



Development of Public Spaces: the Impact of Metro Stations Construction on the Formation of the Structure of the Adjacent Territory

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Abstract. The article aims to study the development potential of local urban centers around the rapid transit system with due regard to the historical traditions of urban development and modern urban planning principles. To attain this end, the authors use a set of methods, including site analysis, data collection, classification, and project proposal development. The paper presents the tradition of forming a peripheral public space within the historical boundaries of the city. It is demonstrated that the current development of local public spaces based on peripheral rapid transit stations can be considered a continuation of this tradition at a new historical and technological stage. The authors select metro stations suitable for the formation of local urban centers. To determine the possibility of placing a public space in the vicinity of metro stations, calculations are made for territories included in forty-three metro zones of the peripheral part of the city and thirteen zones of the middle part of the city. Based on a group of indicators for the selected stations, the authors conduct an analysis and compile a table that characterizes the territories near each rapid transit station. As a result, the density and floor space index, passenger traffic per day, and the balance of the adjacent territory for each station were determined. There are draft projects for the development of territories, layouts, and visualizations of the proposed options for building open public spaces. The authors consider scenarios for the placement and transformation of public centers near metro stations. The study reveals how the construction of each metro station affects the adjacent territory. It is worth mentioning that new stations affect not only the lifestyle of citizens, with improved transport accessibility, the status of the territory increases, new centers of social activity, and new public spaces emerge.

Keywords: peripheral part of the city, development of public spaces

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1. INTRODUCTION

Historically, Russian cities developed in two directions: the radial expansion of the territory with the absorption of neighboring settlements and the ring closure of the city with the help of walls and roads. Let us consider the development schemes of Moscow between the 11th and 12th centuries [1].

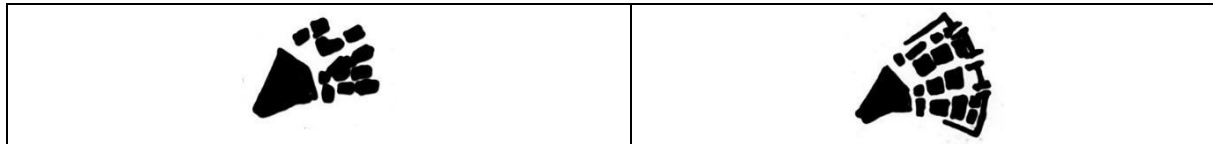


Fig. 1. Development schemes of Moscow between the 11th and 12th centuries.

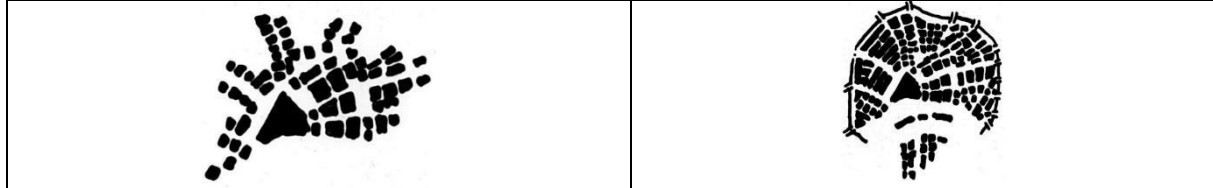


Fig. 2. The city crossed the Neglinka River and was encircled by the ring of Bely Gorod.

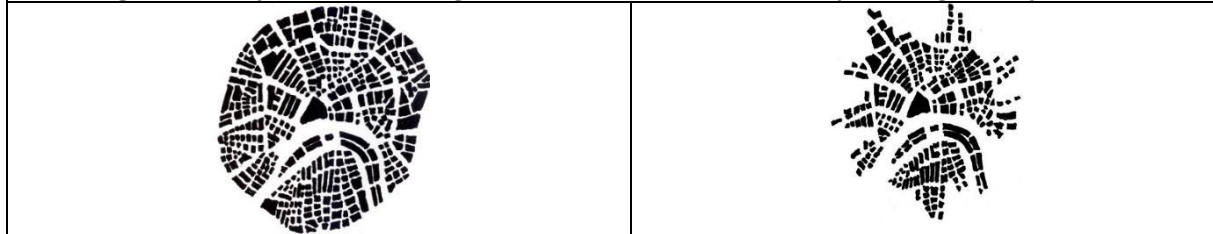


Fig. 3. Between the 15th and 16th centuries, the city overstepped the Moskva River surrounded by the wall of Zemlyanoy Gorod.

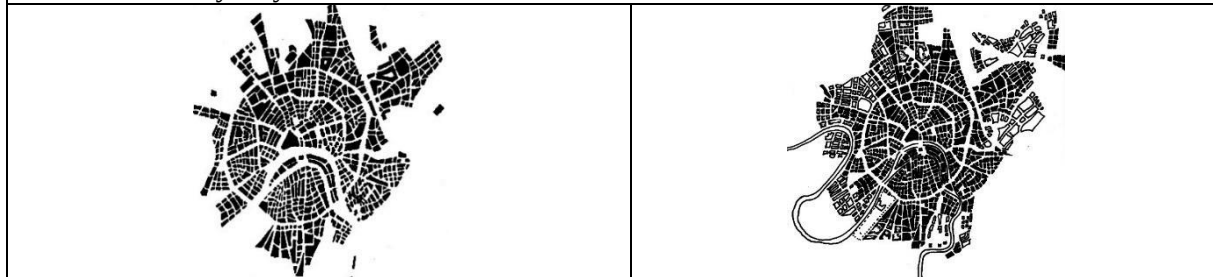


Fig. 4. Between the 17th and 19th centuries, the city continued to expand in all major directions and was bordered by Kamer-Kollezhsky rampart.

