

FEATURES OF GREEN BUSINESS CENTERS PLACEMENT IN AN URBAN ENVIRONMENT

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Abstract. The features of green business centers (GBC) location in the structure of the city and district are investigated using the example of London and Moscow. A graphic-analytical analysis of the location of environmentally sustainable business complexes is carried out. The environmental, social and economic aspects of the design of commercial buildings are highlighted. This study is necessary to identify successful practices and experience of foreign countries in the placement of green business centers that could be adapted and applied in Russia. The results of the study allow us to draw conclusions about the prospects for the development of ecological construction of commercial buildings in Russian cities.

Key words: green business centers, environmental certification, environmental standard, green building technologies, sustainable development.

1. Introduction

At the current stage of society's development, the consequences of human activity have created global problems that require immediate solutions. One of the most significant sources of these problems is the construction industry.

Buildings worldwide consume approximately 40% of all primary energy, 67% of electricity, 40% of raw materials and 14% of drinking water. In addition, up to 35% of carbon dioxide emissions and 45% of all municipal solid waste are

generated from construction sites (Botequilha-Leitão and Díaz-Varela, 2020; Franco *et al.*, 2020; Kumar and Mani, 2023). However, construction can be a source of not only problems, but also an area of search for new solutions.

In recent decades, there has been a growing interest in sustainable development and ecology, which is reflected in architecture and urban planning. Green business centers, positioned as environmentally friendly and energy efficient, are becoming an

important element of urban infrastructure in developed countries (Chu *et al.*, 2023; Rui *et al.*, 2024).

Many researchers have been studying the design features of environmentally sustainable facilities in an urban environment. The impact of sustainable architectural and urban planning practices on environmental, economic and social aspects is addressed in works Yuan Gao (Gao and Yang, 2011), Tytti Bruce-Hyrkäs (Bruce-Hyrkäs *et al.*, 2018), Zhu Shiyao (Shiyao *et al.*, 2024).

The methods of assessing the environmental impact of buildings, their applications and development trends were studied by the authors Drury Crawley (Crawley and Aho, 1999), Tatiana Meshcheryakova (Meshcheryakova, 2017), Wim Lambrechts (Lambrechts *et al.*, 2019), Mary Franco (Franco *et al.*, 2021). The impact of environmental technologies on the environment has been considered in the works Meg Calkins (Calkins, 2005), Jia ChunXia (ChunXia *et al.*, 2017), Ellen Douglas (Douglas *et al.*, 2018), Christina Duisebekova (Duisebekova *et al.*, 2020), Rui Guo (Guo *et al.*, 2024).

The study revealed that the location of green business centers in European cities and Russia differ depending on the economic, environmental and social characteristics of the region and the country as a whole.

In foreign practice, the placement of green business centers is usually based on: the inclusion of a building in the natural framework of the city; accessibility to infrastructure; increasing green spaces and public spaces. Today, Russia maintains a relatively low level of implementation of the principles

of sustainable architecture in comparison with Western countries (Klochkova and Sukhinina, 2017).

The main problems are: underdeveloped legislation on environmental construction; lack of awareness among users, developers and investors; insufficient government funding for green technologies (Meshcheryakova, 2017; He *et al.*, 2018; Yufeng *et al.*, 2024).

Due to the above circumstances, a difficult situation has developed in Russia with the placement and development of green business centers in large cities. This necessitates the development of clearer directions for the transition to sustainable construction practices in order to improve the environmental and economic situation in the country.

Research objectives:

1. Identify the factors influencing the placement of green office buildings in an urban environment;
2. To conduct a graphoanalytic analysis of environmentally sustainable business complexes abroad and in Russia at the city and district level;
3. Compare foreign and domestic practices of introducing commercial complexes into the urban environment;
4. Develop recommendations to improve the efficiency of the placement of green business centers in Russia.

2. Materials and methods

To analyze the collected material, an integrated approach is used, including analytical and graphical methods. Data on existing green business centers were collected both in Russia and abroad through open sources. Graphical analysis has become a meaningful stage in the

research. It allowed us to visualize the collected data and draw conclusions.

The main methods of graphical analysis include:

Cartography – the creation of maps using GIS technologies to display the location of green business centers in the city structure. The geographical characteristics of the location of business centers, their proximity to natural areas, transport infrastructure and other key facilities were analyzed. The analysis made it possible to identify patterns in the placement of complexes and assess the impact of urban infrastructure on their development.

Graphical visualization of data – the construction of graphs, charts and infographics for the analysis of quantitative indicators.

Comparative analysis – creation of analytical tables and graphs showing the differences and similarities between foreign and Russian experience in designing environmentally friendly buildings.

As a result of the applied integrated approach, a complete and qualitative understanding of the state and prospects of the development of green business centers was obtained, which allowed a deeper understanding of the peculiarities of their location in the urban environment abroad and in Russia.

3. Results and discussions

3.1. Analysis of the location of green business center in foreign practice

The heterogeneity of the natural, climatic, environmental, socio-economic and political conditions of European countries has a direct impact on the possibility of building green business centers. The

study of the relationship between the placement of green office buildings in an urban environment and optimal green architectural and planning solutions of objects is especially relevant (Donmez-Turan and Kiliclar, 2021; Mingran *et al.*, 2024).

The main factors associated with the placement of green office centers at the city level are: the role in the master plan of the city; location in the functional area of the city; interaction with the transport structure; integration into the water-green framework of the territory.

For an in-depth understanding of the impact of the above-described factors on the development of ecological construction in megacities, a grapho-analytical analysis of environmentally certified business centers in London was conducted.

This methodological approach made it possible to visually present and compare the main parameters affecting the location and functioning of green office centers in an urban environment.

3.1.1. At the city level

Based on the grapho-analytical analysis of the location of green office buildings at the city of London level, the following patterns were identified.

- **Functional zoning.** The location of eco-friendly facilities is fairly uniform, which contributes to creating a comfortable urban environment and reducing the concentration of people in one place (Fig. 1):
 - 58% of green office buildings are located near residential buildings;
 - 25% of business centers are located within a radius of 100 meters from commercial and shopping areas;

