ARCHITECTURAL, PLANNING, ENGINEERING AND SOCIAL REQUIREMENTS FOR MODERN SPORTS COMPLEXES

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Annotation: *This article provides a comprehensive analysis of the main architectural-planning, functional, structural-engineering, environmental and socio-economic requirements for the design of modern sports complexes. The study considers sports complexes not only as structures intended for sports activities, but also as an important element of the urban environment serving integrated, multifunctional and sustainable development. The article systematically covers the criteria of functional efficiency, separation of traffic flows, inclusiveness, urban planning compliance, structural reliability, safety and environmental sustainability. The results of the study serve to adapt international experience to local conditions in the design of modern sports complexes, increase operational efficiency and enhance their social significance.*

Keywords: *modern sports complex, sports facility architecture, functional planning, urban planning integration, structural systems, environmental sustainability, inclusive design .*

Introduction

In recent years, the development of sports infrastructure has become one of the important factors of sustainable development, promotion of a healthy lifestyle and revitalization of the urban environment on a global scale. In Uzbekistan, as a result of state policy aimed at the sports sector, modern sports complexes are being built, existing facilities are being reconstructed. However, practical experience shows that many sports facilities are still limited to narrow functional tasks, their integration with the urban environment and social effectiveness are not sufficiently ensured.

1. Systematic analysis of architectural and planning requirements

The main planning requirement in the design of modern sports complexes is the formation of a centralized and integrated spatial model . This approach implies

the interpretation of sports facilities not as objects isolated from the urban environment, but as multifunctional urban complexes, inextricably linked with public spaces, green areas and the transport system . Within the framework of this model, the internal structure of the sports complex is formed on the basis of clear functional zoning.

1.1. Sports activity zone

The sports activity zone constitutes the main functional core of the sports complex and includes the main sports venues where competitions and professional training are held. The following architectural and planning requirements are important in the planning of this zone:

compliance of the dimensions of sports fields and halls with regulatory requirements;

ensuring visual comfort through structural solutions with no columns or minimal columns;

direct but controlled visual and functional connection with the audience area;

convenient integration with athlete entry and exit corridors.

From a scientific point of view, the sports activity zone is considered the spatial center of the complex , and the remaining functional zones are logically placed around this core.

1.2. Training and education zone

The training and education zone serves to train athletes, conduct training processes, and continuously develop sports knowledge. This zone includes: training halls, sports classes, seminar rooms, and methodological offices.

Architecturally and planwise, this zone:

located close to the sports activity area, but partially separated acoustically and functionally;

have natural lighting and ventilation capabilities;

It must be inextricably linked to the athletes' internal movement flows.

shapes the sports complex not only as a competition facility, but also as a center for education and development .

1.3. Spectator zone

The spectator area is intended for watching sporting events and includes stands, lobbies, waiting areas and general service areas. The following requirements are prioritized when planning this area:

providing optimal viewing angles for the sports field;

separation of spectator traffic flows from athlete and service personnel flows;

compliance of emergency evacuation routes with regulations;

universal design and accessibility for persons with disabilities.

Scientifically, the spectator area is a key component that determines the level of social activity of a sports complex .