In the 1930s-1960s, the city developed along the main flying routes. The walls of Bely Gorod were replaced with the Boulevard Ring. The walls of Zemlyanoy Gorod transformed into the Garden Ring. The next stage of creating a ring around the city was the construction of a ring road around the city of Moscow (MKAD). In the 20th century, the ring defensive walls were replaced by ring highways. The historian of urban planning G.Ya. Mokeev proved that the cyclic process of the spiral development of cities was typical of all ancient Russian cities.

However, this process went through a different number of cycles in different cities.

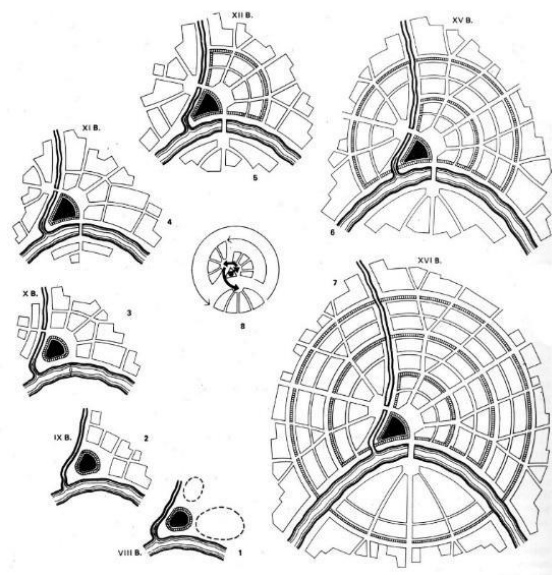


Fig. 5. The spiral development of Russian cities by G.Ya. Makeev [2].

At each stage of ringing walls and roads, a new belt of peripheral public space emerges when the main radial streets go beyond them. At each travel tower, there is a town square with a marketplace. It is the place where goods of the inhabitants of the adjacent settlements are exchanged and new products enter the city. Accordingly, customs and other administrative institutions should be present on the square. Temples are also built on this small local market as they serve as symbolic landmarks for arriving people, representing the city and its surrounding settlements. These contribute to religious and commercial interaction with society. At each exit from the city, a local community center emerges in front of the gateway.

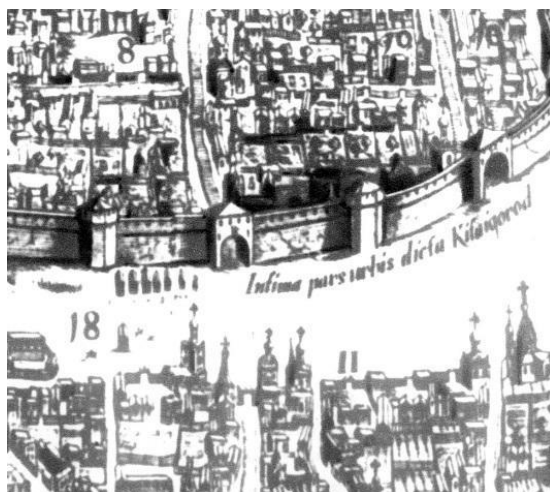


Fig. 6. Commercial settlements are represented by temples in front of the gateway. Sigismund's Plan of Moscow. Fragment.

With the development of cities, commercial settlements, which became part of the city, fit into its structure. A new public center is formed with a temple, a market, and other public institutions. The main streets of the city converge towards the center or the main public space, i.e. the Kremlin. This is the traditional historical development of Russian cities [1].

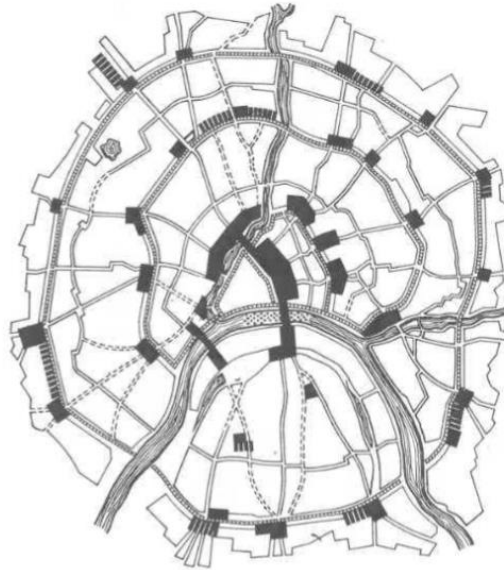


Fig. 7. The system of trade shops in the 17th century: three main ones in the center and secondary ones along the periphery [2].

The traditional system of trade shops at the intersection of the main radial streets and ring structures of Moscow was destroyed only in the second half of the 20th century since these areas turned into transport interchanges, as exemplified by the Garden Ring. Shopping malls were built on the new ring structure (the Moscow Ring Road) at its intersection with flying routes.

On the one hand, the natural system of the Russian city looks quite traditional. On the other hand, the formation of public spaces at peripheral public transport stops has its history. The emergence and development of local public centers at the metro terminals during different periods of construction are superimposed on the historical scheme.