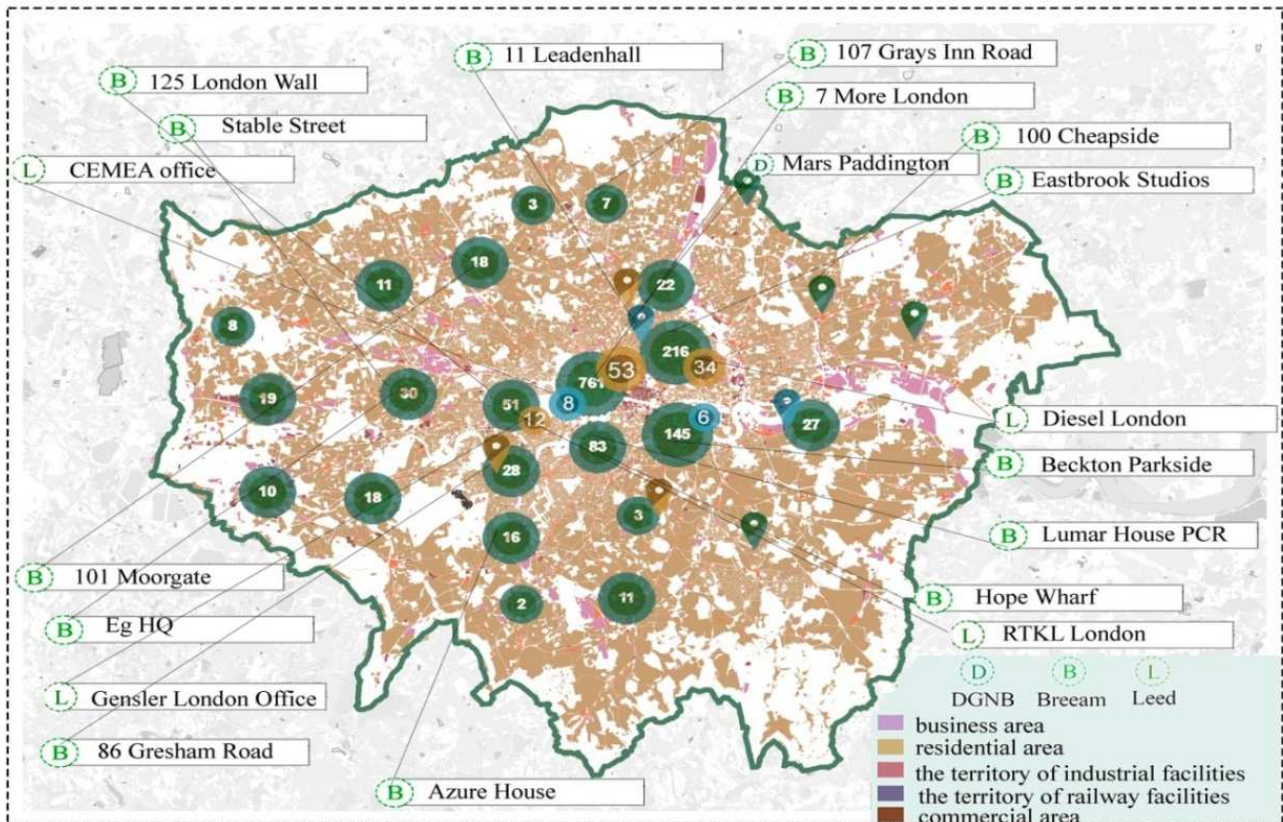


Fig. 1. Placement of green business centers in relation to the main functional areas of London (Source: Authors).

- 9% of the shopping malls are located 100 meters from significant railway stations;
- 8% of office buildings are located at a distance of 100 meters from industrial areas.

• **Transport scheme.** The objects are evenly distributed throughout the territory, which indicates an integrated approach to the greening of office real estate (Fig. 2):

- A large shopping mall is located in the central Administrative District (AD);
- 66% of shopping malls are located within a radius of 80-120 meters from regional roads;
- 34% of green office buildings are located 100-200 meters from metro stations, providing convenient access to office buildings for employees and customers.

• **Water-green frame.** Green business centers strive to be located near natural

resources to create a comfortable environment and reduce the negative impact on the environment (Fig. 3):

- 9% of business centers have equidistant access to water and green resources, which allows employees to enjoy proximity to nature;
- 18% of office buildings are located near water bodies within a radius of 300-400 m;
- 73% of the objects are close to recreation areas and are located within a radius of up to 400 meters from green spaces.

3.1.2. At the district level

The placement of green office centers requires taking into account many factors that affect their success and attractiveness in the area (Leyzerova *et al.*, 2016).

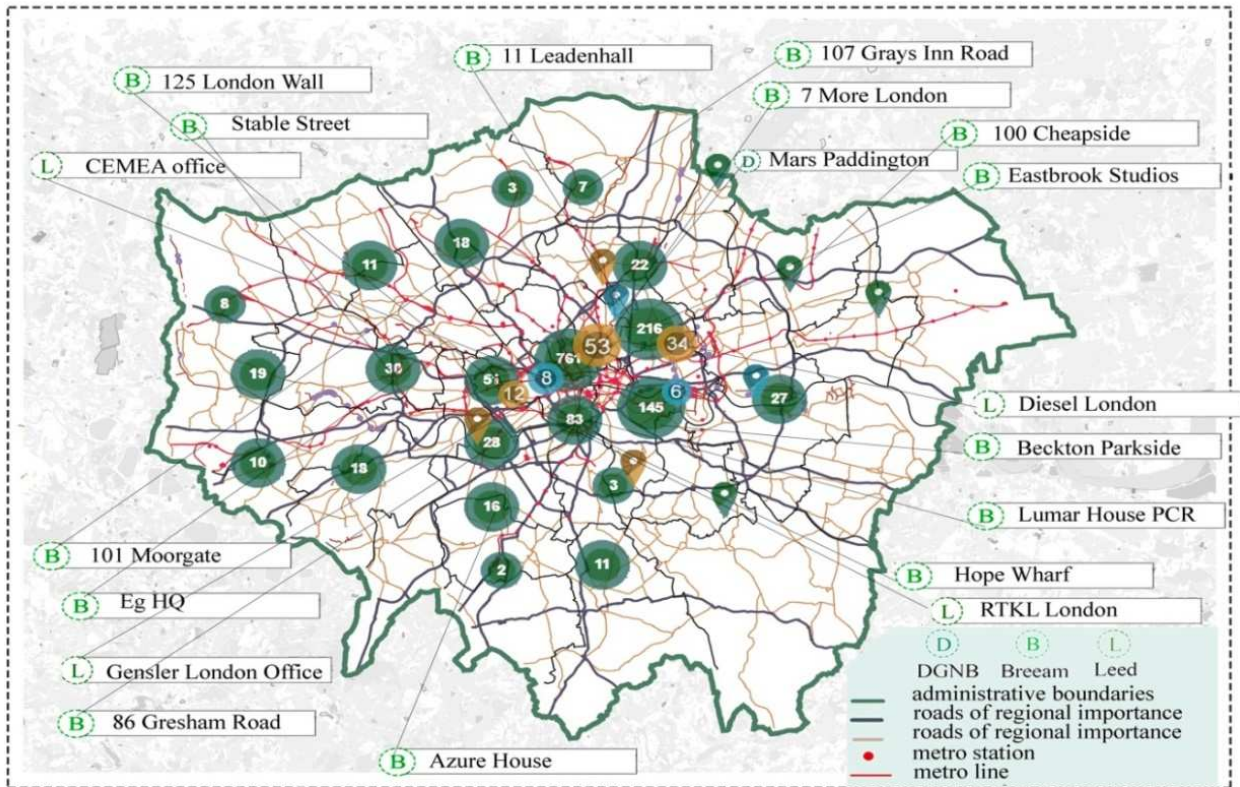


Fig. 2. The scheme of transport accessibility of green business centers in London (Source: Authors).