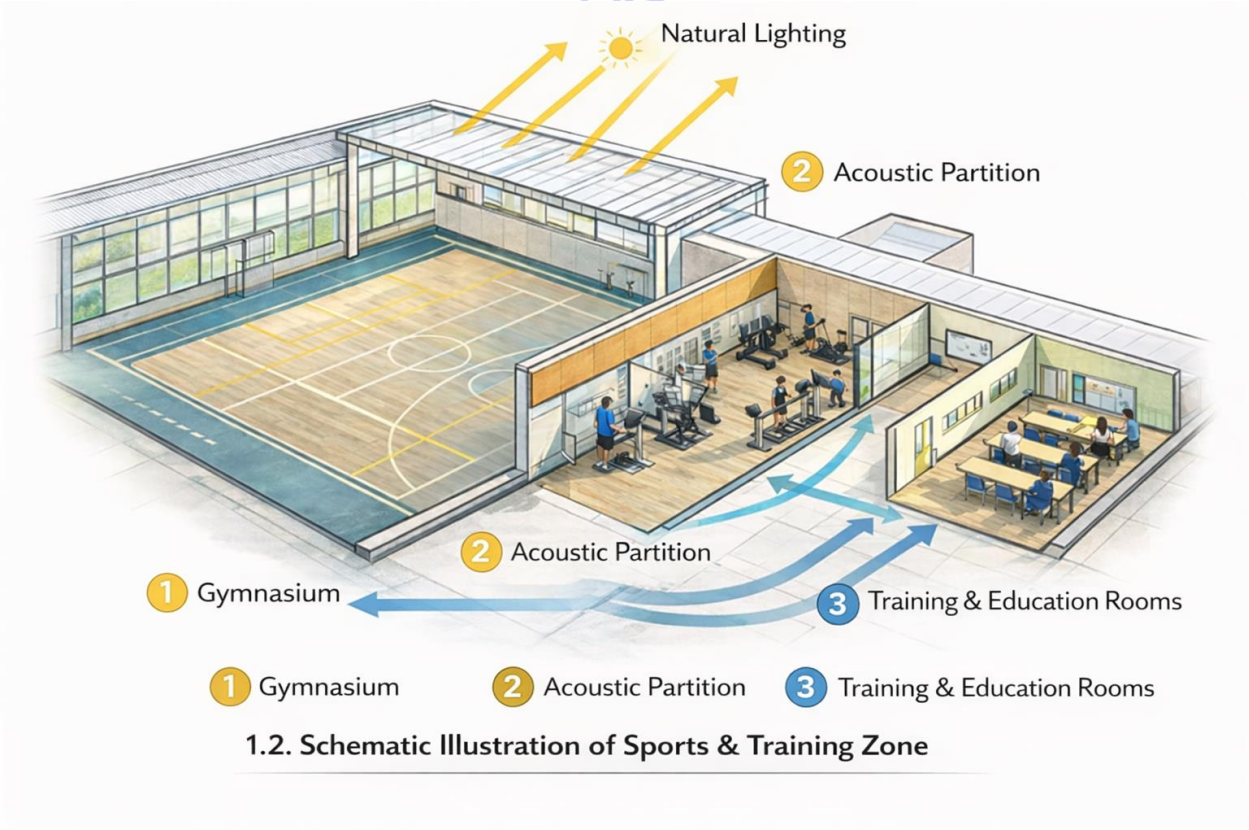

Figure 1. *Functional organization of the training and education zone in the sports complex* . Training halls and education rooms are located close to **the** *sports activity zone, but partially separated acoustically and functionally, and are provided with natural lighting and ventilation options.*

1.4. Administrative and service area

The administrative and service area provides management, control and operation processes of the sports complex. This area includes administrative rooms, service points, medical service rooms and auxiliary spaces for employees.

In planning:

functional proximity of control rooms to sports and spectator areas;

hidden and efficient organization of service corridors;

A logical layout that optimizes operational processes is important.

This zone is an important management component that ensures the stable and uninterrupted operation of the sports complex .

1.5. Technical and engineering zone

T he technical and engineering zone includes all engineering systems of the sports complex - power supply, heating, ventilation, air conditioning, water supply, security and automation systems. This zone is usually located in a way that is isolated from spectators and athletes, but convenient for maintenance.

Architectural and planning requirements:
quick and safe access to engineering rooms;
separation of technical noise and vibration from the main functional zones;
the possibility of integrating "smart building" and energy-saving systems.
Scientifically, the technical and engineering zone is considered a hidden but crucial system that determines the operational efficiency of a sports complex.

