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RESEARCH ARTICLE

FUNCTIONAL ZONING AND LANDSCAPING OF THE SCHOOL TERRITORY DURING THE DEVELOPMENT OF THE GENERAL PLAN

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Abstract. *The article deals with the issues of developing a general plan of the school grounds by creating a space with a green area and the use of ecological materials. In large cities of Kazakhstan, including Almaty, there is a problem with the architecture and landscaping of school buildings. There is a complete lack of landscaped areas around educational institutions, which is a serious problem, not just a lack of modern schools. Another problem is the shortage of places in pre-school institutions, where sports stadiums at schools, if any, are transferred for the construction of kindergartens or other institutions. This significantly reduces the school grounds that should be used for the education, aesthetic development and health of students. As a result of this study and the analysis of available experience, a key principle in the development of general plans for school buildings has been identified: the harmonious interaction of the context, the content of the learning process and the learning process itself. Trends are outlined and variants of transformations in architectural and planning solutions concerning functional zoning of the territory and improvement of the space adjacent to the school are given. The example of the general plan of the school "Terekti" in Alatau district of Almaty is considered. Based on the obtained data, effective models of school space organization were proposed and the taxonomy of territory formation around the school building was determined. As a result of the study, three main concepts for the formation of a modern general plan were identified, which meet the requirements of the latest approaches in education.*

Keywords: *School, landscaping, general plan, functional zoning, vertical layout, landform organization.*

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БАС ЖОСПАРДЫ ӘЗІРЛЕУ КЕЗІНДЕ МЕКТЕП АУМАҒЫН ФУНКЦИОНАЛДЫҚ АЙМАҚТАРҒА БӨЛУ ЖӘНЕ АБАТТАНДЫРУ

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Аңдатпа. *Мақалада көгалдандырылған аумақпен кеңістік құру және экологиялық материалдарды қолдану арқылы мектеп жанындағы аумақтың бас жоспарын әзірлеу мәселелері қарастырылады. Қазақстанның ірі қалаларында, соның ішінде Алматыда мектеп ғимараттарының сәулеті мен абаттандырылуында проблема бар. Білім беру мекемелерінің айналасында толықтай жабдықталған аумақ жоқ, бұл қазіргі заманғы мектептердің жетіспеушілігі ғана емес, күрделі мәселе болып табылады. Тағы бір мәселе - мектепке дейінгі балалар мекемелеріндегі орындардың тапшылығы, онда мектептердегі спорттық стадиондар, егер бар болса, балабақшалар немесе басқа мекемелер салуға беріледі. Бұл білім беру, эстетикалық даму және оқушылардың денсаулығын сақтау үшін пайдаланылуы тиіс мектеп жанындағы аумақтарды айтарлықтай қысқартады. Осы зерттеу және қолда бар тәжірибені талдау нәтижесінде мектеп ғимараттарының бас жоспарларын әзірлеудегі негізгі қағидат анықталды: контексттің, оқу процесінің мазмұнының және оқу процесінің үйлесімді өзара әрекеттесуі. Трендтер белгіленіп, мектепке іргелес аумақты функционалдық аймақтарға бөлуге және кеңістікті абаттандыруға қатысты сәулет-жоспарлау шешімдеріндегі трансформациялардың нұсқалары келтірілген. Алматы қаласы Алатау ауданындағы "Теректі" мектебінің бас жоспарының мысалы қаралды. Алынған мәліметтер негізінде мектеп кеңістігін ұйымдастырудың тиімді модельдері ұсынылды және мектеп ғимаратының айналасында аумақты қалыптастыру таксономиясы анықталды. Зерттеу нәтижесінде білім берудегі жаңа тәсілдердің талаптарына сәйкес келетін заманауи Бас жоспарды қалыптастырудың үш негізгі тұжырымдамасы анықталды.*

Түйін сөздер: *Мектеп, абаттандыру, бас жоспар, функционалды аймақтарға бөлу, тік жоспарлау, рельефті ұйымдастыру.*