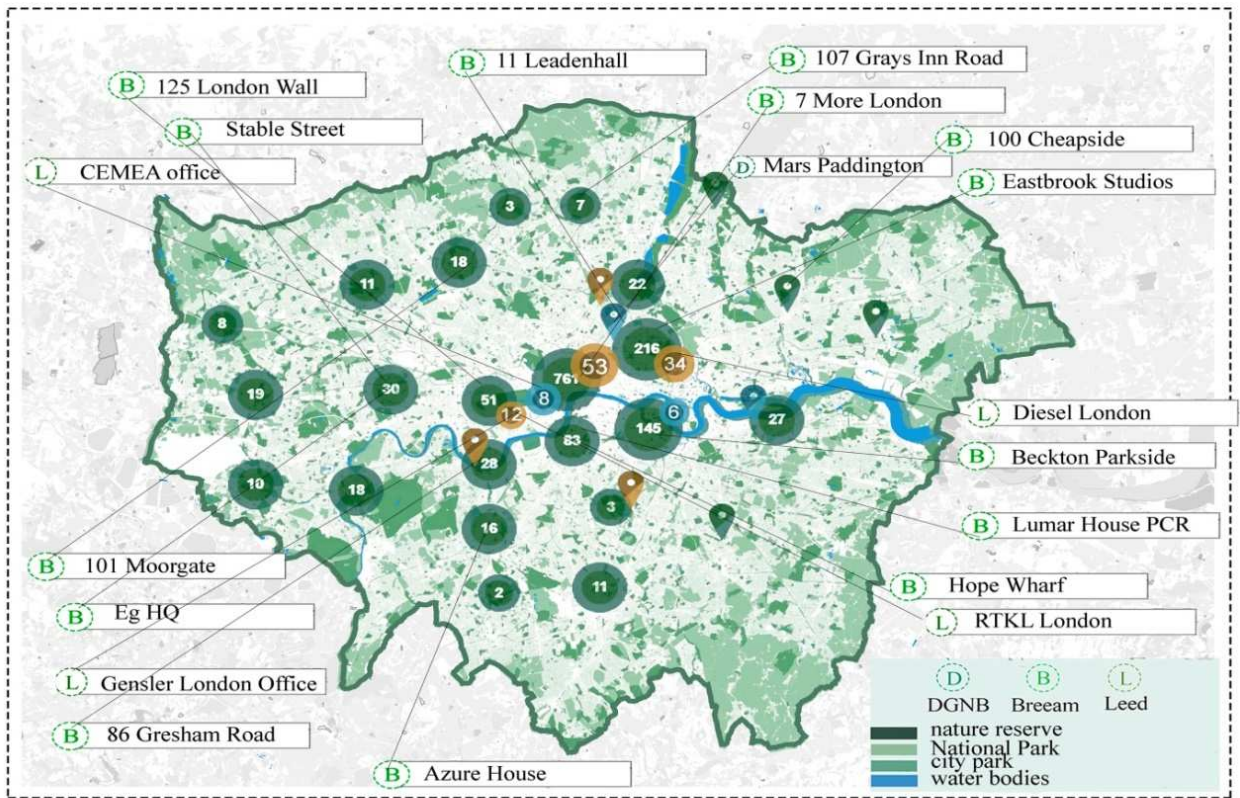


Fig. 3. The scheme of the relationship of green business centers with the water-green framework of London (Source: Authors).

In addition to general factors related to the location of business centers at the city level, which plays a key role, there are a number of additional factors that must be taken into account to create optimal conditions: accessibility of public transport (bus stops, trams or metro stations nearby); availability of alternative transport; proximity of social infrastructure; walking distance to green and water facilities.

The Westminster area of London was considered one of the unhealthiest places to live in the UK. The reason for this was the high level of air pollution, a lot of outlets that are harmful to health and a lack of green spaces. Various green solutions have been applied to improve the environmental situation in the Westminster City Council area. As of 2024, this district has the largest number of constructed and reconstructed office buildings (450 facilities) certified according to environmental standards (Douglas *et al.*, 2018; Hiroki, 2020).

A graphoanalytical analysis of the Westminster district was carried out, which made it possible to visualize and compare key parameters affecting the location and operation of green office centers.

- **Functional zoning.** The distribution of office buildings in the area is carried out evenly, which contributes to the creation of a comfortable urban environment and reduces the congestion of people in one place (Fig. 4):
 - Placement of green office buildings within a radius of 80-100 meters from each other;
 - 66% of office buildings are located in residential areas, which contributes to the development of the ecosystem in the city;
 - 21% of business centers form a single public and business zone;
 - 13% of office buildings are located within a radius of 600 meters from industrial areas.

- **Transport scheme.** The location of business centers increasingly takes into account the convenience of transport accessibility for employees and customers (Fig. 5):

- 63% of business centers are located within a radius of 20-80 meters from public transport stops;
- 21% of green office buildings are located 100-200 meters from metro stations, providing convenient access to office buildings for employees and customers;
- 16% of business centers have access to the main thoroughfares within a radius of 100-300 meters, allowing easy access by private or public transport.

- **Water-green frame.** Modern business centers are increasingly striving to create environmentally friendly and comfortable conditions for employees and customers (Fig. 6):

- 61% of offices are located within a radius of 364-520 meters from green spaces;
- 34% of green office buildings are located within a radius of 400-640 meters from water bodies, which creates a favorable environment for employees to relax and reduce heat island;
- 5% of the objects are close to recreation areas and are located within a radius of up to 400 meters from them.

3.2. Analysis of the location of green business centers in Russia

Taking into account the political and economic situation in the Russian Federation, the introduction of green standards in the construction of business centers began only at the beginning of the XXI century. This process was driven by increased attention to environmental aspects and sustainable development, which is associated with increasing global awareness of the importance of climate change.

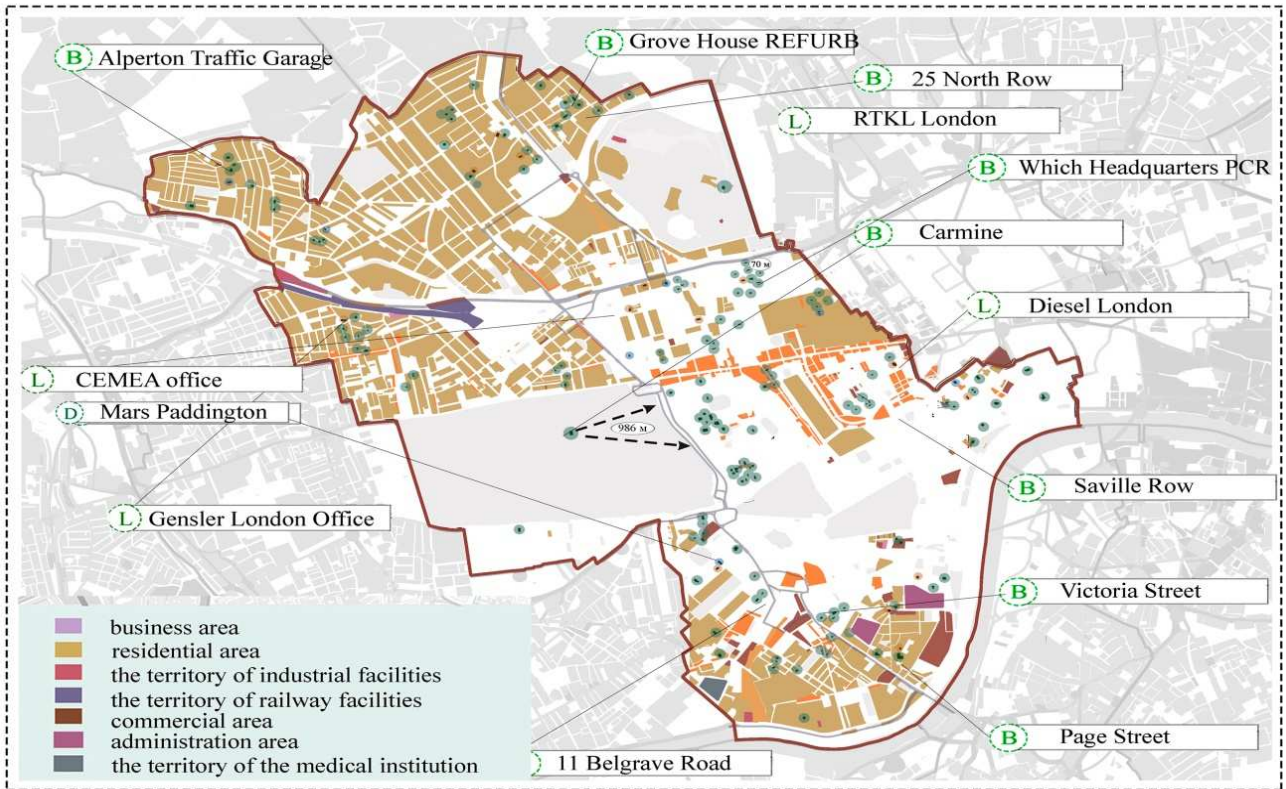


Fig. 4. Placement of green business centers in relation to the functional zoning of Westminster (Source: Authors).