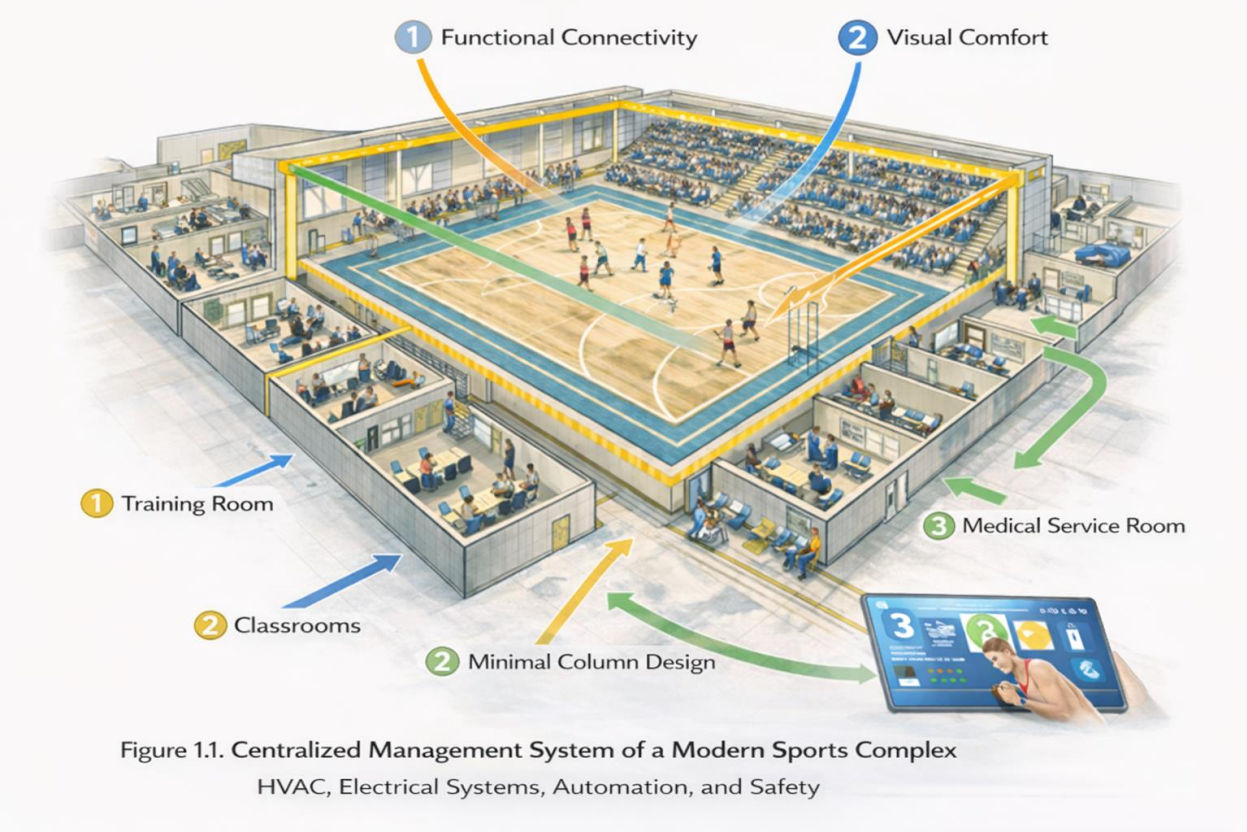

Figure 2 A centralized and column-free planning solution for a sports activity zone in a modern sports complex.

In the figure, the main universal sports hall is located as a spatial core, and a minimal column structural system ensures visual comfort of the sports process and a controlled functional connection with the audience.

2. Assessing the impact of engineering and environmental solutions on the sports process

In modern sports complexes, engineering and environmental solutions directly affect the quality, sustainability and effectiveness of the sports process. These systems play a crucial role in optimizing the physical condition of athletes, ensuring the comfort of spectators and increasing the operational efficiency of sports facilities. Therefore, engineering and environmental components are considered not as secondary infrastructure of a sports complex, but as active determinants of sports activities .

