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SPACE UTILIZATION MODEL AND FORMATION PRINCIPLES OF METRO HUB

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Abstract: The paper to the formation of comfortable conditions for pedestrians in multilevel public transport centers with subway stations in large cities is devoted. The principles and models for multifunctional use of spaces and ways to improve them are proposed. The principles and requirements for their improvement in the design are traced. The specifics and peculiarities of urban and suburban transport of a large city have been revealed.
Key words: metro hub - transport hub with the subway station, subway, shuttle service, interchangeable junction, the complex solution.

I. INTRODUCTION

The development of underground urban development is an inevitable condition for the formation of large and major cities and agglomerations. When their conditions or other factors limiting development of residential areas are cramped and public service objects the need to develop underground space increases significantly.

For objective estimation of necessity of underground building it is necessary to consider all set of indicators, including reduction of time expenditures of population for labor and cultural-household trips, reduction of communication length, reduction of transport overruns, improvement of sanitary-hygienic conditions etc. It is also necessary to consider the effect of preservation of valuable urban development and rational use of the territory. In a number of cases the construction of even very expensive underground structures can be not only the only possible but also economically justified solution. Particularly critical in these conditions are areas of transport hubs with subway stations -metro hubs. [1, 2].

Subway is designed to provide transport unity of large cities, freeing up the population maximum free time.

Inefficient use (functioning) of territory, space and unnecessary waste of time on the movement, changing, waiting. Getting a minimum of services and information with limited space and time is paramount to its socio-economic feasibility of formation [2, 3, 4, 5].

The study of the current state of the organization of design, construction and operation in a sharply continental hot climate has shown that they do not meet modern requirements. The integrated transport system of agglomeration and the scheme of subway lines are solved locally with different terms of design and construction, as a result there is no single integrated solution of the most important public transport centers and hubs of urban and interurban values. makes it urgent to take an integrated approach to the formation of their functional-planning and architectural-spatial structure [3, 6]. Being located in the planning structure of the city, it makes it possible to offer structural and logical models of public transport centers with metropolitan centers: with the local

center; with the center of urban significance; with the center of regional significance; with the center of inter-settlement significance [7, 8, 9].

In a particular urban planning situation can be solved in different combinations of the use of surface and underground spaces, as well as service and labor application facilities [9, 10].

II. PROBLEM STATEMENT

Being located in the infrastructure of a large city should also solve the corresponding problems [9, 10, 11] on the effective use of valuable urban areas:

- In the core of the city - make the most efficient use of underground and surface space. Actively incorporate into the infrastructure of administrative, business, banking, shopping and other facilities for multifunctional use in the form of business meetings and recreation (the center of inter-settlement value - the metro hub with a transfer station);
- in the centers of residential districts - to make the most efficient use of the underground space. To be actively included in the infrastructure of public-transport, public-trade, cultural-educational and public-settlement objects. As well as, to the extent possible, mass-traffic facilities (the center of urban significance - a metro hub with a transfer station to other modes of transport);
- in the peripheral centers of attraction - as far as possible and the significance and value of the area, effectively use the underground space of the metro station. Link to the public-transport infrastructure (train stations, parking lots, garages) as much as possible. To be linked to the buildings and facilities of the supplying transport, both urban and interurban (the center of regional importance - subway station with a transfer station to other modes of transport) as much as possible;
- in the emerging centers of mass, seasonal attendance (sports, campus, cult, entertainment, agricultural trade) - use the underground-ground space with moving sidewalks and paths with mobile transforming facilities (specialized center of regional significance - metrosite with transfer station to other modes of interurban transport);
- in the established protection and conservation area (historical and ethnographic; cult; dendro-, zoo-, botanical parks) (a specialized center of regional importance - a metro hub with a transfer station to other modes of interurban transport of seasonal, episodic, tourist nature);
- episodic character of attraction - mainly maximum use of subway space only for the subway and other modes of transport, transport and engineering facilities. Minimal use of above-ground objects, with organic coordination with the protective and preservation character of the silhouette and architectural form of the existing buildings (specialized center - metro station with interchange to other modes of mini transport of departmental, episodic character);
- in administrative-industrial centers - efficient use of underground space mainly for mass visiting of large objects of labor application. To maximally connect with the passageway, vestibule and administrative and household group of objects (specialized center of regional significance - metro hub with the transfer station to other modes of transport).

Pedestrian accessibility zones of metro stations. Based on actual field surveys you can identify a pedestrian accessibility zone and transport accessibility zone [4. 6].