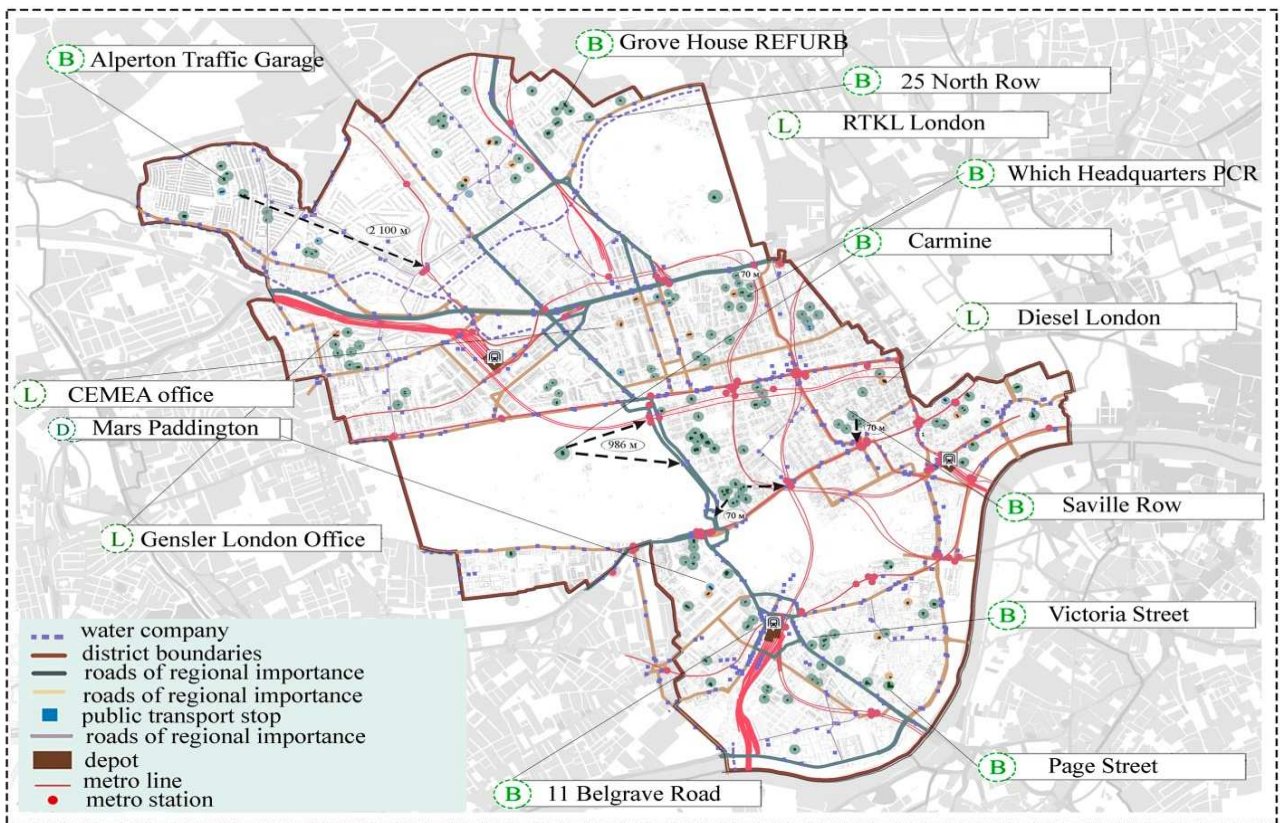


Fig. 5. The scheme of transport accessibility of green business centers in Westminster (Source: Authors).

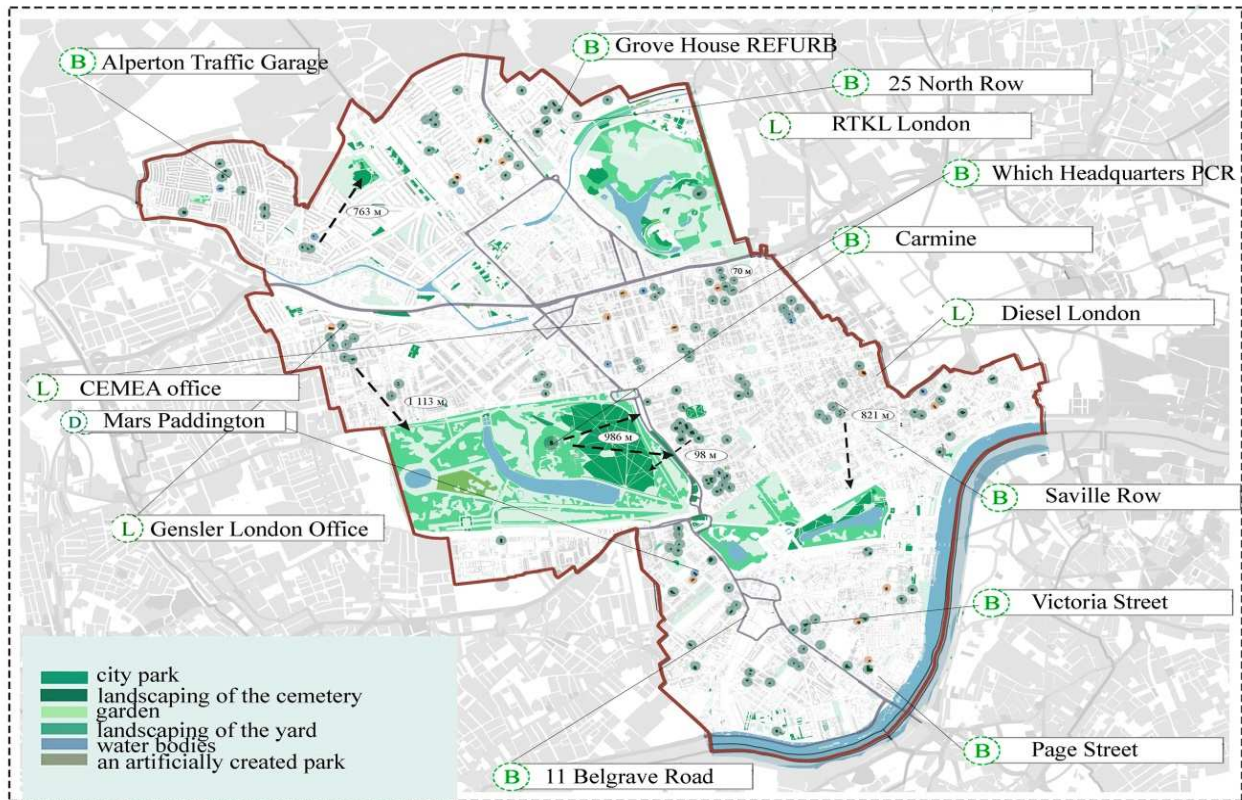


Fig. 6. The scheme of the relationship of green business centers with the water-green framework of Westminster (Source: Authors).