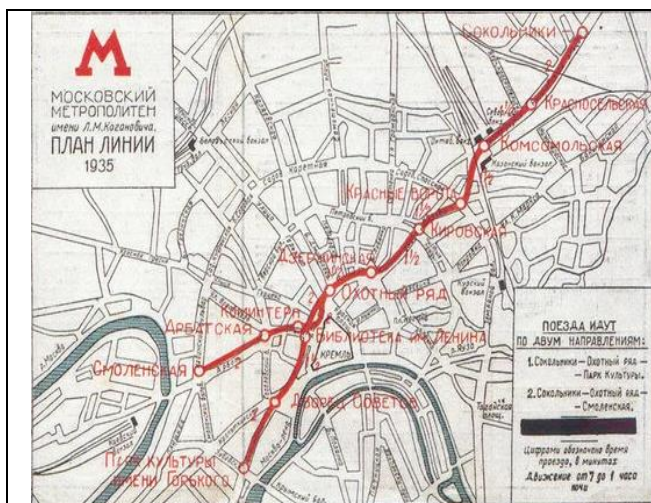


Fig. 8. The construction plan of the Metropolitan in 1935. Linear development.



Fig. 9. The Moscow metro map of 1997. Closing metro lines into a ring structure.

Initially, the metro terminals connected the existing open public spaces. Nowadays the construction of stations is the reason for developing public spaces. From an urban planning point of view, all public spaces could be divided into the following types and by their popularity among the urban population (Fig. 10):

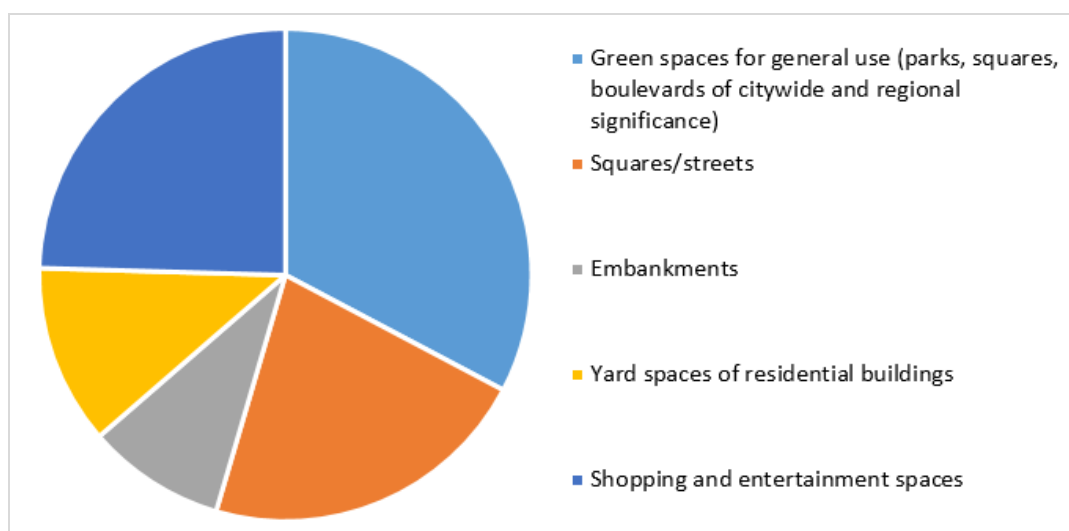


Fig. 10. Most popular public spaces.

From the viewpoint of a modern city policy, “the main principles for the development of public spaces are determined following the general principles for the development of urban areas [3]. Public space should meet the following requirements:

1) Economic aspect is the diverse use of territories that do not perform the functions of transit traffic;

2) Social aspect means the presence of social service objects to meet daily needs and ensure social interaction;

3) Environmental aspect involves improving the environmental safety of urban territory by reducing the impact of all possible negative impacts” [4].

The main condition for the development of the city as a whole, including its public spaces, is the development of transport and communications. The system of urban passenger transport is formed in two directions: the development of rapid transit transport and ground passenger transport [5, 6]. The modern urban system is represented by the main types of transport (subway and railway) and auxiliary systems (passenger transport, high-speed tram, monorail, and light railway). “The main purpose of the metro system is high-speed, routed and intracity movement of citizens between points of attraction, including the centers of residential areas, industrial territories, large shopping, entertainment, and cultural objects” [7].

When building new metro stations in the city, the cost and status of these territories increase. In the conditions of high population density, the organization of transport and pedestrian traffic is closely related to the functional planning and spatial composition of this territory [8]. Favorable conditions are created for the placement of administrative, commercial, entertainment, and educational buildings near metro stations [9]. “The territories of public zones in the middle and peripheral parts of the city have the following disadvantages: an increase in the intervals between houses, which affects the density of the environment; monotonous visual characteristics of architectural solutions; the disproportionate size of buildings for a person; the poor typology of public urban spaces” [10]. Residents of peripheral areas, the so-called “bedroom suburbs”, often do not have full-fledged urban centers suitable for various forms of activity. Public centers assume free access for visitors, and a variety of building ownership (state, municipal and private). In the vicinity of a metro station, they can meet the concept of Ray Oldenburg’s “Third Place”, where a vital space for social life should be located between the home and the workplace, where people can gather for informal communication. Its characteristics are as follows: public space that is free at any time; no economic or political segmentation of visitors; meeting the need for informal communication; the location within transport accessibility from the place of residence; regular visitors [11, 12]. Centers near metro stations in the middle and peripheral parts of the city can attract residents. Due to their territorial accessibility, it is convenient to place administrative and business centers, objects of science, culture, and hotels there. The center might include retail, catering, service, technical areas, and parking areas [13]. Their functions can be changed with the help of

new objects erected on free plots or the site of the demolition of low-value buildings, removed during the reconstruction of buildings, or added or extended to increase the intensity of use [14]. Local public centers can form a single spatially and functionally connected environment in which a developed transport infrastructure unites several sub-centers of various levels into a unified whole, being one of the main factors in creating favorable conditions [7]. The development of comfortable living conditions is a priority and is included in the Federal project “Formation of a comfortable urban environment”. The document puts forward a criterion for a high-quality urban environment, reflecting the connection of all elements of the city’s development. Urban spaces are analyzed according to six criteria: safety, comfort, environmental friendliness and health, identity and diversity, modernity and relevance, and management efficiency [15].