2.1 . The impact of microcurrent control systems on the sports process

Microclimate control systems (heating, ventilation and air conditioning – HVAC) directly affect the physiological adaptation of the athlete's body and training efficiency. Scientific studies show that optimal temperature (18–22 °C), relative humidity (40–60 %), and air exchange rate increase the endurance and concentration of athletes.

Energy-efficient HVAC systems:

maintains a stable microclimate in gyms;

reduces fatigue factors during competitions and training;

optimizes operational energy consumption.

As a result, the sports process takes place in a stable and controlled environment , which ensures the objectivity of sports results.

2.2. Efficiency of lighting and acoustic solutions

Lighting systems are one of the most important factors in ensuring visual perception and safety in a sports complex. The optimal combination of natural and artificial lighting:

reduces the visual load of athletes;

creates comfortable viewing conditions for viewers;

improves the quality of television broadcasting.

Acoustic solutions stabilize the psychological state of athletes by controlling the spread of sound in sports venues. Excessive acoustic noise can reduce the concentration of athletes, which is why the use of acoustic panels and sound-absorbing materials in modern sports complexes is important.

Scientific evaluation shows that optimizing lighting and acoustics significantly improves the psychophysiological quality of the sports process.

2.3. Environmental requirements

In accordance with the requirements of the OAK, environmental issues in modern sports complexes should be considered as a separate scientific section. Environmental requirements are aimed at ensuring the long-term sustainability, economic efficiency and reducing the environmental impact of sports facilities.

2.4 Renewable energy sources

The use of solar panels, geothermal systems and other renewable energy sources in sports complexes:

reduces electricity consumption;

optimizes operating costs;

increases the energy independence of the sports facility.

Scientifically, these solutions serve to shape sports complexes as low-carbon infrastructure .

2. 5. Green roofs and passive design solutions

Green roofs and passive design elements help regulate heat exchange in sports complexes in a natural way. These solutions:

reduces summer overheating;

reduces heat loss in winter;

improves the urban microclimate.

From a scientific point of view, green roofs turn sports complexes into active components of the urban ecological system.

Picture 3. The complex impact *of engineering and ecological systems on the sports process*

The figure schematically shows the complex impact of engineering and environmental systems on the sports process in a modern sports complex. Around the universal sports hall located in the center, microclimate control (energy-efficient HVAC), lighting and acoustic solutions (LED lighting, acoustic engineering), renewable energy sources (solar panels), water-saving technologies, as well as green roofs and passive design elements are integrated.

3. Revealing the social significance of sports complexes

Modern sports complexes act as an important **social institution in the life of society** . They serve not only to develop professional sports, but also to strengthen the health of the population, promote a healthy lifestyle, and increase public activity. Scientific research shows that the integration of sports complexes into the urban environment significantly increases their social effectiveness and ensures territorial social stability. These aspects shape sports complexes as centers of social integration and communication on a city-wide scale.

3.1. Social openness

The social significance of sports complexes is determined, first of all, by their social openness . Social openness means that sports facilities operate in an open, accessible and equal way for all segments of the population.

3.1. Serving popular sports

Modern sports complexes are the main infrastructural base for the development of mass sports. They should serve not only professional sports, but also daily physical activity, health training and amateur sports. From a scientific point of view, the orientation of sports complexes to mass sports:

improves public health;

serves to prevent diseases;

forms a healthy lifestyle as a social norm.

allows us to interpret sports complexes not only as competition facilities, but also as **centers of daily physical activity .**

3.2. Youth and children's infrastructure

The presence of infrastructure for youth and children in sports complexes is one of the important factors determining their social significance. Scientific research shows that regular participation in sports during childhood and adolescence:

ensures physical and mental development;

forms social adaptation and discipline;

creates a reserve of professional sports in the future.

Therefore, the presence of children's sports schools, training halls, and safe open spaces in sports complexes is considered **a factor of socially sustainable development** .

3.3. Adaptation for women and people with disabilities

Creating equal conditions for women and people with disabilities in the design of modern sports complexes is a key criterion of social justice and inclusion. Architectural, planning and engineering solutions:

provide a barrier-free environment (ramp, elevator, wide aisles);

provides for separate dressing and hygiene rooms;

It should ensure that sports activities are adapted to different needs.

