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THE ECOLOGICAL ASPECT OF ESTABLISHING A NETWORK OF SPORTS AND LEISURE COMPLEXES WITHIN AN URBAN ENVIRONMENT

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Abstract. *This article investigates the ecological aspect of forming a network of sports and leisure complexes within the structure of a modern city. It has also identified techniques for forming these complexes within a city's green spaces. Additionally, the main elements of the network of sports and leisure complexes and their principles of integration into the "ecological framework" of a city have been determined. These elements and principles can be used for planning and developing various cities, contributing to the creation of a more sustainable and environmentally balanced environment.*

Key words: *ecological framework of a city, green space, integration, network, sports and leisure complex, urban environment.*

Introduction.

The consequences of ongoing urbanization include not only economic development and technological progress but also a range of negative phenomena. One of the negative aspects is the deterioration of both the physical and mental health of urban populations [1, p. 82], which suffer from hypodynamics and lack of physical activity. The comfort of urban conditions reduces the levels of physical exertion in both occupational and domestic settings, leading to a deterioration in the functioning of all physiological systems of the body. Therefore, the increasing interest in an active lifestyle among city residents and the growing significance of the environment for sports and leisure activities should be considered a natural process.

In this study, sports and leisure complexes (SLCs) are considered as a collection of physical activity facilities that urban residents. These complexes which vary in size and equipment, are located in parks, gardens, squares, boulevards, and riverfronts, which tend to be close to residential areas (Fig. 1-3). Each SLC includes a different set of sports grounds designed for such types of physical activity as panna football, streetball, bodyweight workouts, CrossFit, skateboarding, BMX, and parkour. These complexes, along with pathways for pedestrians and cyclists connecting various locations within these complexes and residential areas, form a network of sports and leisure complexes. This contributes to the promotion of an active lifestyle and the development of sports communities in the city. Thanks to the accommodation and accessibility of these complexes in different areas of the city, residents have the opportunity to more fully utilize their potential for physical development and engage in a healthy lifestyle [2].

Thus, the SLC network is defined as a special functional type of urban space. It is an important component of the urban environment that contributes to its humanization, and spatial integrity, as well as the health improvement and increased

social activity of the population. SLCs play a special role in satisfying the needs of urban residents to realize their creative potential and self-actualization during leisure time. Their functions encompass physical exertion, restoration of various resources (physical, spiritual-intellectual, energetic, and psycho-emotional), as well as enhancing informal communication among the population, fostering social cohesion [6, p. 74]. The importance of supporting these life processes is emphasized in the concepts of sustainable urban and community development [7-9]. Furthermore, the organization of the SLC network is an essential aspect of shaping an attractive urban environment.

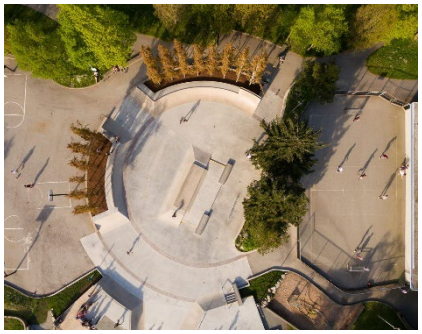

Figure 1 - Sports and leisure complex in the structure of Ambleside Park, West Vancouver, BC, Canada.

A source: [3]

Figure 2 - Sports and leisure complex in the structure of the Youth Park, Kharkiv, Ukraine.

A source: [4]

Figure 3 - Sports and leisure complex on an empty industrial site, Lemvig, Denmark.

A source: [5]

It can be argued that in the post-war period, the need for recovery and development of sports and leisure environments in Ukrainian cities will increase. Therefore, questions of rational placement of elements of the SLC network, their effective utilization and accessibility, as well as ensuring comfortable parameters of the physical activity environment, become relevant. The latter is especially important in the context of climate change [10, p. 9]. The harmonious combination of artificial and natural components in the formation of the SLC network will contribute to addressing the ecological problems of the modern city.

The research hypothesis consists of the assumption that integrating elements of the SLC network into the "ecological framework" of a city (taking into account their anthropogenic load) will ensure an increase in the effectiveness of its operation.