As exemplified by the city of Moscow, we can trace the development of various public spaces: the reconstruction of parks, the greening of squares, or the repair of pedestrian zones (Fig. 11).

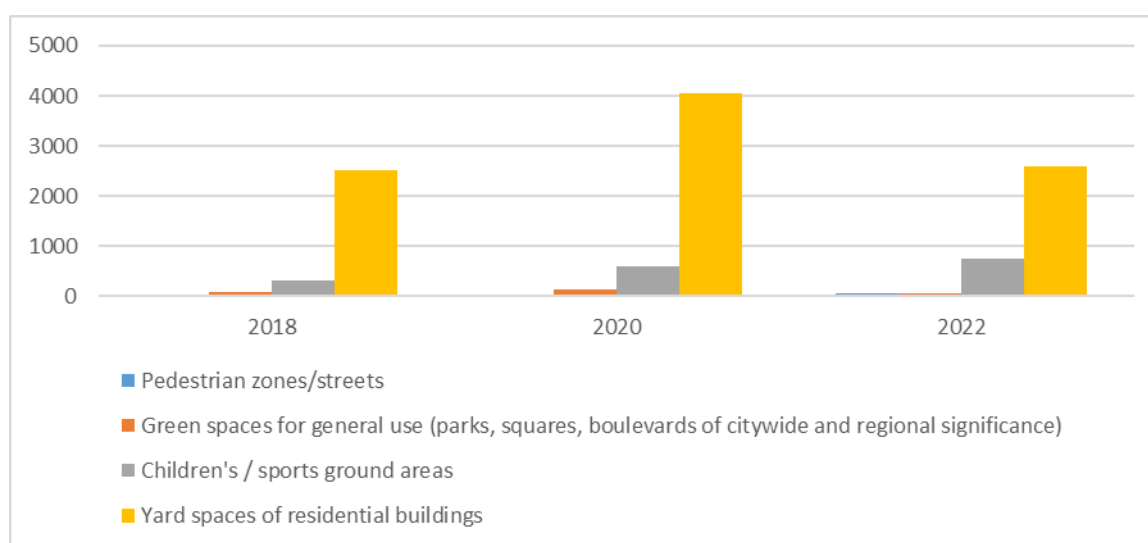


Fig. 11. Dynamics of improvement of Moscow urban public spaces from 2018 to 2022.

Nevertheless, improvements are mostly made to the central part of the city. When analyzing the peripheral areas of the city, a sufficient number of ill-equipped public areas are found, especially areas near the exits of the rapid transit system. This territory can become a local center of microdistricts and attract residents for leisure activities [16, 17].

Thus, the article considers the development of public spaces in the pedestrian zone of rapid transit stations in the peripheral areas of Moscow, focusing on the formation of local urban centers and the design of improved public areas.

2. METHODS AND MATERIALS

The Moscow State University of Civil Engineering studied the development of public spaces within the pedestrian zones of rapid transit stations in the peripheral part of the city of Moscow.

To conduct an experimental study of the development of territories within the pedestrian zone of metro stations, it is necessary to determine the boundaries of such territories, identify the system of parameters for their development, select the form of collecting initial data, process the results, and develop a classification according to the system of parameters.

To characterize the areas influenced by the selected rapid transit stations, we collected information on the station passenger traffic, density, floor space indices, and the balance of adjacent territories. Various sources, including official reports, maps, and statistics, were used to compile comprehensive datasets for analysis.

For each design object, we started with an analysis of the territory, collection of information about the site, the study of cadastral maps, photographic fixation, and historical research. We studied the main ways of moving people and transport routes, as well as emphasized scenery points. Draft models

were prepared for the transformation of open public spaces. Some of them are presented in this article. Creative groups of undergraduate and postgraduate students participated in the work on draft designs and gained valuable experience in building an open public space in real territory.

3. RESULTS AND DISCUSSION

Here is a scheme for the resettlement of the population across the territory of Moscow (along the ring transport zones) as of January 1, 2020 (Fig. 12).