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НАУЧНАЯ СТАТЬЯ

ФУНКЦИОНАЛЬНОЕ ЗОНИРОВАНИЕ И БЛАГОУСТРОЙСТВО ТЕРРИТОРИИ ШКОЛ ПРИ РАЗРАБОТКЕ ГЕНЕРАЛЬНОГО ПЛАНА

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Аннотация. *В статье рассматриваются вопросы разработки генерального плана пришкольной территории, путем создания пространства с озелененной территорией и применением экологических материалов. В крупных городах Казахстана, включая Алматы, существует проблема с архитектурой и благоустройством школьных зданий. В полной мере отсутствует обустроенная территории вокруг образовательных учреждений, что представляет собой серьезную проблему, а не просто недостаток современных школ. Другой проблемой является дефицит мест в детских дошкольных учреждениях, где спортивные стадионы при школах, если таковые были, передаются под строительство детских садов или других учреждений. Это значительно сокращает пришкольные территории, которые должны использоваться для воспитания, эстетического развития и поддержания здоровья учащихся. В результате данного исследования и анализа имеющегося опыта, был выделен ключевой принцип в разработке генеральных планов школьных зданий: гармоничное взаимодействие контекста, содержания учебного процесса и самого процесса обучения. Обозначены тенденции и приведены варианты трансформаций в архитектурно-планировочных решениях, касающихся функционального зонирования территории и благоустройства пространства, прилегающего к школе. Рассмотрен пример генерального плана школы «Теректи» в Алатауском районе г. Алматы. На основе полученных данных были предложены эффективные модели организации школьного пространства и определена таксономия формирования территории вокруг здания школы. В результате исследования выявлены три главных концепта для формирования современного генерального плана, которые соответствуют требованиям новейших подходов в образовании.*

Ключевые слова: *школа, благоустройство, генеральный план, функциональное зонирование, вертикальная планировка, организация рельефа.*

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CONFLICT OF INTEREST

The authors state that there is no conflict of interest.

АЛҒЫС / ҚАРЖЫЛАНДЫРУ КӨЗІ

Зерттеу жеке қаржыландыру көздерін пайдалана отырып жүргізілді.

Автор зерттеу барысында консультациялық көмек көрсеткен Халықаралық білім беру корпорациясының (ҚазБСҚА кампусы) әріптестеріне алғысын білдіреді.

МҮДДЕЛЕР ҚАҚТЫҒЫСЫ

Авторлар мүдделер қақтығысы жоқ деп мәлімдейді.

БЛАГОДАРНОСТИ/ИСТОЧНИК ФИНАНСИРОВАНИЯ

Исследование проводилось с использованием частных источников финансирования.

Автор выражает благодарность коллегам Международной Образовательной корпорации (кампус КазГАСА), оказавшим консультационную помощь при проведении исследования.

КОНФЛИКТ ИНТЕРЕСОВ

Авторы заявляют, что конфликта интересов нет.

1 NTRODUCTION

Kazakhstan is a multinational country with rich traditions and unique customs. Historically, Kazakh families tend to have several children, often more than four, which creates the need to choose the best educational institution for their education. In such families, preference is given to educational organizations that offer a continuum of learning from kindergarten onwards. There are such institutions in Kazakhstan, however, most often they are private, which makes their cost unaffordable for the majority of citizens.

Thus, it can be argued that one of the possible directions of development of educational institutions in Kazakhstan could be complexes of continuous education, covering the entire cycle of education - from kindergarten to higher education. It is important to note that the quality of these complexes will depend not only on the architecture of buildings and structures, as well as the improvement of the school grounds. The general plan of such complexes should take into account all aspects of the educational process and orientation, including modern educational programs and highly qualified teaching staff. Architectural solutions can certainly play a significant role in the successful realization of this idea.

One of the most pressing problems in our country's residential neighborhoods is the lack of social facilities, particularly educational institutions such as schools and kindergartens, especially in new neighborhoods. A school is an important piece of infrastructure where children receive their primary education. It is extremely important that the architecture of this building is not only safe, but also comfortable for students and teaching staff. The process of designing a school is a multifaceted and labor-intensive task that involves the development of a general plan for the future structure. During this process, various technical requirements, architectural features and structural elements are taken into account, which ensures the creation of a quality improvement of the educational space.

