Methodology for the selection of the integrated development territories for the multi-story residential building construction with the eco-standards implementation

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Abstract. In modern conditions, the tasks of transition to the territorial sustainable development are complex and cannot be reduced only to the sectoral issues. The solution of the tasks set must be based on taking into account the natural environment development laws, as well as the laws of the public institutions’ development and the economic mechanisms development. An economic policy with an analysis of the state of the Rostov Region economy sectors is presented in the Strategy for the Socio-Economic Development of the Rostov Region 2020-2030 (hereinafter referred to as Strategy 2030), which also considers the key trends in the construction industry. According to Strategy 2030, the Rostov Region, according to many indicators of the construction complex, is consistently among the leaders in Russia. The volume of work performed by the type of economic activity “Construction” is steadily growing. The Don region is in the TOP-10 of the constituent entities of the Russian Federation with the maximum housing commissioning volume.

1. Introduction
The development of an integrated approach to residential development is currently becoming a real alternative to the punctiform development. A growing number of developers are working within the territorial integrated development framework using the new standards for the urban environment formation. Complex development projects are carried out as a part of a single general plan, which includes, in addition to the actual residential facilities, social and commercial infrastructure located within the residential neighborhoods [1].

At the same time, there is an increase in the volume of eco-houses construction (renovation of used housing) with zero energy consumption and “active” houses, which reduce their operation cost in most developed countries. Green building certification systems are being developed (BREEAM (Great Britain), Demarche HQE (France), LEED (USA), EcoProfile (Denmark), DGNB (Germany), CASBEE (Japan) and GBI (Canada). “Green zoom” green standard has been developed in Russia, and has two functions: assessment of the buildings’ energy efficiency and a system of recommendations for improving energy efficiency.

Based on Strategy 2030 [2], the authors of the article developed a SWOT analysis of the construction complex of the Rostov Region, presented in Figure 1.
| Strengths                                                                 | Weaknesses                                                                 |
|------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 1. According to many indicators of the construction complex, the Rostov Region is consistently among the leaders in Russia | 1. Land scarcity for development.                                           |
| 2. Good strategic and local location                                   | 2. Low innovation activity of the construction organizations.              |
| 3. Growing market                                                      | 3. Shortage of personnel in the construction specialties.                  |
| 4. The emergence of the new technologies in construction               | 4. Administrative restrictions on obtaining the building permits.          |
|                                                                      | 5. Difficulties of putting the real estate objects on the state cadastral registration and procedures for the state registration of rights to real estate. |
|                                                                      | 6. The emergency housing availability.                                     |

| Capabilities                                                                 | Threats                                                                 |
|-----------------------------------------------------------------------------|-------------------------------------------------------------------------|
| 1. Strengthening urbanization and, as a result, increased demand for new housing in the cities. | 1. Economic crisis. Consequences of COVID-19                             |
| 2. Growing requirements for the integrated residential development, providing for the associated development of infrastructure. | 2. Decline in fertility and mortgage lending                              |
| 3. Improving the efficiency of the construction activities through the new technologies’ introduction. | 3. Environmental degradation                                              |
| 4. The spread of environmental technology in construction.                  |                                                                         |
| 5. Humanization of urban space.                                             |                                                                         |

**Figure 1.** SWOT analysis of the construction complex in the RO

Moving forward to the goals of Strategy 2030 will require work to update the regional legal framework, because the modern legislation should offer a model for the harmonious development of the society, maintaining a balance of private and public interests [3].

**2. Theoretical part**

It is worth noting that under the current conditions of urban density and spot construction, the quality of the urban environment and the comfort of living are declining, respectively, the construction with the environmental requirements’ observance and the infrastructure development come to the fore. Compliance with these conditions becomes possible during the construction in the territories of integrated development with the eco-standards’ introduction [5].
Based on the foregoing, it is required to develop a methodology that can generalize, systematize and optimize the process of managerial decisions when choosing the place of the residential building construction with the eco-standards’ introduction. The choice of construction site is extremely important and a whole range of factors should be taken into account:
- local environmental conditions;
- environmental and geological risks;
- terms of the territorial engineering equipment;
- social, industrial and transport infrastructures;
- large enough to accommodate all types of construction.

The right territorial choice will help to avoid the rise in price of the construction object and the project as a whole, as well as the effectiveness of investment in the populated areas territories’ development.

In the process of conducting research, a methodology for choosing the territories of integrated development for the construction of a multi-storey residential building (hereinafter MSRB) with the introduction of eco-standards, consisting of six stages has been developed. Depending on the scale of implementation, the stages are combined into three levels: “City”, “Micro-district” and “Object”. The developed methodology is presented in Figure 2.