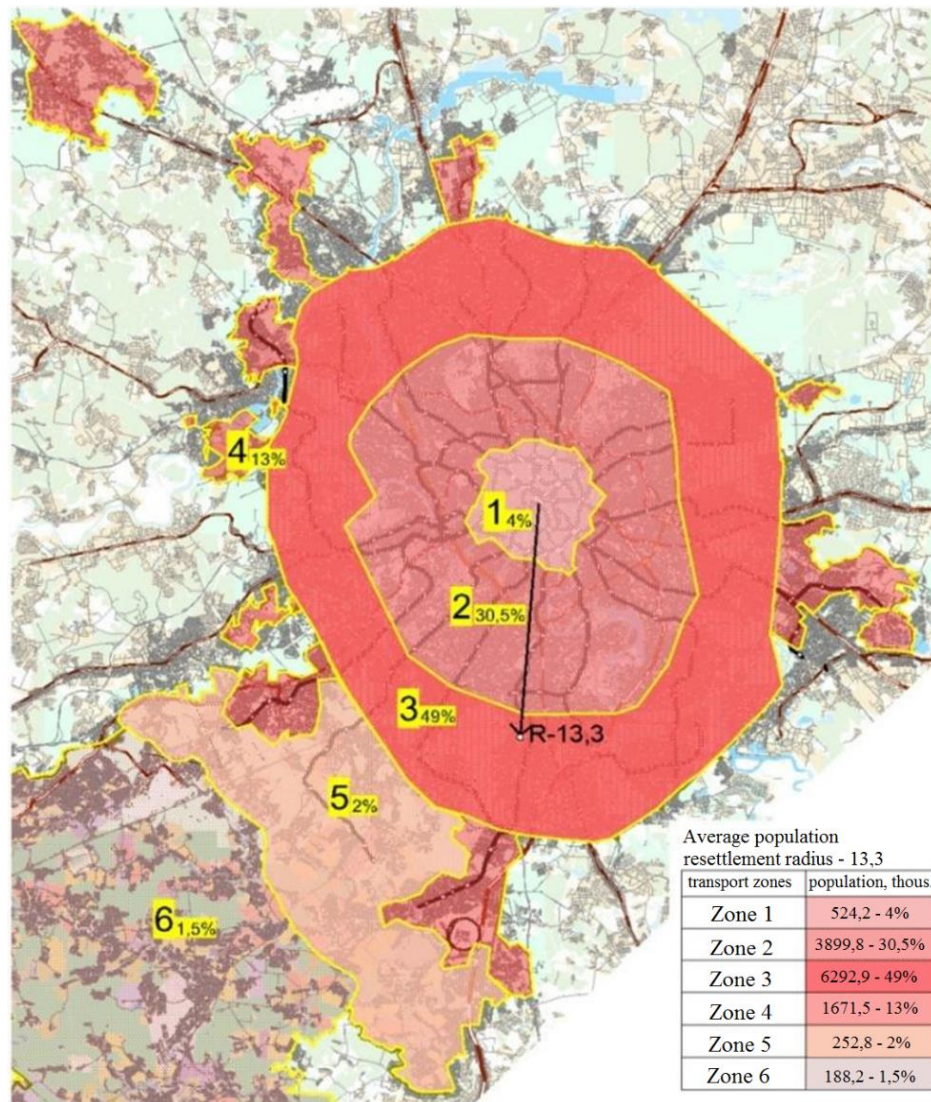


Fig. 12. The resettlement of the population across the territory of Moscow (along the ring transport zones) as of January 1, 2020 [18].

To assess the existing system of population resettlement and passenger transport, we grouped information on transport areas into the so-called “ring transport zones” located at different distances from the city center:

Zone 1 is the central part of the city within the Big Circle Line of the Moscow Metro;

Zone 2 is the middle part of the city, conditionally limited by the Moscow Central Ring from the north and by the Big Circle Line from the south;

Zone 3 is the peripheral part of the city located between the middle zone of the city and the Moscow Ring Road;

Zone 4 comprises the areas of Moscow located outside the Moscow Ring Road (excluding the territories annexed in 2012);

Zone 5 includes the settlements of the Novomoskovsky Administrative District of Moscow (the first zone of the annexed territories);

Zone 6 is the second belt of the annexed territories of the Troitsky and Novomoskovsky Administrative District.

Metro stations in the peripheral and middle parts of Moscow are identified that are suitable for the formation of local urban centers in their zone of influence and the design of public spaces (Table 1).

Table 1. Identified Metro Stations for Local Urban Center Formation and Public Space Design.

Peripheral zone of the city	Middle zone of the city
Konkovo, Otradnoye, Bibirevo, Shipilovskaya, Kantemirovskaya, Kolomenskaya, Perovo, Pervomayskaya, Izmaylovskaya, Babushkinskaya, Belomorskaya, Strogino, Molodyozhnaya, Krylatskoye, Belyayevo, Yuzhnaya, Alma-Atinskaya, Lyublino, Bratislavskaya, Maryino, Borisovo, Shipilovskaya, Kuzminki, Sviblovo, Vodny Stadion, Prazhskaya, Yasenevo, Yugo-Zapadnaya, Skhodnenskaya, Lomonosovsky Prospekt, Ryazansky Prospekt, Orekhovo, Kantemirovskaya, Verkhnie Likhobory, Novogireyevo, Chertanovskaya, Ozyornaya, Spartak, Volzhskaya, Ulitsa Akademika Yangel'ya, Universitet, Akademicheskaya	Profsoyuznaya, Novye Cheryomushki, Nakhimovsky Prospekt, Kolomenskaya, Semyonovskaya, Preobrazhenskaya Ploshchad, Sokol, Aeroport, Bagrationovskaya, Filyovsky Park, Pionerskaya, Lomonosovsky Prospekt, Ramenki