The lack of a properly landscaped area around educational institutions is a serious problem that goes beyond the simple shortage of modern schools. In order to combat the shortage of places in preschool institutions, sports stadiums located on the territory of schools are often given over to the construction of kindergartens. This practice significantly reduces the school grounds that should serve for the education, aesthetic development and health improvement of students. It is important to revise architectural approaches and include in the general plan the development of infrastructure of educational institutions with a focus on creating multifunctional and landscaped spaces conducive to the full development of children.

According to the existing regulations and educational standards, sports are a key component of the educational process, including the organization of outdoor physical activity. In this regard, reducing the school area by removing the stadium and adjacent sports facilities will have a negative impact on the quality of educational services provided. It is important to take these aspects into account when developing architecture and landscaping based on the general plan of the school.

Based on the conducted research, it can be concluded that a school cannot be considered solely as a physical building. In the process of learning, children spend a significant amount of time in the educational institution, which implies the need to create a comfortable and diverse environment. The architecture and landscaping of the school grounds play a key role in organizing walks, sports activities and recess, which has a positive impact on the health of students. Modern international educational programs include mandatory outdoor activities during the school day and in some cases several times a day. This makes such programs more attractive to parents when choosing an educational institution, where consideration of the general plan and quality organization of space become priority factors.

Developing a universal general plan that could meet the requirements of all educational institutions is an extremely difficult task. This is because the architecture and landscaping of schools vary according to their structure and educational specificities. A general plan that takes into account these differences would be a key element in developing effective and adapted solutions for each educational school with its own structure and essence:

1) General education schools are institutions where teaching is carried out in strict compliance with state educational standards;

2) Boarding schools provide round-the-clock care for students, offering not only instruction but also care during non-school hours;

3) Specialized schools focus on in-depth study of specific subjects, providing students with more complex educational material and giving them priority;

4) Schools with an aesthetic bias emphasize art education, allowing students to develop their creative abilities;

5) Schools of supplementary education offer a variety of programs that broaden pupils' horizons beyond the core curriculum;

6) Institutions for children with special educational needs provide education for pupils with physical or mental difficulties. The professional approach to the architecture and improvement of the school infrastructure is in line with the general plan aimed at creating a comfortable and safe learning environment for all categories of students.

2 LITERATURE REVIEW

Amandykova (2010), Yakovleva (2016), Bogdanova et. al. (2024), Nikulshina (2011), Novak et. al. (2023), Minina and Rehakkainen (2023), Beregovskikh (2019), Grakhov et. al. (2014) were engaged in the development of general plans in Kazakhstan and the post-Soviet space, including for educational institutions.

Buitelaar and Sorel (2010), Getimis (2012), Granqvist et. al. (2021), Liu and Wu (2022), Nadin et. al. (2021) studied the influence and integration of policies on spatial planning in European cities and research on urban spatial planning problems.

When designing schools, as well as when developing general plans of schools, the following normative documents valid on the territory of the Republic of Kazakhstan are used.

Thus, the storey and basic requirements for structural solutions, materials of bearing and enclosing structures are accepted, according to Table 9.2, **SP RK 2.03-30-2017 "Construction in seismic zones"** and in accordance with **SP RK 3.02-111-2012* "General education organizations"**.

The main requirements for the volume-planning solution of the building are adopted in accordance with **SP RK 3.02-111-2012*, SP RK 3.02-107-2014 "Public buildings and structures"**.

Requirements for ensuring the living conditions of immobile groups of population are adopted in accordance with **SN RK 3.01-00-2011 "Instructions on the procedure for developing, coordinating and approving urban development projects in the Republic of Kazakhstan"** and **SP RK 3.06-101-2012* "Design of buildings and structures taking into account accessibility for people with limited mobility. General provisions"**.