In this study, the "ecological framework" of a city is defined as a set of geosystems (both natural and artificial) that perform specific ecological functions within the urban territory [11, p. 33]. It includes natural areas (e.g., forests, natural river valleys, and streams), landscaped areas (e.g., parks, gardens, boulevards, and squares), as well as landscaped areas of public, industrial, and communal facilities [12].

The purpose of the work is to study the ecological aspect of forming the SLC network within the structure of the modern city. The main focus of the study is aimed at determining the techniques and principles for integrating elements of the SLC network into the "ecological framework" of a city.

To achieve the research objective, the following **tasks** were consistently solved:

- analysis of scientific and practical experience in shaping locations for sports leisure within the structure of urban green spaces;
- identification of elements of the SLC network recommended for placement within the structure of urban green spaces;
- determination of principles for integrating elements of the SLC network into the "ecological framework" of a city.

Analysis of research sources and recent publications.

Works that consider the variety of functional content of green areas in a city and the conditions for their rational use, including for sports leisure, are important for this study.

A study by Lee et al. points out that in studying the use of urban green space, it is important to consider not only its characteristics such as accessibility, quality, availability of amenities, attractiveness, and safety, but also its functionality. The local community uses the green space for various types of activities, whether for physical exercise or socio-cultural events. However, it is the functionality of the space that determines the practical benefit it can provide [13]. A study by Vernihorova that the effectiveness of park facilities' functioning and the opening of new horizons in these areas depend on solving several problems: maintaining park ecosystems as they provide recreational and cultural opportunities; the presence of appropriate program support for urban parks in their activities; increasing the rating of parks in the lives of residents; attracting additional funds and interested people; and creating new parks that will satisfy all categories of residents [14, p. 73].

In 2009, the municipal government of Copenhagen proposed an action plan called "Pocket Parks, Trees, and Other Green Spaces," which focused on integrating public spaces with urban landscape planning. This increased access to green public spaces emphasized their physical and environmental benefits and therefore changed the land use model [15; 16]. Scientific studies also emphasized the necessity of ensuring equal access to green public spaces [17]. Research on their spatial distribution has profound implications for optimizing spatial location and promotion of sports activities [18; 19]. People living more than 1 km away from green spaces are less likely to use them for exercise and fitness compared to those living closer than 300 m [20]. One of the main conclusions of Ribeiro and Nowak is that differences in urban typology, population density, as well as household conditions, and socioeconomic data should be key considerations in formulating green space usage policies [21]. Such a remark becomes one of the main tasks when using a network approach. It is essential for ensuring equal opportunities in the use of sports facilities in a city and taking into account the needs of different social groups.

For example, urban parks located in neighbourhoods with low socio-economic status and outside the central area of the cities such as Helsinki, Berlin, Bucharest, and Lisbon were structurally less diverse than parks located in the city core [22]. In the Netherlands, it was found that green spaces in poorer areas are less aesthetically appealing than in wealthier areas [23]. Additionally, among adult residents, there is a tendency towards prolonged sedentary leisure (over 3 hours per day), which is a more common practice in areas with less green space [24].

Due to the dynamic development of cities, road infrastructure, recreational spaces, and the necessity to preserve the landscape, newly drafted local spatial development plans require close cooperation between architects, landscape designers, gardeners and specialists from many other fields [25]. Together, these studies contain important aspects for the formation of the SLC network within the structure of cities.

The works of landscape architecture have been highly beneficial for this study, addressing issues such as the effective distribution of anthropogenic load on green areas, the selection of natural components to obtain certain effects (including microclimatic effects), and harmonious combinations of natural and anthropogenic elements [26-30].

One aspect of anthropogenic impact is noise pollution. Noise, which is one form of physical (wave) pollution of the environment, can become a significant issue when integrating SLC into the green spaces of cities. For example, walking is the most common form of physical activity in natural areas, but jogging is becoming increasingly common. Joggers move faster and create more noise than walkers, especially on gravel surfaces. Therefore, wildlife may perceive them as a significant threat. Scientific studies confirm that land users should regulate not only the type of stimuli that may disturb wildlife but also the speed of movement in the surrounding environment [31]. Studies also indicate that plants under the influence of noise grow more slowly, they have excessive (even complete, leading to death) release of moisture through the leaves, and may experience cell disruptions. Leaves and flowers of plants located near loudspeakers die [32]. Therefore, effective regulation and limitation of noise pollution becomes an extremely important task for landscape designers and urban space architects.