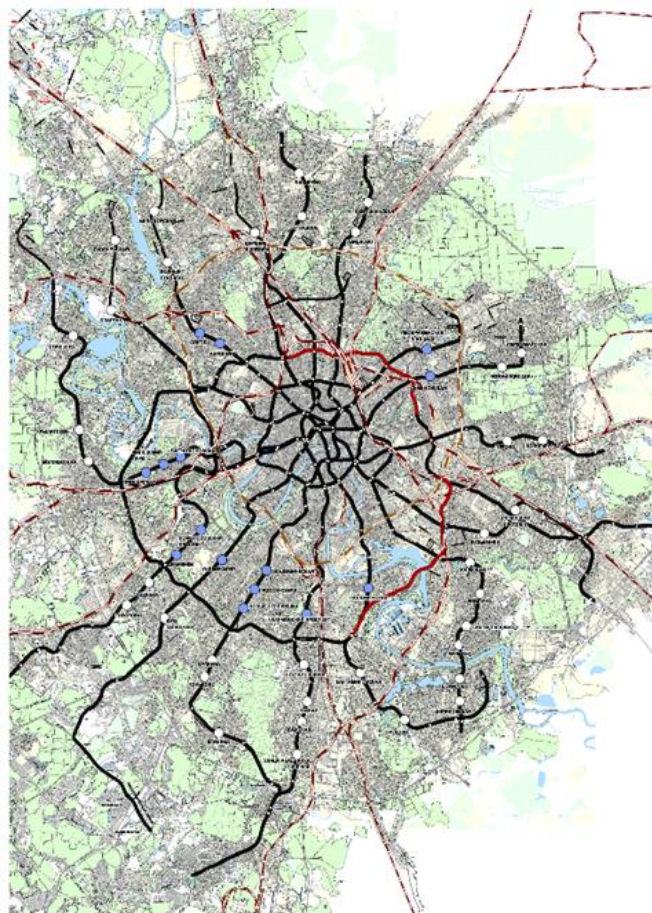


Fig. 13. The location of the selected metro stations on the city plan.

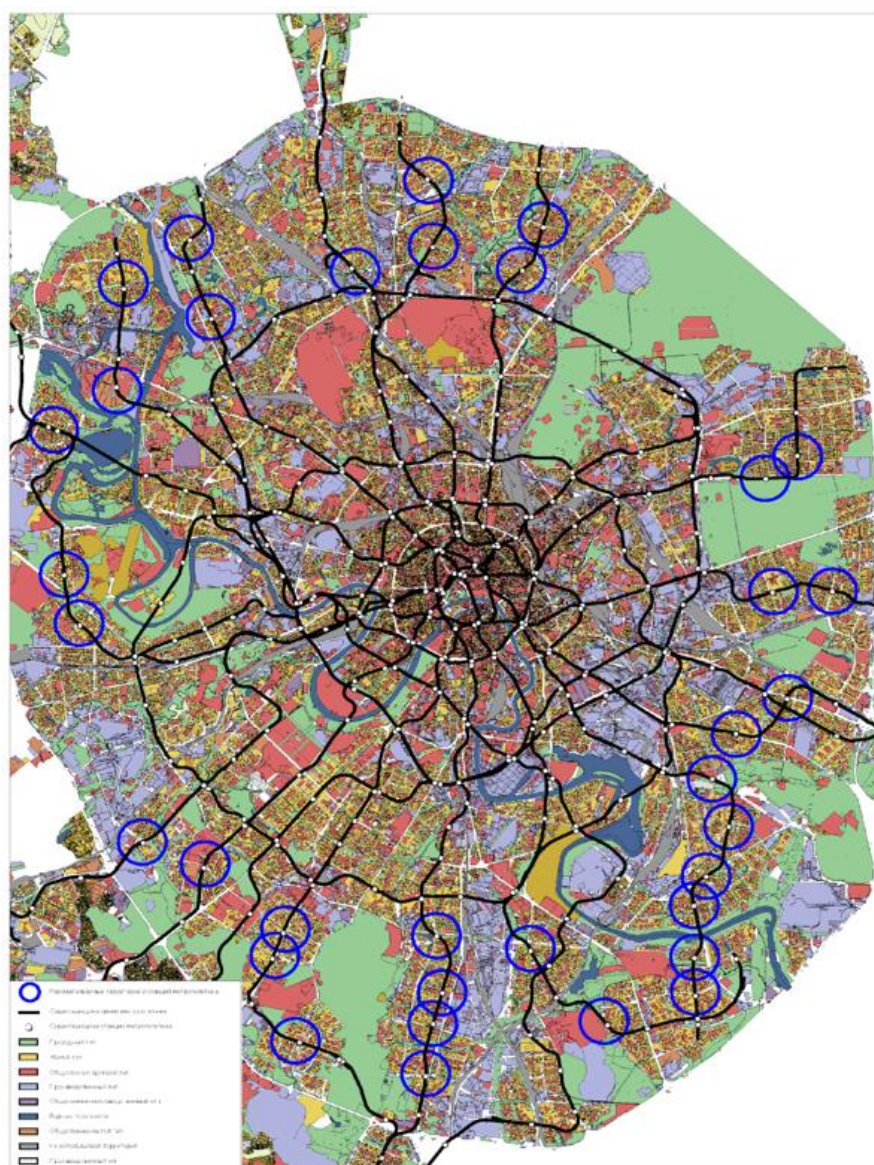


Fig. 14. The zones of influence of local urban centers and functional planning of Moscow

We analyzed the data obtained and compiled a table for the territory near each rapid transit station. Consequently, we determined the density and floor space index, passenger traffic per day, and the territory balance for each station of the rapid transit system (Table 2).

Table 2. Analysis of rapid transit stations and surrounding territories.