**Figure 2. Methodology for the integrated development territories’ selection for the construction of a multi-story residential building with the eco-standards’ implementation**

**City «Level»** includes the stages 1 and 2 of the Methodology and an integrated study of the city.

**Stage 1.** This stage includes an analysis of the master plan for the city development, which allows not only to analyze the urban development, but also to study the main directions of the city urban development, as well as the volume assess of the existing and new housing construction. Also, at the 1st stage, an analysis of the Land Use and Development Rules is carried out in order to assess the territories for compliance of the land’s actual use with the permitted use types, as well as to establish the sizes and parameters of the land, to identify the areas within which boundaries it is possible to construct the multi-storey residential buildings within the framework of the integrated territorial development.
Stage 2. At the stage 2, an analysis of the map for a comprehensive assessment of the territories of the Rostov-on-Don city and the selection of several options for the territories subject to integrated development.

A map of the comprehensive assessment of territories is a graphic display of the total value coefficient of each of the city territories [6-8]. In Rostov-on-Don, the Department of Architecture and Urban Planning has currently identified 4 areas of integrated development, presented on a comprehensive assessment map, where the value of the territory grows from the periphery to the center, and from the lightest to the darkest color (Figure 5).
Figure 5. Map of a comprehensive assessment of the Rostov-on-Don city

Level “Micro district” includes the 3rd and 4th stages of the Methodology with the study of the separate territories previously selected by the Department of Architecture and Urban Planning of Rostov-on-Don.

Stage 3. At this level, the refined environmental factors for a comprehensive assessment of the territory, necessary for a more thorough assessment of the territories are being developed.

Stage 4. A comparative assessment of the territories is carried out according to the specified factors with the choice of the territory for the multi apartment buildings’ construction (hereinafter - MAB) with the eco-standards introduction.

At the “Object” level, within the 5th and 6th stages of the Methodology, a point analysis of a specific object is performed.

Stage 5. The development of a feasibility study and working draft with the implementation of eco-standards is carried out at the 5th stage. A set of project documentation is being formed; documentation is being evaluated by the categories of the standard of the national association of civil engineers 2.35.4–2011 “Green Building” eco-standard categories to assign a habitat sustainability class.

The total value of the S-factor indicator obtained as a result of the calculations will be the final rating assessment of the environment sustainability. Which one of the seven classes of environmental sustainability will be assigned to the project (building) depends on the amount of points obtained as a result of determining the S-factor: A, B, C, D, E, F, G.

Environmental certification is a reasoned and evidence-based confirmation of the quality of a product or object for the customers, users, partners and the expert community.

The eco-standards’ introduction in the development, design and construction in the territories of integrated development will allow to pay special attention to the development of both green initiatives, engineering infrastructure and landscaping.

Table 1. Assessment Factors for Each Level of Procedure.

| Level "City" | Level "Microdistrict" | Object Level |
|--------------|------------------------|--------------|
| Standard factors for the integrated territory assessment | Refined factors for a comprehensive assessment of the territory | MCD assessment factors with the introduction of an eco-standard |
| 1. Accessibility of the population to the city center, cultural and consumer services of citywide significance | 1. Landscaping of the territory | Category 1. Comfort and environmental quality |
| 2. Provision with centralized engineering equipment and landscaping | 2. The proximity of the aquatic environment and visual comfort | Category 2. Quality of architecture and layout of the facility |
| 3. The development level of the cultural and public services sphere for the population | 3. Accessibility of ecological transport | Category 3. Comfort and the environment |
| 4. The historical value of the building, the aesthetic and landscape value of the territory | 4. Quality of sanitary protection | Category 4. Quality of sanitary protection and waste disposal |
| 5. Environmental conditions, sanitary and microclimatic conditions | 5. The quality of waste management | Category 5. Rational Water Use |
| 6. Engineering and geological conditions of construction and the | 6. The choice of the territory for development | Category 6. Energy Saving and Energy Efficiency |
Stage 6. The development of a set of measures to improve the environmental situation and reduce the environmental risks is carried out at the 6th stage of the methodology. These events are grouped by the technical features and are presented in Figure 7.

| degree of territory susceptibility to the destructive effects of nature | 7. Recreational value of the territory | 8. Development of the territory. Restoration of green spaces. Maximizing the open space | 9. Thermal effect |
|---|---|---|---|
| 7. Building density and infrastructure availability | Category 7. Use of alternative and renewable energy | Category 8. Ecology of the creation, operation and disposal of the facility | Category 9. Economic Efficiency |
| 8. Development of the territory. Restoration of green spaces. Maximizing the open space | Category 10. Quality of preparation and project management |