Methodology.

The research methodology involves an interdisciplinary approach, which allows the consideration of the integration of SLCs into the "ecological framework" of a city from different points of view, taking into account both ecological and social aspects. This approach includes analysis and systematization of scientific works on the research topic; visual and iconographic analysis to obtain detailed information about the object of study; comparison of different techniques for integrating sports and leisure facilities into the urban landscape; development of principles that consider the preservation of natural ecosystems in the city and avoid negative impacts on natural elements.

Main text.

Analysis of practical experience in forming SLCs enabled to identification of their main elements and planning techniques that contributed to addressing the task of harmonizing natural and anthropogenic components in the structure of the urban environment.

Thus, in Canadian cities, the infrastructure of sports leisure for urban residents is developed based on the preservation of the natural environment. For example, SLCs are located with consideration for preserving the forested area and natural landscape in Central Park in Burnaby, British Columbia (Fig. 4-6). The area of the recreational territory is 86.4 hectares. The percentage of greenery is 80%. The interaction of SLCs with the "ecological framework" involves integrating small sports grounds into the

natural surroundings. This planning technique promotes a balance between anthropogenic load and the sustainability of the natural landscape.

In this example, the SLC is represented by an outdoor fitness area consisting of 12 stations equipped with outdoor exercise equipment. They are located at certain distances from each other along the 2.5-kilometer Trail of Hope. This complex is intended for a systematic effect on a person's physical condition: maintaining and supporting optimal cardiovascular functional activity and developing balance, strength, and flexibility.

The circular graveled route, Trail of Hope, is connected to outdoor fitness circuit stations which have recycled tire rubberized surface. This creates a unique "ribbon" type of SLC that is characterized by its branching spatial form, adding a new aspect to improving the physical training of users. It provides the opportunity not only to engage in sports but also to explore the natural environment. These locations highlight the main natural features of its territory to park visitors.

The SLC also includes a cycling route designed for use by pedestrians, cyclists, joggers, and individuals using wheelchairs. This cycling route significantly expands the opportunities for physical improvement for various categories of park visitors. The track runs along the perimeter of the park, forming a 3.5-kilometer loop, and ends near the Patterson SkyTrain station. It is equipped with a special rubberized surface that provides optimal shock absorption, and it is also equipped with lighting systems to ensure comfortable use of the track at night. This creates favorable conditions for engaging in physical activity in a natural environment, emphasizing the importance of an inclusive approach.

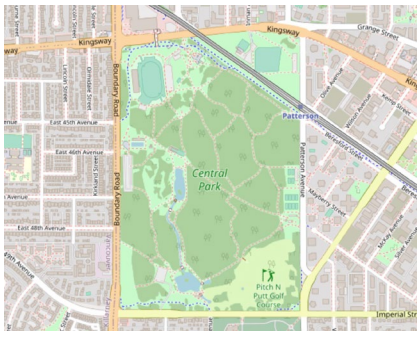

Figure 4 - Scheme of Central Park in Burnaby, BC, Canada.
A source: by author

Figure 5 - Fitness area within the structure of Central Park.
A source: by author

Figure 6 - Fitness area within the structure of Central Park.
A source: by author

Another example is Mount Pleasant Park in Vancouver, British Columbia (Fig. 7-9). This Park is located near residential buildings and a school, providing easy access for youth and school children. The recreational area covers 1.12 hectares. The functional structure of this park also includes the SLC, consisting of a skateboard park and streetball courts, as well as a cycling route.

Typically, locating a skateboard park near a residential area causes significant unintended noise impacts on nearby residents. In this case, it was no exception. Skateboarding at Mount Pleasant Park was occurring after 10 pm and prior to 6 am, resulting in significant noise. Independent noise assessments indicated that

skateboarders at this facility generated noise levels exceeding permitted decibel levels according to Noise Control By-law No. 6555. As a result, in 2013, an action plan was developed to reduce noise pollution. Modifications were made to the design of the skateboard park for this purpose: a 3-meter chain-link fence was installed, and signs were placed around its perimeter indicating the permitted hours of use (from 9:00 am to 9:00 pm), requirements regarding respect for nearby neighbors and safety information. The gates leading to the skateboard park are manually locked and unlocked daily. Practical application results indicate that these measures proved ineffective. Currently, the operating hours of the skateboard park are monitored by volunteers who take measures to ensure compliance with the established quiet hours by youth [33, p. 2].