Ducat Place (2008) and Japanese House (2012) became one of the first office buildings in Moscow that meet international standards of ecological construction. These buildings have played an important role in the introduction of green standards in the Russian commercial real estate market. By 2024, there are more than 30 office buildings in Moscow that are certified according to environmental standards (Meshcheryakova, 2017).

Based on the conducted graphical analysis and diagrams, the following conclusions can be drawn on the placement of eco-certified business centers in Moscow.

3.2.1. At the city level

• **Functional zoning.** The location of the studied objects is fairly uniform, which contributes to the creation of a comfortable urban environment and reduces the concentration of specialists in one place (Fig. 7):

- Most of the green office buildings are located 400-800 m from each other;
- 48% of green office buildings are located in residential buildings;
- 25% of business centers are concentrated within a radius of 100 m from commercial and shopping areas;
- 18% of green business centers are located 100 m from significant railway stations;
- 9% of office buildings are located at a distance of 100 m from industrial areas.

- **Transport scheme.** The placement of certified business centers is mainly concentrated in the central part of the city (Fig. 8):
 - Most of the GBC are located in the central Administrative District;
 - There are no certified business centers in the eastern part of the city;
 - 65% of green business centers are located within a radius of 80-120 m from regional roads;

- 21% of green office buildings are located 100-200 m from metro stations;
- 14% of the green business centers are located outside the administrative border of the city.

- **Water-green frame.** Modern business centers are increasingly striving to create environmentally friendly and comfortable conditions for employees and customers (Fig. 9):
 - Location up to 800 m to urban and national parks have 70% of green office buildings;
 - 26% of office buildings are located 800 m from water bodies;
 - 4% of green business centers have equidistant access to water and green resources.

3.2.2. At the district level

Presnensky district in Moscow is considered one of the greenest in the central part of the city. Of all the districts of the capital in 2014, it has the largest number of offices built taking into account environmental standards (North Tower, Neva Towers, Ducat Place III, Ducat Place II, Beijing Gardens).

Despite the central location and the presence of transport interchanges, the area is considered green and has a good environmental situation. According to EcoStandard group monitoring data, the district's score is 6 points out of 10 (Klochkova and Sukhinina, 2017). Due to the transfer of enterprises to the periphery of the city, there is zero impact of enterprises on the ecology of the area and a high density of green areas.

A graphoanalytical analysis of the Presnensky district was carried out, which made it possible to visualize and compare key parameters affecting the location and operation of green office centers in the area (Fig. 10-12).

Analyzing the urban development situation, the following conclusions can be drawn:

- **Functional zoning.** The location of the objects is uniform (Fig. 10):

- More than 50% of the green office buildings are located 80-100 m from each other;
- The trend of the location of green office buildings in residential areas is 82%;
- 9% of business centers form a single public and business zone;
- 6% of business centers are located 100-200 m from railway stations;
- 3% of office buildings are located 600 m from industrial areas.

- **Transport scheme.** The following problems with accessibility and infrastructure are identified (Fig. 11):

- 52% of business centers have access to the main transport routes within a radius of 80-200 m;
- Over 34% of business centers are located 80 m from public transport stops;
- More than 14% of office buildings are remote (more than 1001 m) from metro stations;
- Lack of cycling infrastructure in close proximity to green business centers.

- **Water-green frame.** Modern business centers are increasingly striving to create environmentally friendly and comfortable conditions for employees and customers:

- The demarcation of highways and office buildings with green stripes was revealed in 2% of objects;
- 21% of green buildings have a location within a radius of 638-640 m from water bodies;
- More than 77% of green business centers are located near green areas.

3.3. Environmental aspects of the placement of green office buildings abroad and in Russia

With the help of a graphic-analytical analysis of the city and the district, the environmental, economic and social aspects of the placement of the GBC are revealed.

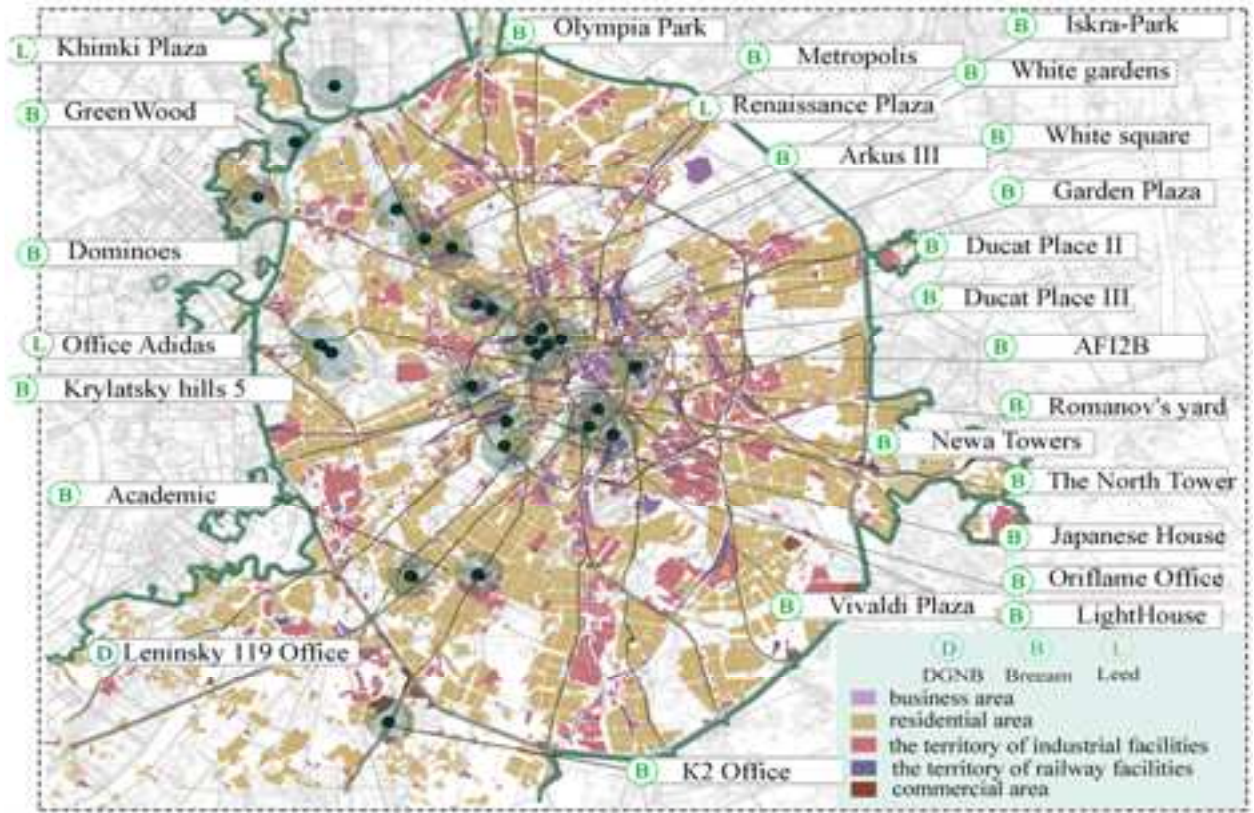


Fig. 7. Placement of green business centers in relation to the functional areas of Moscow (Source: Authors).