The area of the land plot should be adopted in accordance with the urban planning provisions of **SP RK 3.01-101-2013 "Urban planning. Planning and development of urban and rural settlements".**

3 MATERIALS AND METHODS

When developing general plans of schools, if necessary, the following types of buildings and structures can be provided:

-autonomous boiler house (if necessary);
-transformer substation (if necessary);
-canalization septic tank (if necessary);
-control and checkpoints;
-sports grounds;
-playgrounds for games and recreation;
-utility areas;

-workout grounds;

-platforms for mass events.

The following recommendations should be taken into account when developing general plans of schools:

-to apply modern solutions for the transformation of the territory of general education schools, including for various events and active recreation;

-when landscaping, use local species of trees, shrubs, perennial flowers and grasses that require minimal maintenance;

-functional small architectural forms should be designed according to the age group of students;

-recreational areas for high school students can serve as a sports area;

- entrance to the school territory and a circular driveway around the building are provided.

- driveways can be paved with asphalt concrete, sidewalks can be paved with paving bricks/paving stones;

- vertical planning ensures surface water drainage from the building and grounds;

- small architectural forms of stationary installation are provided;

- a system of automatic watering of plantings and lawns is provided.

To analyze the development of the general plan, let's take the working draft of the general plan "Construction of a school in the Microdistrict 'Terekti' for 2000 students of Alatau district of Almaty (without external engineering networks)".

The school under consideration is a 3-storeyed secondary general education school for 2000 students, for classes in 1 shift. Providing the implementation of general education process in accordance with the programs of three levels of education 1 level - primary education (from 0 to 4 classes); 2 level - basic secondary education (from 5 to 9 classes); 3 level - general secondary education (10 - 11 classes).

The projected site is located in the north-western part of Almaty, Alatau district, Microdistrict "Terekti", north of Raiymbek Avenue and the intersection of Ashimov Street (**Figure 1**). The area is bounded by projected local streets.

Near the territory of the school there are houses of private sector, in 290 meters from the territory there is a gas station "Helios", in 400 meters market "Zhibek Zholy", in 320 meters car dealership "Hyundai Qalqaman", in 440 and 620 meters there are hospital number 7 and children's infectious disease hospital.

Figure 1 – Situation diagram (**www.etomesto.ru/map-mir**)

4 RESULTS AND DISCUSSIONS

Solution and composition of buildings and structures according to the general plan

The main task in designing the general plan of the school is to maximize the efficient use of the allocated land plot. The area of the land plot is 3.0000 hectares.

Placement of the projected school on the site complies with the requirements of sanitary and fire protection norms and rules.

Functional zoning of the plot

The land plot of the school is divided into functional zones:

(1) Entrance zone - located on the southeast side of the plot. The area near the main entrance is intended for gathering students and holding school-wide events.

(2) Physical Education and Sports Zone - located on the northeast side of the site and includes a soccer field and a combined basketball and volleyball court.

(3) Student Recreation Area - located on the northeast and north side of the site. Playgrounds are equipped with playground equipment. Benches are provided along the pedestrian sidewalks and in the quiet recreation area.

(4) Utility area - located on the north side of the site and designed to accommodate engineering structures. Block-modular boiler house, Complete transformer substations and diesel generator sets serve for uninterrupted power supply of the school building.

Places for temporary parking of cars and buses will be organized outside the school site on a specially allocated area on the south-west side (T-2, area -0.87 ha.).

Complete transformer substations and diesel generator sets

Calculation of the required amount of playground area

According to **SP RK 3.02-111-2012***:

(a) grounds for mobile games of elementary school students (from 2 to 4 classes) are accepted at the rate of not less than 50 m^2 for each class (21×50=1050 m^2), and for children of 6 years of age (1 class) and pre-school classes - not less than 100 m^2 (4 m^2 per pupil) with small game forms (350×4=1400 m^2);

(b) areas for quiet recreation of the main school are accepted for 40% of students at the rate of not less than 25 m^2 for each class (35×25=875 m^2).

For high school students, the recreation area is the area of the sports zone.