The percentage of greenery in the park is 75%. Green areas containing various types of trees and shrubs are used both on the periphery of sports and leisure areas and within them. This leads to several important consequences:

- Greenery creates a natural barrier that reduces the impact of negative factors such as noise and dust, which may arise due to car parking and the proximity of sites to the road. This enhances the comfort of park users and maintains the cleanliness of the natural environment;

- Different types of plants help visually and functionally delineate various designated areas (e.g., sports, recreation, and playground). This helps effectively organize the park space and enhances its functionality;

- Using various types of trees, shrubs, and flowers allows for creation of a free landscape layout. This makes it more attractive and natural for visitors and adds artistic value to the place.

The bike route runs along the eastern part of the park on Ontario Street. It is a protected bike lane separated from traffic by physical barriers such as planters, curbs, or bollards. This approach promotes safe and convenient movement for cyclists and other route users, avoiding potential accidents with vehicle traffic.

Figure 7 - Scheme of Mount Pleasant Park in Vancouver, BC, Canada.

A source: by author

Figure 8 - Streetball court within the structure of Mount Pleasant Park.

A source: by author

Figure 9 - Skateboard park within the structure of Mount Pleasant Park.

A source: by author

The Culture and Recreation Park along the riverfront in Rzeszów, Poland (Fig. 10-12), stands out for its diverse opportunities for entertainment and physical activity.

The total area of the recreational area is 14.08 hectares, with greenery comprising 87% of this area. A defining feature of this area is the presence of the Vistula River, which forms a significant ecological corridor running through the central part of the city. This provides convenient access to the park for all city residents.

The green area of the park, located on the left bank of the river, includes the SLC. This complex consists of a street workout area, skateboard park, dirt park, and snow park, all compactly organized spatially. Additionally, there are bike routes and a running track equipped with a rubberized surface, situated along the riverfront. This creates ideal conditions for relaxation and physical activity in one of the nodes of the city's "ecological framework" and provides diverse opportunities for residents to develop their sports skills. The planning organization techniques are subject to the features of the natural landscape with a picturesque character.

Sports and leisure facilities, such as the skateboard park, dirt park, and snow park, are strategically separated from residential areas and located adjacent to the sports complex and parking, mitigating the impact of noise pollution on the surrounding environment. In particular, the skateboard park, with its special mobile covering, is an effective facility suitable for use during the winter season. This technical solution expands the functional range of the facility, which in turn increases demand for its services throughout the year.

Figure 10 - Scheme of Culture and Recreation Park in Rzeszów, Poland.

A source: by author

Figure 11 - Street workout area within the structure of Culture and Recreation Park.

A source: by author

Figure 12 - Dirt park near Culture and Recreation Park

A source: by author

The Urban Park on VDNG in Kyiv, Ukraine is a characteristic example of the SLC (Fig. 13-15). The recreational area covers three hectares. The Park is located adjacent to the botanical garden and has good transportation connections with various districts of the city. This location promotes the development of various sports and provides opportunities for outdoor activities in a natural environment. The complex includes a skateboard park, streetball courts, street football courts, street dance area, street workout area, and parkour area, as well as a 3.5-kilometer long running track along the forest.

One of the characteristic features of the planning organization of SLCs in Ukrainian cities is the clustering of sports and leisure facilities in one area. The planning organization of these complexes predominantly follows a regular pattern.

Greenery is mainly located around the perimeter, while they are usually absent inside the area. For example, the Urban Park on VDNG only has 27% of greenery, which may potentially hurt the microclimatic and aesthetic characteristics of the complex's environment.

Similar planning techniques for SLCs can be observed in cities like Kharkiv, Lviv, and Lutsk. This planning technique needs improvement, particularly taking into account ecological and aesthetic aspects to ensure a favorable microclimate and convenience for users.