Rapid transit station	Density and floor space index		Passenger traffic of the station per day		Territory balance	
	p-housing development	K-housing development	Entrance	Exit	Residential	Social-business
Orekhovo	4,250.55	0.07	22,296	21,318	23%	62%
Yugo-Zapadnaya	14,836.45	0.17	57,524	58,227	20%	72%
Molodyozhnaya	9,255.93	0.13	51,442	50,490	35%	52%
Krylatskoye	8,346.76	0.10	29,297	28,629	27%	58%
Prazhskaya	7,575.64	0.16	51,101	51,030	30%	58%
Ulitsa Akademika Yangel'ya	9,202.71	0.12	29,677	29,114	35%	53%
Yasenevo			31,914	31,136	32%	56%
Konkovo	8,949.07	0.12	28,738	28,612	44%	45%
Belyayevo	10,409.22	0.15	38,709	39,124	49%	46%
Shipilovskaya		0.12	16,369	16,196	49%	51%
Maryino	11,316.80	0.15	37,278	36,562	37%	52%
Bratislavskaya	10,401.00	0.14	44,358	43,658	33%	49%
Lyublino	9,856.28	0.14	50,723	49,047	42%	53%
Volzhsкая	3,330.51	0.09	20,268	20,302	15%	51%
Kuzminki	8,751.02	0.14	64,126	64,172	51%	45%
Ryazansky Prospekt	8,252.61	0.13	37,035	37,270	43%	51%
Novogireyevo	9,010.91	0.14	78,358	74,972	38%	59%
Izmaylovskaya	8,443.35	0.11	22,380	22,578	22%	28%
Pervomayskaya	13,231.35	0.18	40,496	39,758	48%	49%
Sviblovo	7,473.93	0.17	28,133	27,990	29%	64%
Verkhnie Likhobory	5,359.44	0.17	13,896	13,784	16%	71%
Otradnoye	10,158.91	0.15	55,814	55,957	38%	52%
Bibirevo	7,305.63	0.19	33,181	33,242	30%	61%
Belomorskaya	12,238.74	0.16	33,036	31,092	32%	60%
Spartak	2,069.36	0.08	3,260	3,188	0%	91%
Strogino	10,694.49	0.14	30,074	29,572	34%	57%
Borisovo	6,840.57	0.09	14,004	13,605	24%	51%
Perovo	9,312.33	0.15	46,110	45,558	47%	48%
Babushkinskaya	8,772.03	0.14	54,389	53,734	37%	51%
Ozyornaya	6,715.28	0.13	18,661	18,232	22%	62%
Skhodnenskaya	10,518.14	0.16	55,007	54,099	49%	42%
Kantemirovskaya	6,191.85	0.12	47,445	46,827	31%	55%
Yuzhnaya	7,073.45	0.17	25,847	25,796	26%	66%
Vodny Stadion	9,854.26	0.17	44,198	44,233	19%	77%
Gorovo	7,067.93	0.11	13,060	12,368	24%	71%
VDNKh	7,419.41	0.12	71,961	70,450	19%	62%
Medvedkovo	9,957.31	0.12	57,181	55,213	47%	40%
Shchyolkovskaya	9,549.38	0.16	83,807	79,422	42%	53%
Novoperedelkino	9,574.90	0.11	17,541	16,334	25%	58%
Borovskoye Shosse	4,117.42	0.08	6,016	5,587	14%	58%
Solntsevo	10,329.58	0.11	17,439	16,466	30%	52%
Novye Cheryomushki	10,829.70	0.15	44,383	45,107	42%	53%
Altufyevo	9,790.03	0.12	52,113	50,688	35%	45%
Kakhovskaya	9,176.76	0.14			46%	50%
Preobrazhenskaya Ioshchad	9,795.72	0.19	51,677	52,937	38%	60%
Mitino			29,056	27,084	36%	55%
Akademicheskaya	10,690.64	0.16	38,960	38,901	42%	52%
Profsoyuznaya	9,905.31	0.15	38,396	39,374	43%	53%
Proletarskaya	9,769.13	0.19	37,676	38,629	32%	65%
Ramenki	14,924.96	0.14	18,856	18,436	35%	56%
Zyuzino	7,682.98	0.14			50%	44%
Nekrasovka	11,768.50	0.09	52,274	48,645	74%	19%
Kosino	6,747.43	0.12	4,351	3,994	46%	53%
Narodnoye Opolcheniye	10,641.59	0.16	9,791	9,190	44%	44%
Rasskazovka	5,345.34	0.11	20,680	18,990	58%	29%
Ulitsa Skobelevskaya			20,217	19,318	40%	55%
Oktyabrskoye Pole	9,846.85	0.18	48,818	50,124	41%	58%
Mayakovskaya	15,326.40	0.36	42,255	44,488	29%	67%
Rizhskaya	5,377.55	0.15			14%	85%
Zhulebino	8,783.40	0.11	27,770	26,834	34%	57%

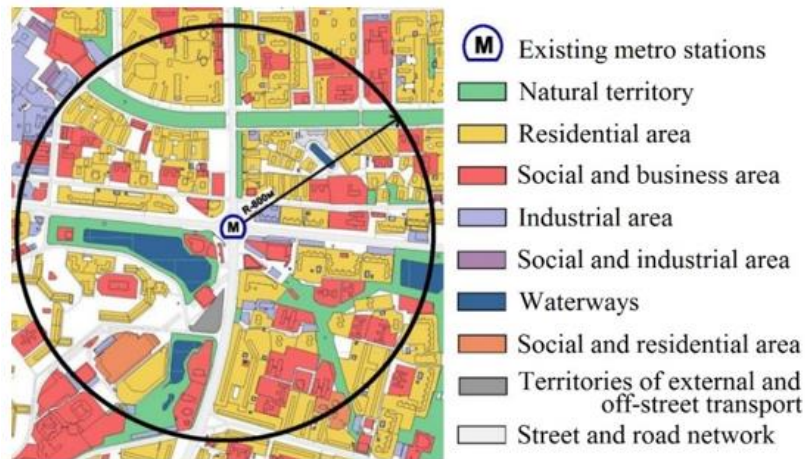


Fig. 15. The scheme of the territories in the pedestrian zone near rapid transit stations: functional diversity (the area near the Kakhovka metro station).

As a result of the classification, we identified indicators for each group of territories in the pedestrian zone of rapid transit stations (Table 3).

Table 3. Key indicators for pedestrian zones around rapid transit stations.