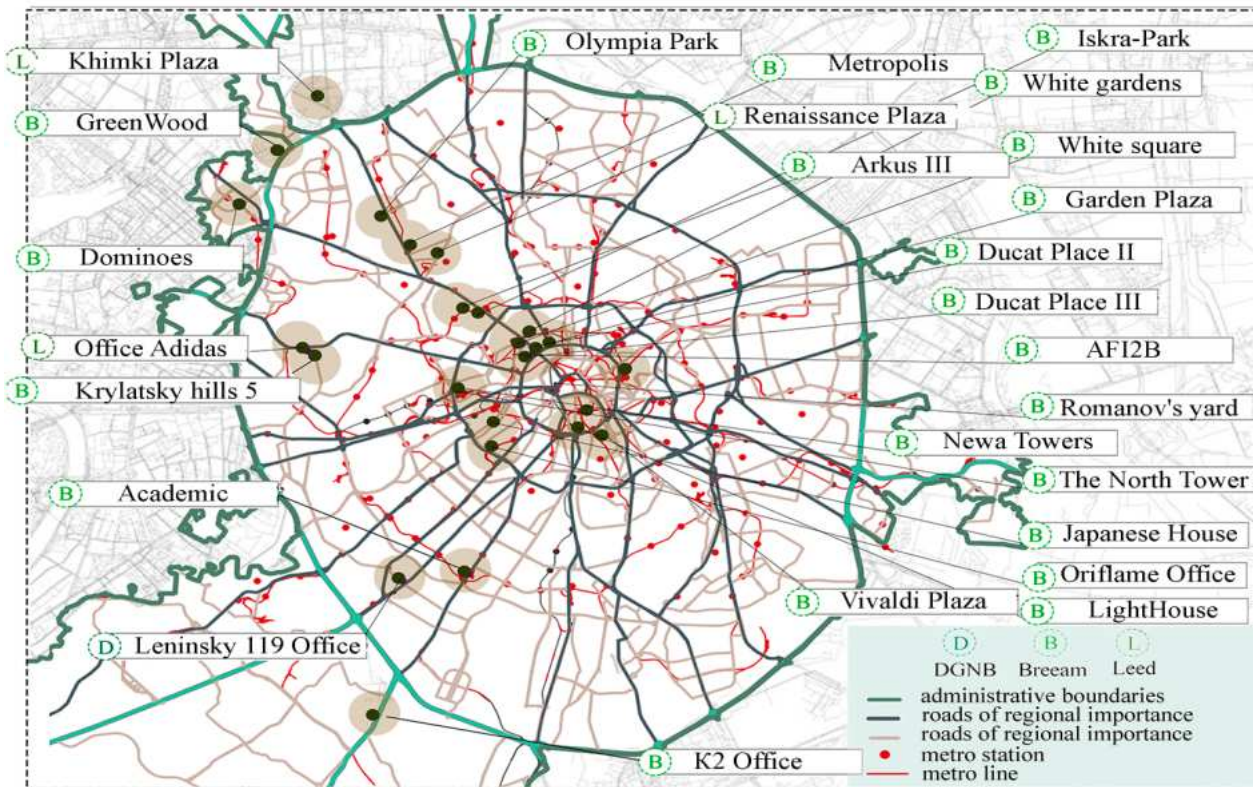


Fig. 8. The scheme of green business centers transport accessibility in Moscow (Source: Authors).

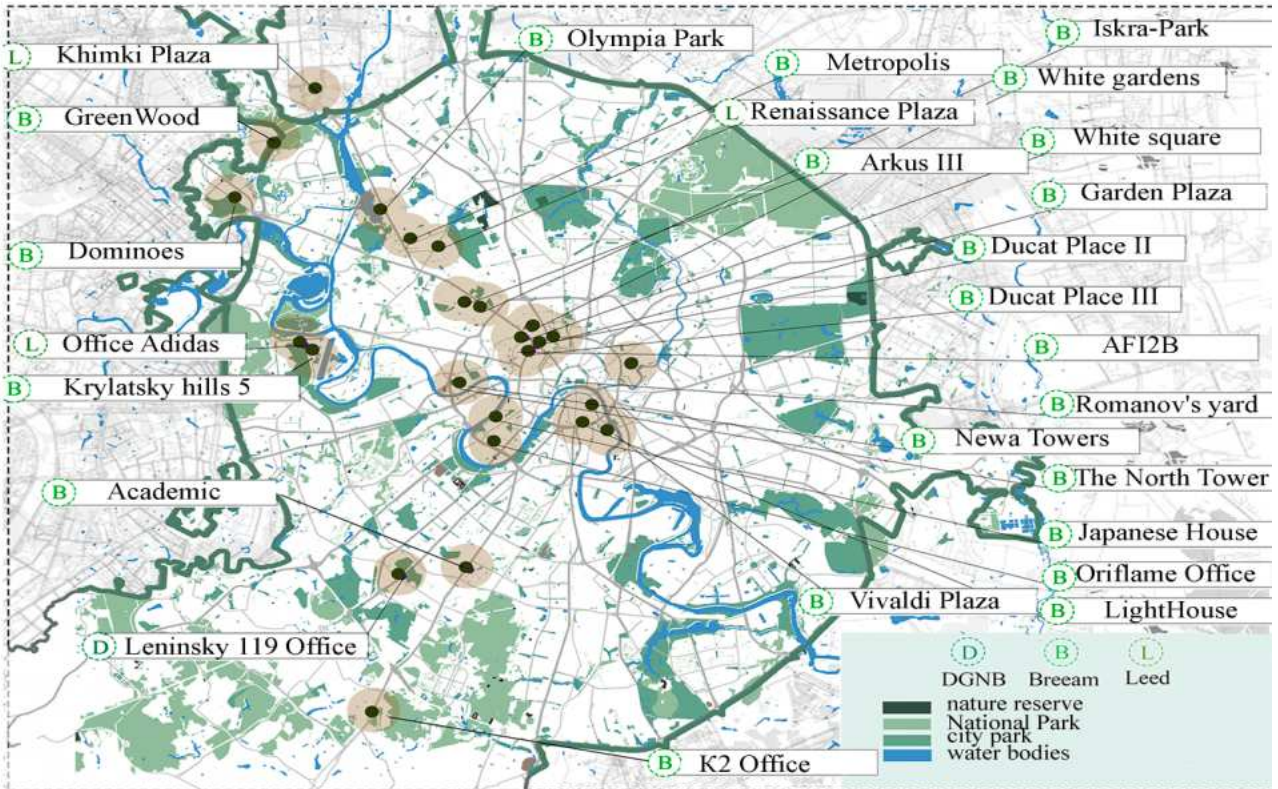


Fig. 9. The scheme of the relationship of green business centers with the water-green framework of Moscow (Source: Authors).