Pedestrian accessibility zone of subway station with sustainable parameters has different solutions depending: on the place and territory in the city, requires special forms of transport services and architectural and spatial organization. Pedestrian accessibility of a subway station is mainly determined by psycho-physiological capabilities of a person and only to a small extent by the location of the station in the city plan.

For the population of the city, the most valuable are those subway lines that provide greater accessibility to the central district and other places of mass gravity (including non-transit connections).

III. RESEARCH METHODS

Analysis of transport-planning solution, that is determination of a territory share (range of area coverage), as well as population, place of labor application and non-labor objects of non-labor gravity located within the zones of mass pedestrian and transport accessibility of subway stations, enables to determine the efficiency of transport service and the degree of mutual correspondence of the city layout and its transport network, as well as transport-planning organization of the metro influence zone.

Reduction of travel time loss is possible with compact subway stations. One of the ways to achieve it is to achieve "compactness" - concentration of attraction objects in accessible areas.

The study of the functional and planning organization of the station areas is recommended to lead in three directions: a theoretical study on the formation of service centers in a complex with a metro station; development of the typical techniques for intensification of the station areas in different areas of the city; the experimental design on specific situations of the station areas with the placement of service facilities, ground transport stops, which is an attempt to integrated use of valuable urban

Comprehensive study of public-transport centers, in which metro stations play a structural role, combined with the centers of planning districts, unload the historically established core of the city center, create a convenience of service to the population, reduce the time to reach the objects. In addition, the public transport hubs contribute to the formation of high-rise residential, hotel and public architectural ensembles here, the spatial solution of which will create a new scale and individual architectural appearance of the city [7. 8, 13].

IV. RESEARCH RESULTS

The development of the subway is closely linked to the planning organization of the territory in the area of its influence. Formation of the spatial environment, saturated with objects of various activities, acquiring in the minds of people a special significance: the station area becomes a "spatial reference point", a memorable element of the urban structure.

Studies of the problem allowed to formulate the basic principles of transport and planning organization of the territory in the metro influence zone: the intensification of integrated urban development of the territory, by means of functional zoning and differentiation of population density and the formation of transport and community centers on their basis.

The results of the subway network operation efficiency depend on the factors that determine the comfort of the subway and their interaction with the subsystems of the ground mode of transport. In this case, it is understood in the improvement of transport service quality. In urban planning it is important to anticipate changes in the transport situation associated with the growth of the city and its population, increasing the quality of transport services and the level of motorization, as well as in accordance with changes in the increase in movement of city residents [3, 5].

Time consumption for movement, being the most important factor in the formation of urban connections, depends significantly on the speed qualities of the transport system and volume-planning solution of transport hubs. Each planning solution corresponds to a certain length of high-speed transport network, providing a standard cost of time for movement. The optimal configuration of this network is a consequence of placing the main mass of departure and arrival objects [4, 5, 7].

Subway stations are differentiated by the number of interchange traffic gravitating to them. Of particular importance are stations that are terminal or temporarily terminal in a staged development of subway network [6, 7, 8]. With the advent and development of the subway, three practical problems are solved: the implementation of citywide transport and planning transformations; zoning of the city territory according to the relative accessibility, depending on the subway system; the rational organization of valuable station spaces.

Transport-planning:

- Provide a dense network of ride-hailing vehicles with stopping points within areas adjacent to the subway, so that comfortable conditions and passenger approaches are created throughout the area;
- the routes of feeder transport should be routed with strong passenger flows (enterprises, residential areas, railway stations, stadiums, etc.) with the metro stations;
- transfer hubs should be compact;
- Improvement and reconstruction of the street and road network is necessary in order to provide transportation by the shortest routes, allocating, in particular, special lanes for priority traffic of the pickup transport during the "rush hour" and taking into account natural and climatic conditions of the region. Organizational and operational:
- a combination of regular and semi-express routes to provide non-stop traffic to the subway stations is advisable for pickup of passengers from large residential areas;
- provide routes during the "rush hour" to objects of periodic action (or periodic, seasonal service by transport, for example: children's camps, rest homes, recreation areas, carnivals, festivals, fairs, bazaars, etc.) to ensure the specified regularity of traffic;
- depending on the station and area to provide the necessary interval and capacity of mobile transport;
- pickup to ensure the rhythmic loading of entrances and exits and the flow of electric trains and rhythm.