**Constructive decisions**
- Selection of enclosing structures, parameters and selection of thermal insulation
- Absorption heating and cooling systems
- Finished materials and furniture with low air pollution and / or FSC certification
- Mechanical ventilation with heat recovery
- Facade dimming structures

**Energy saving measures**
- Energy-efficient elevators and escalators
- LED lightening
- Natural daylight
- Presence sensors
- Accounting for the consumption of thermal electric energy (by zones)
- Water consumption metering
- Water-saving plumbing equipment
- Reuse of purified water
- Indoor gardening

**Alternative energy sources**
- Solar panels and collectors
- Vertical wind generators
- Green roof

**Operational activities**
- Building management systems
- Waste management
- Technical audit of building engineering systems
- Stormwater Management

**Infrastructure**
- Availability for the low mobility groups
- Infrastructure for the use by bicycles
- Transport planning, transport social infrastructure

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Figure 6. The key eco-development activities

Particular attention should be paid to the refined assessment factors for the territories and facilities. The refined factors for a comprehensive assessment of the territory were developed on the basis of the eco-standards standard of the national association of civil engineers 2.35.4–2011 “Green Building” and LEED. Within the framework of the methodology, a calculation formula that makes it possible to assess the environmental suitability of the territories of integrated development (formula 1), the maximum value of which is 1, is proposed. The method is based on determining the environmental suitability coefficient of the assessment area.

\[ K_{eco} = f_1 + f_2 + f_3 + f_4 + f_5 + f_6 + f_7 + f_8 + f_9, \]  

where \(K_{eco}\) – is the appraisal site environmental suitability coefficient;
$f_1 - f_9$ – are the specified environmental factors presented in Table 2.

3. Experimental part

The recommended numerical values, names and methods for determining the developed refined environmental factors are presented in Table 2.

Table 2. Calculation methods for refined factors of integrated assessment.

| № p/p | Sub-factors | Recommended Thought values | Method for determining the numerical value |
|-------|-------------|----------------------------|-------------------------------------------|
| Factor 1 | Environmental Quality, Sanitation and Waste Management |
| 1.1 | Territory Landscaping ($f_1$) | 0.13.0.17 | We carry out the calculation of the greened house territory area ratio to the total area of the house territory. With the obtained value of more than 15%, we assign the numerical value $\sim 0.17$. If the value is in the range of values from 11-15%, then $0.15$. If it is in the range of 5-10%, then 0.13. |
| 1.2 | Proximity to the aquatic environment and visual comfort ($f_2$) | 0.025.0.05 | The influence of the proximity factor of the aquatic environment and visual comfort is determined by the presence of the unbogged natural water bodies, and the presence of artificial water bodies in the local area. Visual comfort is determined by subjective assessments of the landscape, facades, roofs, windows, interiors monotony lack. |
| 1.3 | The availability of ecological transport ($f_3$) | 0.13 | Analysis of the design documentation data for the presence of bicycle parking, bicycle paths in the adjacent territory and special parking for electric vehicles. |
| 1.4 | Quality Sanitation ($f_4$) | 0.05 | Analysis of the project documentation and visual inspection for the presence of: sealed garbage chutes and compartments with autonomous mechanical ventilation, automated antibacterial treatment systems (UV installations, ozonation) and automated rodent and insect protection systems for garbage chutes, pantries, basements and underground parking lots. |
| 1.5 | The quality of waste management ($f_5$) | 0.10 | The organization of the primary sorting of waste, the availability of a system for the disposal of used mercury wastes is determined by the sub-factor “Quality of the organization of waste collection and disposal”. |
| Factor 2 | SS (sustainable sites): Adjoining territory |
| 2.1 | The choice of the development territory ($f_6$) | 0.20 | Sub-factor 1 “Selecting a development area” means a ban on the development of ecologically valuable lands, such as agricultural land, on lands that are the habitat of animals protected by the state law on the protection of endangered species, on previously undeveloped lands at a distance of less than 15 m from water (seas, lakes, rivers, streams and canals), on land, which was supposed to be parks before the start of the project. The fulfillment of the conditions is estimated at 0.20 point. |
| 2.2 | Building | 0.10 | Sub-factor 2 “Building Density and Accessibility of |
Density and infrastructure availability \((f_7)\) | Infrastructure” assesses the development of urbanized areas with existing infrastructure, the protection of undeveloped territories, and the provision of building density. Object should:  

- settle on previously developed lands;  
- within a radius of 800 m from the residential area with an average building density of 13,800 m² per 1 ha;  
- have at least 10 objects of social, cultural and domestic use (schools, kindergartens, hospitals, utilities, shopping and entertainment centers, etc.) within an 800 m radius.  