Figure 13 - Scheme of Urban Park on VDNG in Kyiv, Ukraine.
A source: by author

Figure 14 - The Urban Park on VDNG in Kyiv, Ukraine.
A source: [34]

Figure 15 - Panna football grounds in Urban Park on VDNG.
A source: [34]

Another example is the GAME Streetmekka in Esbjerg, Denmark, which emerged from the reconstruction of a historic railway depot (Fig. 16-18). The area of the site is one hectare. This modern SLC is designed for the development of street sports and is accessible all year round. It caters to various age groups. It includes areas such as a covered transition zone and a skateboard park, indoor and outdoor streetball courts, a street dance area, and a street art area.

The architectural complex has a circular shape with an open central area. It aims to stimulate the internal and external activity of visitors. This structure implements the clustering of sports and leisure facilities on one site while providing a smooth transition from the architectural structure to the natural environment. Research shows that the percentage of greenery in this area is 50%, which contributes to the creation of a harmonious facility. The greenery located between the covered part of the complex and the central open space serves as a transitional zone and enhances interaction with the natural surroundings. This adds aesthetic value to the facility and promotes comfortable use of the space.

Adjacent to the SLC is the construction of Remiseparken, where pathways and slopes are being formed for a future forest garden. However, its significance lies not only in functionality but also in its contribution to ecological sustainability. By minimizing the need for maintenance and simultaneously promoting the removal of a significant amount of CO2, the project addresses the task of improving environmental quality and reducing the carbon footprint.

A significant aspect of this project is the municipality's decision to preserve trees on the site, despite the necessity for soil remediation measures to address site

contamination. This demonstrates a substantial approach to preserving the natural environment and biodiversity within urban planning and underscores the importance of natural resources for sustainable development.

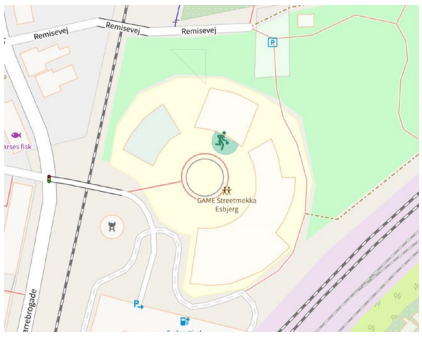

Figure 13 - Scheme of the GAME Streetmekka in Esbjerg, Denmark.
A source: by author

Figure 14 - The central outdoor courtyard at GAME Streetmekka.
A source: [35]

Figure 15 - Skateboarding area at GAME Streetmekka.
A source: [35]

Results.

Based on the analysis of practical experience in forming SLCs, elements that are integrated into the "ecological framework" of a city have been identified. The main elements include:

- ***sports and leisure modules***. These are specialized areas designed for various forms of physical activity, including extreme sports;
- ***sports and leisure routes***. These routes are intended for a safe and comfortable walking, cycling, and jogging to places where visitors can engage in physical activity. These specialized pathways such as pedestrian, running, and bike lanes connect different sports and leisure modules and recreation areas;
- ***recreation areas***. These are specially equipped locations designed for rest and recovery during physical activities and also for picnics or snacks during long distances. These areas are situated along sports and leisure routes;
- ***landscaping elements***. These include trash bins, benches, changing rooms, gazebos, bicycle parking, and others, that ensure the convenience environment for sports and leisure;
- ***engineering communications elements***. These elements include water supply, sewage, and electricity, which provide the comfort and safety to residents engaged in sports and leisure activities.

The analysis of planning techniques for the identified elements of the SLC network within the structure of the city's "ecological framework" revealed that a significant number of sports and leisure modules have small dimensions (up to 0.01 hectares). These modules include locations with outdoor fitness and street workout equipment for workout exercises. They are characterized by a flexible planning structure, allowing for easy integration into diverse green spaces within the city. It was also found that they have a relatively low anthropogenic impact, which positively affects the environment. Such playgrounds have environmentally safe surfaces and can be located under the canopy of trees without causing them harm. It can be considered that they are harmoniously integrated into the "ecological framework." In

such an environment, anthropogenic and natural elements form a balanced integrity, with natural elements often prevailing. It ensures an active functional utilization of the natural landscape as an integral part of the SLC. They are conveniently located within the structure of urban gardens, squares, and waterfronts, as well as along sports and leisure routes that intersect large urban green spaces (parks, forest parks).