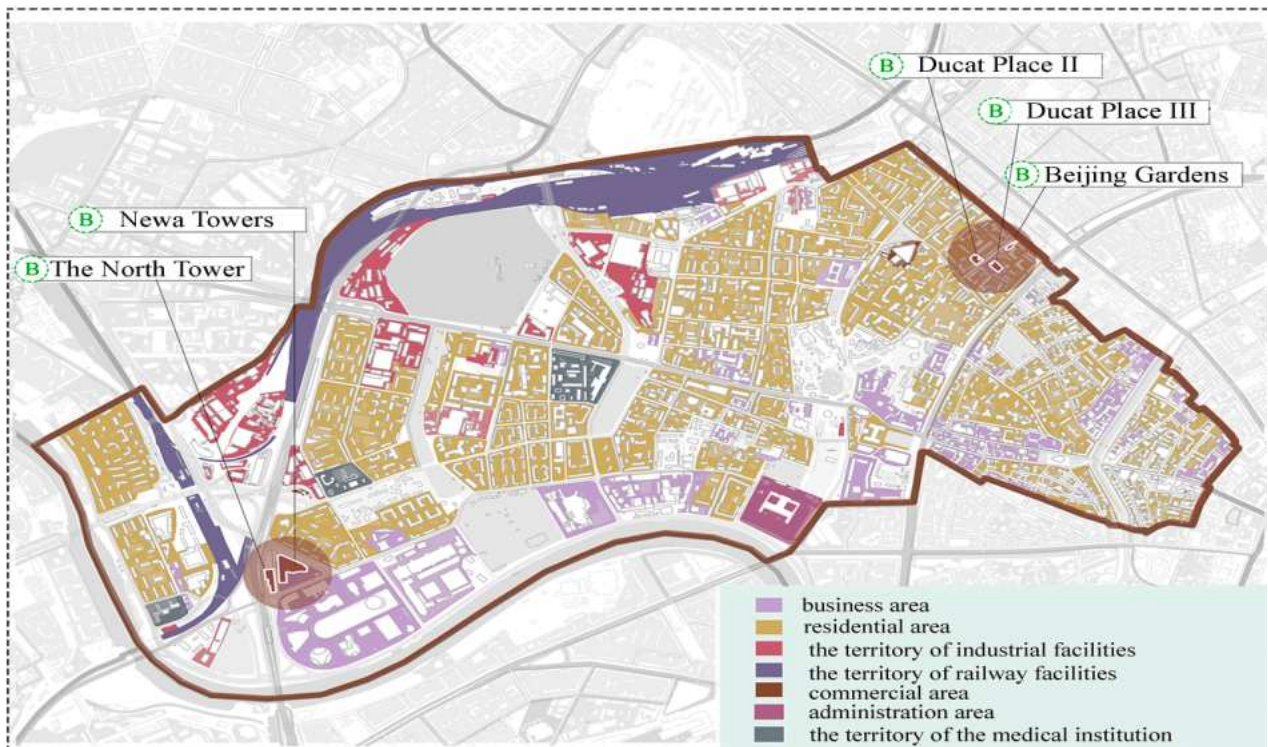


Fig. 10. Placement of green business centers in relation to the functional areas of the Presnensky district (Source: Authors).

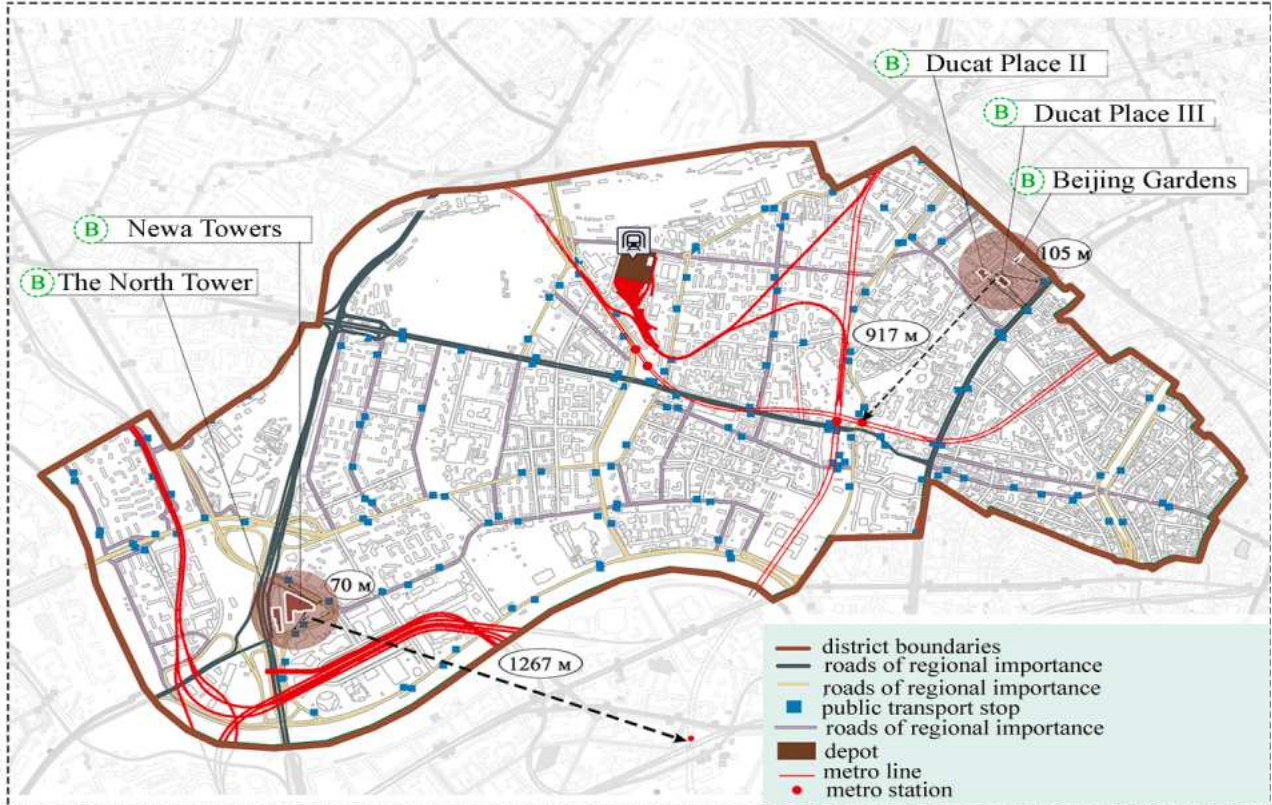


Fig. 11. The scheme of transport accessibility of green business centers in Presnensky district (Source: Authors).