A schematic of the school's general plan is presented on **Figure 2**.

Figure 2 – Schematic of the general plan (**Conceptual design, 2023**)

Explanation of buildings and structures of the school general plan presented in **Figure 2**:

1. School for 2000 seats;
2.1 Sports ground (mini-football);
2.2 Combined sports ground (basketball, volleyball);
3. Playground for mobile games (1st grade and pre-school classes);
4. An area for mobile games (grades 2-4);
5. Quiet recreation area (grades 5-9);
6. Primary military training area;
7. An area for gathering students and holding school-wide events;
8. An area for MSW dumpsters;
9. Block-modular transformer substation with a diesel generator sets;
10. Block-modular boiler house MBH-2,8;
11. Sewage pumping station (SPS);
12.1 Modular security post (checkpoint) - 1;
12.2 Modular security post (checkpoint) - 2.

Vertical planning and relief organization

The relief of the site is simple, with a general lowering of the relief to the north-west.

Absolute ground surface elevations within the boundaries of the projected site vary from 772.18 to 769.61 meters (according to the topographic survey).

Vertical layout of the territory is made on the basis of topographic survey provided by the customer. The project is made by the method of design marks with indication of direction of slopes along the axes of roadways. The system of heights is Baltic.

The design solution is based on the principle of maximum preservation of the existing landscape. For this purpose, the vertical layout is made with maximum approximation to black.

The minimum longitudinal slope of the projected asphalt concrete pavement is 4.5 ‰.

For the conditional mark 0.000 of the projected building is taken the floor level of the first floor that corresponds to the absolute mark 772.55.

Site improvement

Driveways and platforms are designed from concrete tiles (paving stones) with curbs.

For pedestrian traffic, sidewalks are designed with a 1.5 m wide concrete tile covering.

Measures are provided to ensure unimpeded access and movement of low mobility groups. Walkways and sidewalks designed for wheelchairs are at least 1.5m wide. In places of intersections of driveways and walkways with sidewalks, curbs should be deepened with the device of smooth adjacencies to ensure the passage of strollers, sledges, etc.

The whole territory free of buildings and road surfaces shall be landscaped with a lawn of perennial grasses and planting of trees and shrubs of local species.

Planting of green planting on the territory is shown conditionally, will be clarified after the laying of engineering networks, when planting seedlings to take into account the requirements of Table 1-3 of **SP RK 3.01-101-2013 "Urban planning. Planning and development of urban and rural settlements"** and to provide a distance: from power and communication networks, heating networks, water supply and sewage networks to trees - 2 meters, to shrubs - 0.7-1 meters.

Garbage removal

Containers are provided for the collection of municipal solid waste (MSW) and are located on the site in compliance with sanitary distances.

Fire prevention measures

Fire Department No. 2 of Alatau district is located at a distance of 2.6 km. from the projected building.

In the design of driveways and pedestrian paths provided the possibility of passage of fire trucks to the buildings. The distance from the edge of the driveway to the wall of the building is taken 5 m. In this zone it is not allowed to place fences, overhead power lines and to carry out a row planting of trees. The driveway is provided suitable for the passage of fire engines, taking into account their permissible load on the pavement or ground, width of 6.0 m.

Transport network

Entry and exit to the territory is organized from the southern part of the site in two places, there is also a separate entrance to the utility zone.

Places for temporary parking of cars and buses will be organized outside the school site on a specially designated area on the south-western side (T-2, area - 0.87 hectares).

Calculation of the required number of parking spaces

Number of employees according to the Technological Map:

1st floor = 65 people, 2nd floor = 60 people, 3rd floor = 45 people. Total = 170 people.

Required number of parking spaces according to **SP RK 3.01-101-2013* "Urban planning. Planning and development of urban and rural settlements"** (**Table 1**)

- 170 people/8 = 22 m/m.

Required number of parking spaces: 22 m/m + 1 MGN.

Total: 23 m/m (including 1 MGN) + 1 space for a bus.

The finished 3D model of the school is presented at **Figure 3**.