Sports and leisure modules designed for street football or streetball require an area of up to 0.24 hectares and also have a relatively low anthropogenic impact on green spaces. They can be successfully situated within the structure of urban squares and parks.

At the same time, for practicing extreme sports such as skateboarding, stunt scootering, BMX, and rollerblading, large areas of up to 0.63 hectares are typically required. These modules are limited in planning flexibility due to the need for specialized elements and architectural solutions for the safe practice of these types of physical activities. Such types of SLCs, bordering or situated within green areas, form unique "anthropogenic islands" amid green spaces. There is a limited functional use of natural components, where their function is restricted to providing a comfortable microclimate and addressing planning tasks. In this case, it is important to create planning safeguards to prevent the disruption of the spatial integrity of the city's "ecological framework" and to align the level of anthropogenic impact with the characteristics of the natural landscape of a particular site. It is appropriate to located this type of SLCs in neglected areas (for example, in the context of renovating neglected industrial sites) and to form green areas nearby to improve the microclimate and spatial aesthetics.

Recreational areas and landscaping elements can be situated along sports and leisure routes, as well as adjacent to significant sports and leisure modules, provided that measures are taken to preserve the natural environment and enhance the natural components on the site.

The design of engineering communication elements must take into account the characteristics of the natural landscape.

The integration of elements of the SLC network into the "ecological framework" of the city is an important task for creating an environmentally sustainable and functionally efficient urban environment. Based on the work carried out, the following principles have been identified:

- ***preservation of the natural environment*** involves avoiding negative impacts on ecosystems and preserving ecological corridors when locating SLCs;

- ***flexibility in planning decisions*** involves a full consideration of the natural conditions of the areas where elements of the SLC network are located;

- ***ensuring accessibility***, which involves making SLCs accessible to all residents, regardless of their age, physical condition, or place of residence. This is achieved by creating convenient pathways for pedestrians and cyclists;

- ***a balanced distribution of functions*** which involves offering a variety of types of recreational activities to meet the needs of all segments of the population. It is important to balance the distribution of functions and types of leisure activities;

- ***use of sustainable materials and technologies***, which involves using durable materials and technologies that reduce negative environmental impact and ensure a

long operational period when developing sports and leisure modules;

- ***consideration of ecological design***, which involves incorporating elements of ecological design into the formation of sports and leisure modules and recreation areas, such as using local plants and creating natural barriers to reduce noise;

- ***monitoring***, which involves observing and assessing the impact of implemented projects on the natural environment and the health of residents. Monitoring is essential for effective management and maintenance.

Summary and conclusions.

The formation of the SLC network is an extremely relevant and promising aspect of modern city development. Today's urbanization not only involves shaping urban infrastructure but also preserving ecological balance, which requires an integrated approach. This approach should consider the residents' needs for active leisure, physical activity, and the preservation and support of ecological balance in urban ecosystems.

This study has identified planning techniques for forming SLCs within the structure of green spaces, the diversity of which can be classified by various criteria. Additionally, the main elements of the SLC network that are integrated into the "ecological framework" of a city have been identified: sports and leisure modules, sports and leisure routes, recreational areas, landscaping elements, and engineering communication elements.

Taking into account the modern features of SLC formation, fundamental principles of integrating SLC network elements into the "ecological framework" of a city have been derived. These encompass the preservation of the natural environment; flexibility in planning decisions; ensuring accessibility; using sustainable materials and technologies; considering ecological design; and monitoring. These principles enable the determination of the effectiveness of SLC integration into the urban environment.

Therefore, integrating the SLC network into the "ecological framework" of a city is seen as a path to sustainable urban development that meets society's needs. The identified principles of integrating SLC network elements into the "ecological framework" of a city can be applied in various cities to improve the quality of life for the population and serve as an important source of information for decision-making regarding urban environment development and urban planning. Further research should focus on increasing SLC accessibility for all population groups and refining integration principles, particularly through monitoring and assessing the impact of implemented projects on the urban environment and residents' health.

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