Indicators	Pedestrian accessibility of the rapid transit station		Density and floor space index		Passenger traffic of the station per day		Available transport infrastructure		Characteristics of the street and road network (minimum)	
	Distance (m)	t (minutes)	p-housing development	K-housing development	Entrance	Exit	Dedicated lane	Bicycle infrastructure	Width of pedestrian area	Number of lanes in each direction
Territory with the predominant residential function	800	15			12	11	+	+		2
Territory with the mixed functions of residential and public development	800	15			34	34	+	+		2
Community center areas	800	15		0.15-0.18	27	27		+		1

Based on the study results, proposals were made for the transformation of open public spaces located near rapid transit stations. The main task was to develop a convenient and comfortable space that would appeal to people of all ages.

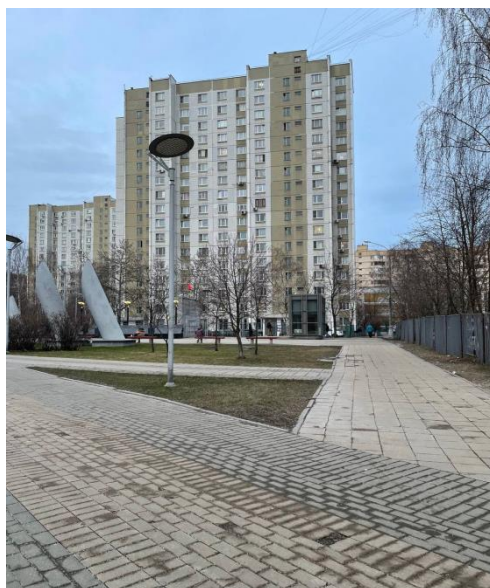


Fig. 16. The photo depicting the territory near the exit from the Borisovo metro station.



Fig. 17. The layout presenting the transformation of an open public space near the exit from the Borisovo metro station (D. Barsegyan, A. Gluga, M. Davydova, A. Nikitin).



Fig. 18. The layout presenting the transformation of an open public space near the exit from the Bratislavskaya metro station (A. Kakovkin, Yu. Berezina, G. Mkrtchan, M. Rabiev).

The project includes benches that constitute a metric row continued by trade kiosks installed. The authors compiled maps of the routes of residents leaving the metro station and visualized the proposed changes.



Fig. 19. The model of transforming an open public space near the exit from the Yuzhnaya metro station (D. Zaslavskaya, A. Ermakova, M. Kim).

It is proposed to include an exploitable roof in the public space development project.



Fig. 20. The model of transforming a public space near the exit from the Prazhskaya metro station (S. Yermishina, A. Panteleeva, P. Uskova, K. Gerasimova).

The transformation of a public space aims to ensure year-round and daily use of this territory for recreation and entertainment, promotion of a healthy lifestyle and family values, landscaping, street lighting installation, the creation of a pedestrian path and parking lots to protect the lawn. The area near the exits of metro stations is a shared space and should be safe, convenient, and beautiful. The improvement of public areas near metro stations is an important element in the formation of an aesthetic perception of the city. The improvement project of the Prazhskaya metro station provides for the replacement of asphalt concrete pavement, the modernization of the street lighting system, planting, the installation of small architectural forms, and the placement of a skatepark. The main principle of zoning is a harmonious combination of sports and recreational functions. The territory has many zones for active recreation: an active recreation area with skateboard elements, a quiet recreation area with benches and awnings, and a space for walking. The lighting concept involves creating a sense of comfort and security in the evening. The project uses three types of lighting: to illuminate the skate park, park lights as the main source of light, and linear lights built into the canopy cover.



Fig. 21. The model of transforming a public space near the exit from the Shipilovskaya metro station (S. Makharkova, P. Dorokhova, A. Kirichenko).

Based on the analysis of the territory and human flows, the territory was divided into five main zones: the central square with kiosks, an event center with an amphitheater, a playground area, a sports area with a skate park, and a green walking area. Within the framework of this work, projects of modular benches, pergolas, and kiosks were developed in the same style.

After making layouts, public areas were visualized from the main viewpoints.



Fig. 22. The visualized transformation of open public space near the exit from the Shipilovskaya metro station (S. Makharkova, P. Dorokhova, A. Kirichenko).

4. CONCLUSION

Within the framework of the project “City Boundaries in a Variety of Typologies, Architectural Images and Meanings, Historical Transformations, and New Proposals”, we conducted a comprehensive study on the development of public spaces in the zone of pedestrian accessibility of rapid transit stations in the peripheral part of Moscow. We identified metro stations in the peripheral and middle parts of Moscow suitable for forming local urban centers and designing public spaces. To determine the possibility of placing a public space in the vicinity of metro stations, calculations were made for territories included in forty-three metro zones of the peripheral part of the city and thirteen zones of the middle part of the city. Based on a group of indicators for the selected stations, the authors conduct an analysis and compile a table that characterizes the territories near each rapid transit station. As a result, the density and floor space index, passenger traffic per day, and the balance of the adjacent territory for each station were determined. We also identified visual axes and pedestrian connections and considered existing and projected dominants and their impact on the territory. There are draft projects for the development of territories, layouts, and visualizations of the proposed options for building open public spaces. We analyzed scenarios for the placement and transformation of public centers near metro stations. The study reveals how the construction of each metro station affects the adjacent territory.

Public spaces are an indispensable condition for the formation of an urban identity. Each district should comply with standards of improvement but the territory of each metro station must be unique. New stations affect not only the lifestyle of citizens, with improved transport accessibility, the status of the territory increases, new centers of social activity, and new public spaces emerge.

5. ACKNOWLEDGMENTS

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