Scientifically, this approach shapes sports complexes as **inclusive social spaces** and increases the level of social participation in society.

3.4 . Social equality

The social openness of sports complexes is based on the principle of social equality. This principle implies the creation of equal opportunities for different social groups of the population in using sports infrastructure. Scientific analysis shows that:

convenient location of sports complexes;

low-cost or subsidized services;

regular holding of mass sporting events

plays an important role in ensuring social equality.

As a result, sports complexes appear as important spaces in the urban environment **that mitigate social differences and unite society .**

Figure 4. *The figure illustrates the social significance of sports complexes in a comprehensive way. The centrally located sports complex is interpreted as a center of social integration and communication on a city-wide scale. The diagram shows four main areas interconnected :*

4. Developing a science-based authoring approach

Based on the above urban planning, functional, engineering, environmental and social analyses, **a scientifically based author's approach to the design and assessment of modern sports complexes** is proposed. This approach is based on the interpretation of sports facilities not as separate objects, but as **multi-factorial and dynamic urban systems .**

The proposed author's model evaluates sports complexes through **the integration of three main interrelated components** :

Architectural and planning solutions → Engineering and environmental systems → Social impact

This integration allows us to determine the effectiveness of sports complexes not only by their sports capacity or competition intensity, but also by their impact on the urban environment, the operational process, and community life.