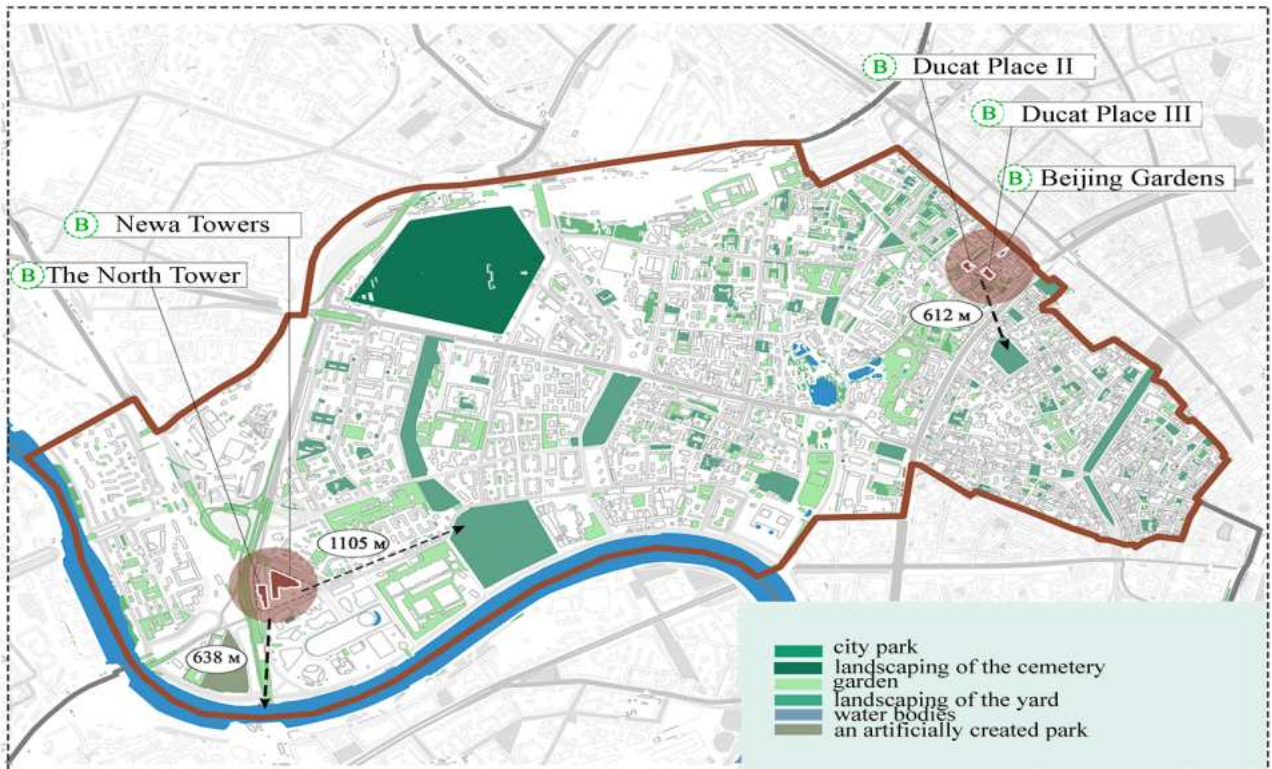


Fig. 12. The scheme of the relationship of green business centers with the water-green framework of the Presnensky district (Source: Authors).

Table 1. Analysis of environmental, economic and social aspects of the placement of green business centers abroad and in Russia at the city level.

№	Placement aspects	City		District	
		London	Moscow	Westminster	Presnensky
ENVIRONMENTAL ASPECTS					
1	Proximity to low-carbon transport	64%	46%	55%	37%
	Water transport	15%	6%	6%	2%
	Tram tracks	33%	30%	-	-
	Metro	16%	10%	43%	35%
	Bike paths	-	-	6%	-
Max=100%					
2	Accessibility of green facilities	73%	70%	54%	77%
	Nature parks	28%	21%	6%	3%
	City parks	45%	49%	41%	44%
	Squares	-	-	5%	21%
	Boulevards	-	-	2%	9%
Max=100%					
3	Accessibility of water bodies	29%	39%	34%	21%
	Rivers	15%	21%	13%	12%
	Lakes	14%	18%	6%	-
	Ponds	-	-	9%	4%
	Small water bodies (fountains)	-	-	6%	5%
4	Distance from industrial areas	57%	64%	43%	67%
Max=100%					
ECONOMIC ASPECTS					
1	Access to major highways	86%	89%	64%	79%
	Federal roads	16%	19%	2%	16%
	Regional roads	21%	31%	12%	21%
	Roads of regional importance	28%	24%	24%	24%
	Railway transport	13%	15%	18%	16%
	Water transport	8%	-	8%	2%
Max=100%					
2	Access to public transport	-	-	92%	55%
	Bus stops	-	-	63%	30%
	Metro	-	-	21%	25%
	Bike paths	-	-	8%	-
	Tram tracks	-	-	-	-
Max=100%					
3	Access to economically significant facilities	52%	49%	58%	52%
	Administrative facilities	11%	15%	10%	19%
	Shopping facilities	18%	20%	19%	17%
	Office buildings	23%	14%	29%	16%
Max=100%					
SOCIAL ASPECTS					
1	Proximity to residential buildings	58%	48%	66%	48%
Max=100%					
2	Access to infrastructure	69%	63%	48%	50%
	Commercial facilities	25%	21%	26%	23%
	Healthcare facilities	13%	14%	7%	12%
	Food facilities	31%	28%	15%	15%
Max=100%					
*«-» - this indicator is not used,					
Max=100% - the maximum percentage that can be obtained for this aspect					

Table 1 provides a summary of key indicators that determine the feasibility of placing eco-friendly facilities at the city and district levels. The analysis takes into account only those business centers that meet the conditions of this indicator. The maximum amount for each indicator is 100%. The formula is used to find the average percentage for each indicator:

$$x\%_{cp} = \frac{x\%_1 + \dots + x\%_n}{n}, \text{ where}$$

$x\%_{cp}$ – the average percentage by aspect;

$x\%_1, \dots, x\%_n$ – the sum of all % criteria by aspect;

n – the number of all criteria for the aspect under consideration.

The analysis of the above data showed that at the city level, London has the highest indicators on environmental and social aspects – 64% and 63,5% than Moscow, which has indicators of 38,75% and 55,5%. This indicates a more effective environmental policy and a high level of sustainable development in London.

In economic terms, London and Moscow show identical results – 60%. At the district level, in terms of environmental aspects, the highest figure is observed in the Presnensky district – 50%, while in the Westminster district it is 46,5%. According to the economic aspect, the Westminster district shows a value of 71,3%, while the Presnensky district has a lower result – 62%. As for the social aspects, in the Westminster district this figure reaches 57%, in the Presnensky district it is much lower and amounts to 49% (Table 1).

4. Conclusions

The analysis of the placement of certified office buildings in Moscow and London made it possible to identify differences and similarities in the location of objects in the city and district, to determine their

impact on the environment and the comfort of living of citizens:

- **Functional zoning:**

- Business centers in both cities under study play a key role in the formation of a social and business zone, contributing to the concentration of business activity and creating conditions for interaction between various sectors of the economy. These zones are important centers of attraction not only for business, but also for various social events.

- The integration of business centers into residential and commercial areas of the city is an important element of the strategy to create a more harmonious urban environment. This helps to reduce the need for travel, which, in turn, reduces the load on the transport system and improves the environmental situation in the city.

- The density of business centers in London is significantly higher compared to Moscow. The high level of urbanization and the limited availability of land in London lead to a more compact location of business facilities in the central and adjacent areas of the city. As a result, business centers strive to maximize the use of available space, which contributes to the creation of a dense and integrated business environment.

- In conditions of high building density in London, there is a tendency to renovate existing office buildings.

- There is a predominance of new construction in Moscow, which is associated with wider opportunities for development and the availability of vacant land.

- **Transport scheme:**

- The cities under study pay significant attention to improving the transport accessibility of business centers, which is an important aspect in urban infrastructure and contributes to improving the efficiency of work processes.

- In London, there is an active desire to create favorable conditions for cycling (bike parks, dedicated bike lanes).
- In Moscow, the infrastructure for cycling is still at an early stage, which limits the use of bicycles for daily movement around the city.
- **Water-green frame:**
 - In Moscow and London, there is a tendency to place office buildings near green spaces, which has a positive effect on the microclimate of the surrounding area and the emotional state of employees.
 - One of the innovative directions in the development of London's urban infrastructure is the Blue Ribbon project, which provides for improving the use of rivers and canals near green office buildings. This project is aimed at integrating waterways into the alternative public transport system, which helps to reduce the traffic load on urban highways and improve the environmental situation.

Based on the conducted research, several directions can be identified to improve the urban "office environment" in Russian cities:

- Improving the quality and convenience of public transport, including the development of new routes;
- Development of infrastructure for alternative modes of transport (bicycles, electric scooters);
- Preservation of existing green areas and integration of new parks into the urban environment in areas with poor ecology;
- Creation of specialized business clusters in the central areas of cities with good transport accessibility and developed infrastructure;

- Integration of advanced green and information technologies into urban infrastructure management (monitoring, data analysis and process automation systems);
- Improving the accessibility and quality of services for people with disabilities, including the creation of a barrier-free urban environment;
- The use of environmentally friendly building materials and technologies in the creation of new urban infrastructure:
 - Installation of specialized filters on major highways and the development of vertical gardens on building facades;
 - Creation of a convenient network for separate garbage collection with clear instructions for the public.

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