Saving time is the main criterion for evaluation of combined trips (subway - ride-hailing), despite some non-straight lines, is the main efficiency sign and criterion of optimality of such transportation system [1, 8, 11].

Researches of transport systems possibilities in city conditions showed that due to the progress of transport means or their systems the speed of movement can increase only by several percents, whereas by planning methods, town-planning means it is possible to reduce transport work volumes by 1,5-2 times.

The main purpose of development of urban transportation systems is to ensure the effective functioning of the city and to meet the needs of the population in transport, as well as the needs of enterprises and service facilities. Integral development of the city and its street and road network will determine to a greater extent the quality of transport services as well as the degree of negative impacts on the environment.

The maximum use will be made of the carrying capacity and its efficiency as a high-speed transport [8].

The size and structure of the actual influence zone of subway stations (pedestrian and transport accessibility zones) is determined mainly by psychophysiological capabilities of a person (for most cities the value of mass walking approach is 600-1000m).

The combination of these parameters of pedestrian and transport accessibility zones gives a comprehensive assessment of the urban planning solution - planning and technical parameters that characterize the quality of the urban planning solution.

The research showed that 66% of total walking time with the use of subway depends on the cost of the approach to the stations and only 34% - on other factors.

Only on the basis of assessing the significance of the hub in the transport infrastructure system, it is possible to make a reasonable design program as a set of interconnected devices in a specific urban situation.

The transition from extensive to intensive development of the national economy requires a significant improvement of the organization of passenger transportation by improving transport systems with the full use of available opportunities. This can be facilitated by creating a unified system of high-speed rail transport for urban and suburban communications in conjunction with the nodal development of the planning structure of the city-center and its agglomeration [3, 11].

Great opportunities for improving the efficiency of transport and urban planning system lay in the wider implementation of the method of focusing public centers of cultural and community services directly near the subway station. The predominance of such centers of higher-storeys, the original for the compact location of the complex of various services (and in the adjoining areas - residential houses, hotels of higher-storeys) will contribute to the economical use of the differentiated areas around the transport hubs and increase the convenience of using or reducing the pedestrian approach.

In general, the implementation of a close relationship between the two subsystems - transport hubs and community centers - will raise the role of the subway in conjunction with the railroads, most

organically incorporating them into the transport and urban development framework of the city, partially relieving the land routes and simultaneously improving services to suburban residents.
Thus, an integrated approach to solving transport and urban planning problems based on a high degree of coordination of the system of high-speed rail transport of different levels, including the subway and the ground transport, with the system of public centers of large cities and their secondary cities provides the possibility of flexible efficient development of the agglomeration and best meets the course of accelerated development in the socio-economic sphere of the country in the interests of people.
Travel time using the subway is made up of travel time on the subway, the ride time and the overhead time. A large overhead time reduces the benefit of the rapidity of travel on the subway. However, the more developed the subway is, the less this reduction is felt (because the ride time and overhead itself are significantly reduced). By relieving street transport from performing long-distance transportation, the subway allows for a more efficient construction of its operation. The increase in the speed and reliability of the city's connections is provided mainly by the growth of subway transportation.
A 10% reduction in overhead time is equivalent (in descending order of impact on travel speed) to a 15% increase in the trip within the subway; a 20% increase in ridership; and a 50% increase in subway ridership.
Reducing the overhead time seems to be the most manageable factor of speed growth, as the measures that implement it are feasible by the period of the start of the subway and bring immediate effect. This is a rational planning of stations and transfer hubs of metro, coordination of internal planning with external transport facilities and amenities, rational organization of feeder routes, and the territory within walking distance (600-1000m) from the station.

V. CONCLUSION

Efficiency of time and space saving is possible at a compact solution of the public-transport center itself (compactness - density, multilevel with the use of underground space) with placement in the center not only the objects of cultural and community services, but also the places of applied labor, not requiring territorial isolation for life activity.
The research revealed and systematized parameters of the influence of the main transport of the largest city, its role in the total volume of intracity passenger transportation. Taking into account the multiple expansion of the passenger service area when the subway with pickup and drop-off transport works, it is necessary to contribute to the reduction of time spent on the movement in the subway. For this purpose, when routing subway lines and stations location it is necessary to take into account urban planning requirements to create an interconnected system of these modes of transport (stations location under the intersections of major streets, creation of compact transfer hubs, etc.). In addition, there is a need to establish an optimal radius of the ride that meets the requirements of the normative time costs. To this end, metro lines and stations should be designed as a single integrated system of all types of passenger transport.

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