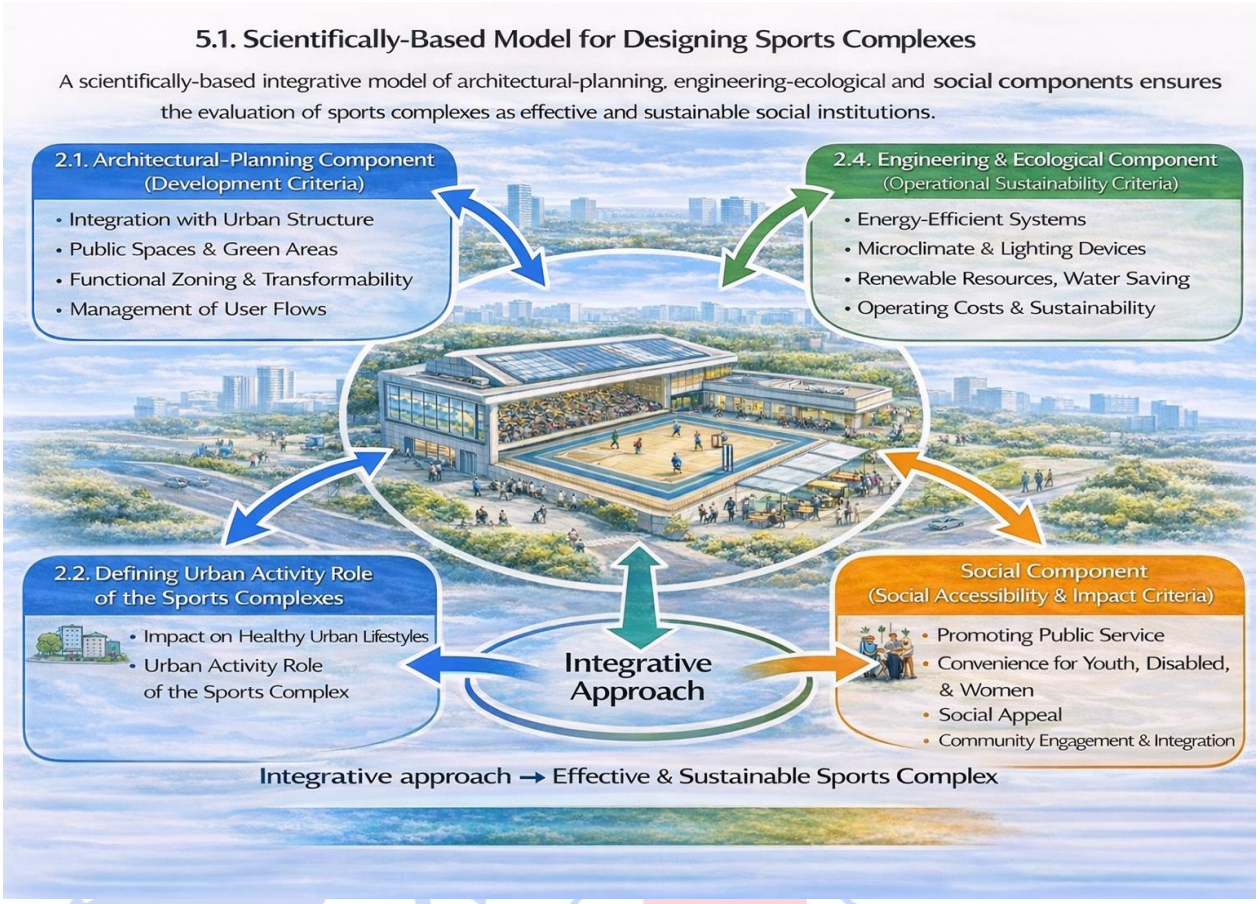

Figure 5. *This figure reflects the author's scientifically based approach to the design and assessment of modern sports complexes. The model interprets sports complexes not as separate objects, but as dynamic urban systems with integrated architectural-planning, engineering-ecological and social components.*

4.1 . Architectural and planning component (spatial-urban criteria)

The first component of the author's approach is aimed at assessing **the spatial and urban qualities of sports complexes** . This component is determined by the following criteria:

the level of integration of the sports complex into the urban structure;

connection to public spaces, green areas and transport infrastructure;

the rationality of functional zoning and the possibility of transformation;

Proper organization of user flows (athlete–spectator–service).

From a scientific point of view, architectural and planning solutions are the main factor determining **the role of a sports complex in urban activities .**

4.2 . Engineering and environmental component (operational sustainability criteria)

The second component of the author's model is aimed at assessing **the technical and environmental efficiency of sports complexes** . This component includes:

application of energy-efficient engineering systems;

suitability of microclimate, lighting and acoustics for the sports process;

renewable energy sources and water-saving technologies;
optimal operating costs and long-term sustainability.
This component allows for an assessment **of the operational life cycle of a sports complex** and makes it an economically and environmentally sustainable infrastructure facility.

4.3. Social component (social openness and impact criteria)

The third and most important component of the author's approach is aimed at assessing **the social impact of sports complexes** . This component is determined based on the following criteria:
the sports complex serves mass sports and a healthy lifestyle;
openness to youth, children, women and persons with disabilities;
its role as a universal space for cultural and social events;
the level of community engagement and social integration.
Scientifically, this component allows us to evaluate sports complexes as **social institutions .**

4.4 . Scientific novelty of the authorship model

The scientific novelty of the proposed author's approach is manifested in the following:
abandoning an approach based solely on sports functionality when evaluating sports complexes ;
systematic integration of architecture, engineering and social factors ;
interpretation of sports facilities as **a strategic element of sustainable urban development ;**
Development of **a comprehensive assessment model** that can be used at the PhD level .
This approach serves as a scientific basis for making theoretical and practical decisions in the design of sports complexes.

Conclusion

Based on the above scientific analysis, the following generalized conclusion can be drawn: The results of the study show that the effectiveness of modern sports complexes is determined not by their sports capacity, but by their integration into the urban environment, the rationality of functional-planning solutions, the stability of engineering and ecological systems, and social openness. A centralized spatial structure, a clear separation of user flows, and the application of inclusive design principles increase the spatial and social effectiveness of sports complexes. The proposed scientifically based author's approach allows for a comprehensive assessment of sports complexes based on the integration of architectural-planning,

engineering-ecological, and social components, creating a methodological basis for their design as a strategic element of sustainable urban development.

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