prior to designing a passenger transfer hub, a **land-use project (LUP)** is designed. This document is developed for the passenger transport facilities that include the hub and commercial areas. The LUP specifies the key parameters of a PTH: technical and economic indicators, PTH engineering part [3], and the structure of the project commercial side. After the LUP gets approval, the design stage begins. PTUs are commissioned in the first place, and then various commercial facilities are being built depending on the city-building situation. To implement the LUP, investors must be attracted to develop the territory and build a commercial part of the project because the complete implementation of the project cannot be funded from the budget only.

**Research Methods** The authors analyzed the architectural and city-building appearance of 30 passenger transfer units (Figure 2). Further, the applied solutions were examined, including those associated with functionality, facades, and general city-building situation. New architectural features specific to the type of public buildings under analysis have been identified.

In the course of the analysis the following research results have been obtained.

According to their city-building significance, PTUs can be classified as follows: **interregional** (facilitating connections between the city and other territories in Russia or abroad [3]) – 40%; **regional/aggomeration** (facilitating the connections between city districts [3]) – 20%; **local** (facilitating transportation services to the residents of municipal districts who live within walking or a transport accessibility distance [3]) – 40%.

According to the current PTU status: construction - 53%; operation and construction - 20%, operation - 3%; design - 23%.

The **commissioning years for PTUs (PTHs)** are 2019-2025, with the majority (80%) scheduled for commissioning between 2020-2022.

**The land areas** of the PTUs in land-use projects (LUPs) and their amenities vary greatly, as well as the PTH proportions in LUPs. The largest LUP occupies 961.3 ha, and a PTH in this LUP takes up 15.5 ha (1.5% of the LUP). The smallest LUP occupies 2.5 ha. The largest PTH area among LUPs is 43.3 ha. The average land area of developed territories is 20-35 ha. There are no direct correlations between the PTU service level (interregional or local) and the land areas of LUP, PTU, or PTH. However, the following conclusion can be made:

The average land area proportion of a PTH in an LUP is 35-55%. This means, that the **commercial space takes up about 65-45% of the entire LUP area**.

The **analysis of planned functions** made the authors draw the following conclusion: the transfer hubs (100%) under analysis comprise several buildings and other constructions that serve various purposes, which manifests their **multifunctional unit (MU) properties**. Unfortunately, the analysis of LUPs showed that only 40% of the projects stipulate for intercepting parking lots and bays whose primary goal is to serve the people using the PTHs. The other 60% of the projects include single-storey and multistorey car parkings but they primarily target a commercial part of the project and serve shopping malls, hotels, and residential projects.