Fulfillment of the conditions is estimated at 0.10 point.

| 2.3 Development of the territory. Restoration of green spaces. Maximizing the open space \((f_6)\) | 0.10 | Sub-factor 3 “Territory Development. Restoration of green spaces. Maximizing open space” evaluates the quality of environmental protection and restoration of green spaces. In the previously developed territories, it is necessary to protect or restore the green spaces at least 50% of the territory (calculation is from the territory not occupied by the building) or 20% of the total area of the site. It is necessary to plant the zoned plants adapted to the local living conditions and requiring minimal watering or dispensing with it. Reconstruction activities may include replacing unnecessary sidewalks and road surfaces with plants or replacing large lawns with trees and shrubs. The fulfillment of the conditions is estimated at 0.10 point.

| 2.4 Тепловой эффект \((f_9)\) | 0.10 | Sub-factor 4 “Thermal effect” estimates the decrease in heat load on the solid surfaces of the developed area (including roads, sidewalks, parking lots, yards). Obtain shading of the territory for 5 years from trees that should be planted during the commissioning of the facility (provide a site plan with the specified shading). Plant zoned fast-growing trees. Get shading from the architectural forms and structures. The material of hard surfaces with a solar reflection coefficient of more than 29 is used. For outdoor parking lots, plastic or concrete lawn grilles are used to give the grass cover high resistance to mechanical stress. Make the most of multi-storey indoor parking lots, including automated ones. The fulfillment of the conditions is estimated at 0.10 point.

\[
\sum = 1
\]

Within the framework of the developed methodology, the environmental suitability coefficient for the territories of the integrated development in Rostov-on-Don was calculated, presented in Table 3. 4 territories of the integrated development in the city of Rostov-on-Don, identified by the Department of Architecture and Urban Planning of the city, were analyzed, the figure is highlighted in blue color.
**Figure 7.** The integrated development territories in Rostov-on-Don

**Table 3.** Calculation of the refined complex assessment factors for the territories of integrated development in Rostov-on-Don

| Factors / Territories                                                                 | 1    | 2    | 3    | 4    |
|-------------------------------------------------------------------------------------|------|------|------|------|
| 1.1 Landscaping of the territory                                                   | 0.17 | 0.13 | 0.17 | 0.15 |
| 1.2 Proximity to the aquatic environment and visual comfort                         | 0.05 | 0.05 | 0.05 | 0.025|
| 1.3 The availability of ecological transport                                        | 0    | 0    | 0.13 | 0.13 |
| 1.4 Quality Sanitation                                                              | 0    | 0    | 0.05 | 0    |
| 1.5 The quality of waste management                                                 | 0.10 | 0    | 0.10 | 0.10 |
| 2.1 The choice of the territory for development                                     | 0    | 0.20 | 0.20 | 0    |
| 2.2 Building density and infrastructure availability                                 | 0    | 0.10 | 0.10 | 0    |
| 2.3 Development of the territory                                                   | 0.10 | 0    | 0.10 | 0    |
Restoration of green spaces.

| 2.4 Thermal effect | 0 | 0 | 0.10 | 0 |
|---------------------|---|---|-----|---|
| Total numerical value $K_{eco}$ | 0.42 | 0.48 | 1 | 0.375 |

As a result, the section with the highest value is selected $K_{eco}$.

For the territory №3 the site environmental suitability is:

$$K_{eco} = 0.17+0.05+0.13+0.05+0.10+0.20+0.10+0.10+0.10=1$$

As a result of the calculation (formula 2), only the territory №3, located in the Voroshilovsky district, has an indicator equal to the maximum value, respectively, this territory is the most environmentally suitable for the construction of the MSRB with the introduction of an eco-standard for both the facility and the territory as a whole.

4. Summary

The developed methodology for the integrated development territories’ selection for the MSRB construction of the MSRB with the introduction of eco-standards meets all the requirements for solving the problems associated with the transition to sustainable development. This technique is intended for use by the specialists in urban planning and spatial planning, as well as in the field of the environmental certification. The work related to the city development planning, as well as the urban planning decisions made when implementing the developed methodology by these specialists, will be distinguished by the increased scientific validity [9,10].

Environmentally sound selection of the territory and construction in compliance with the environmental requirements will allow to achieve the maximum productivity and environmental friendliness of the certified objects, as well as to minimize the operating costs while minimizing the material costs to eliminate the environmental risks.

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