**The facades and architectural appearance of the units** (100%) are interesting, diverse, and designed individually.
| #  | Location                        | LUP Area          | Type          | Parking Lot Status | Status          | Notes                                      |
|----|---------------------------------|-------------------|---------------|--------------------|-----------------|--------------------------------------------|
| 1  | Ryazanskaya PTH                 | 30.1 (22.6) ha    | Interregional | -                  | construction    | (2022)                                     |
| 2  | Salaryevo PTH                   | 961.3 (15.5) ha   | Interregional | yes                | operation,     | construction (2019-2022)                  |
| 3  | Stolbovo PTH                    | 29.1 (11.0) ha    | Local         | -                  | design          | (2022)                                     |
| 4  | Shcherbinka PTH                 | 31.7 (10.3) ha    | Regional      | yes                | operation,     | construction (2021)                       |
| 5  | Tekhnopark PTH                  | 50.14 (32.78) ha  | Interregional | yes                | construction    | (2021)                                     |
| 6  | Rasskasovka PTH                 | 37.37 (32.32) ha  | Regional      | -                  | operation       | (2020)                                     |
| 7  | Paveletskiy PTH                 | 13.43 (13.43) ha  | Interregional | -                  | construction    | (2022)                                     |
| 8  | Ul. Generala PTH                | 13.43 (13.43) ha  | Local         | -                  | construction    | (2020)                                     |
| 9  | Yugo-Vostochnaya PTH            | 10.8 (10.4) ha    | Local         | -                  | operation       | (2020)                                     |
| 10 | Interregional Parking lot* - none |                  |               |                    |                 |                                            |
| 11 | Park Pobedy PTH                 | 29.0 (13.8) ha    | Local         | -                  | design          | (2022)                                     |
| 12 | Khovrino PTH                    | 28.3 (18.9) ha    | Interregional | yes                | operation,     | construction (2020-2025)                  |
| 13 | Khoroshevskaia PTH              | 53.0 ha           | Regional      | -                  | construction    | (2021-2023)                               |
| 14 | Cherkizovo PTH                  | 41.11 (18.0) ha   | Interregional | yes                | operation,     | construction (2020)                       |
| 15 | Khodynskoye Pole PTH            | 70.0 (17.57) ha   | Local         | -                  | operation       | (2020)                                     |
| 16 | Ul. Generala PTH                | 13.43 (13.43) ha  | Local         | -                  | construction    | (2022)                                     |
| 17 | Paveletskiy PTH                 | 13.43 (13.43) ha  | Interregional | -                  | operation       | (2020)                                     |
| 18 | Ul. Generala PTH                | 13.43 (13.43) ha  | Local         | -                  | construction    | (2022)                                     |
| No.    | Location               | LUP area | Parking lot | Status                  |
|--------|------------------------|----------|-------------|-------------------------|
| 7.     | Seligerskaya PTH       | 28.25 ha.| yes         | construction (2021)     |
| 8.     | Lefortovo PTH          | 28.25 ha.| none        | construction (2020)     |
| 9.     | Dmitrovskaya PTH       | 2.5 ha   | none        | construction (2020)     |
| 10.    | Pyatnitskoye Shosse PTH| 77.88 (38.17) ha | yes  | operation, construction (2020) |
| 11.    | Lefortovo PTH          | 28.25 ha.| none        | construction (2020)     |
| 12.    | Dmitrovskaya PTH       | 2.5 ha   | none        | construction (2020)     |
| 13.    | Pyatnitskoye Shosse PTH| 77.88 (38.17) ha | yes  | operation, construction (2020) |
| 14.    | Aviamotornaya PTH      | 20.7 ha  | yes         | operation, construction (2020) |
| 15.    | Aviamotornaya PTH      | 20.7 ha  | yes         | operation, construction (2020) |
| 16.    | Aviamotornaya PTH      | 20.7 ha  | yes         | operation, construction (2020) |

**Figure 2.** Passenger transfer hubs.

### 5. Applicability
Designing a multifunctional passenger transfer hub starts with a planning project and complies with all multifunctional facility design regulations. The majority of passenger transfer units are built in two stages. First of all, a passenger transfer hub is constructed and commissioned. Unfortunately, commercial functions begin to dominate general projects of multifunctional facilities. We must remember that the primary purpose of such facilities is providing passengers with comfortable transfer.
and service conditions between different means of transport. Passenger transfer units are extremely important as passenger infrastructure facilities, city-planning elements, and service providers for interregional, regional, and local connections. PTHs must have intercepting parking lots that do not rely on commercial facilities. There might be parking problems for PTH passengers.

The architectural appearance and facade solution must be implemented with responsibility. Each city-building situation must be addressed individually because PTHs act as dominant elements in cityscapes.

6. Conclusions
Multifunctional passenger traffic systems are based on two functions that should be considered: that of a transfer hub and a commercial facility. Developing such facilities is a multi-stage process engaging specialists from various and vast areas. This type of dominant facilities are important to cities in terms of both transportation and architecture or city-building, and thus they require an individual approach to their development and construction.

7. References
[1] Shatalova M Investors do not want to build transport hubs in Moscow News https://iz.ru/news/557753
[2] Resolution of the Moscow Government dated September 6, 2011 N 413-PP "On the formation of transport hubs in the city of Moscow (as amended on June 5, 2018)"
[3] SP 395.1325800.2018 Transport hubs Design rules Introduction date 2019-03-22
[4] "Urban Planning Code of the Russian Federation" dated December 29, 2004 N 190-FZ (as amended on 27.12.2019)
[5] Order of JSC "Russian Railways" dated September 22, 2016 N 1945r "On approval of the Uniform requirements for the formation of transport hubs and transport interchange complexes on the railway network of JSC" Russian Railways "dated