Figure 3 – 3D model of a school (**Conceptual design, 2023**)

Technical and economic indicators

The technical and economic indicators for the general plan are presented in **Table 1.**

Table 1 – Technical and economic indicators for the general plan

№	Name	Meaning	Note
1	Plot area according to State Act	3,0 ha	100 %
2	Total development area, including:	9424,68 m^2	31,41 %
	- school development area	9196,5 m^2	
	- checkpoint (in 2 places)	9,68 m^2	
	- engineering structures development area	218,5 m^2	
3	Road surface area	14952,93 m^2	49,84 %
4	Greening area	5622,39 m^2	18,75 %

The wide territory of the school provides excellent opportunities for organizing leisure activities for students both outside school hours and during breaks. Currently, schools that meet international standards and educational programs are of the greatest interest to parents. This implies that when developing general plans for new modern schools in Kazakhstan, it is necessary to take into account not only state standards, but also international requirements concerning architecture, landscaping and functional zoning of both internal and external space. It is important that the school grounds include a variety of zones adapted for different age groups of students. Given the growing interest of parents in institutions built in accordance with international standards, the design of buildings and structures should be aimed at creating a competitive educational environment that promotes the comprehensive development of students.

As a result of the analysis of the buildings and facilities required for the school general plan, as well as the study of already implemented projects, three conceptual approaches were developed to meet the requirements of the modern educational process. These approaches are presented in **Figures 4-6**.

In particular, **Figure 4** presents the conceptual scheme of functional zoning, which includes the layout of two blocks of educational facilities: junior high school and middle and high school. Important attention is paid to the architecture and landscaping of the school grounds, which creates a comfortable and functional learning environment.

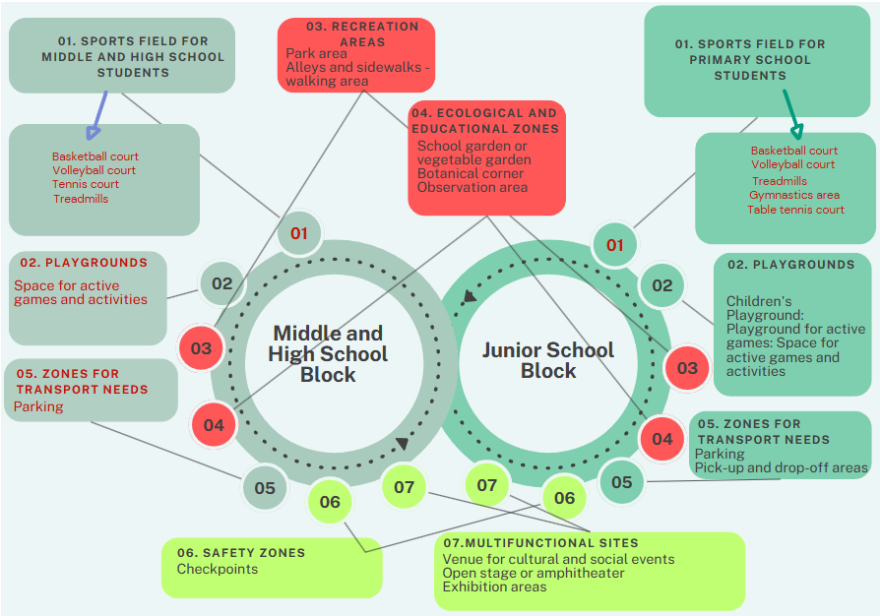

Figure 4 – Conceptual diagram No. 1 of the functional zoning of the school general plan (**authors' material**)

The school territory plays a key role in creating a quality, comfortable and safe educational space. When developing a general plan for the improvement of the school grounds, it is necessary to follow the principles of sustainable architecture, which implies the formation of green spaces using environmentally friendly materials. It is important to allocate on the school territory zones that promote the all-round harmonious development of students, in addition to the main educational process. These can be zones for self-education, sports and recreational areas, as well as various play spaces for students of different age groups (**Figure 5**). It is also necessary to provide an area for research activities which contributes to the comprehensive development of students.

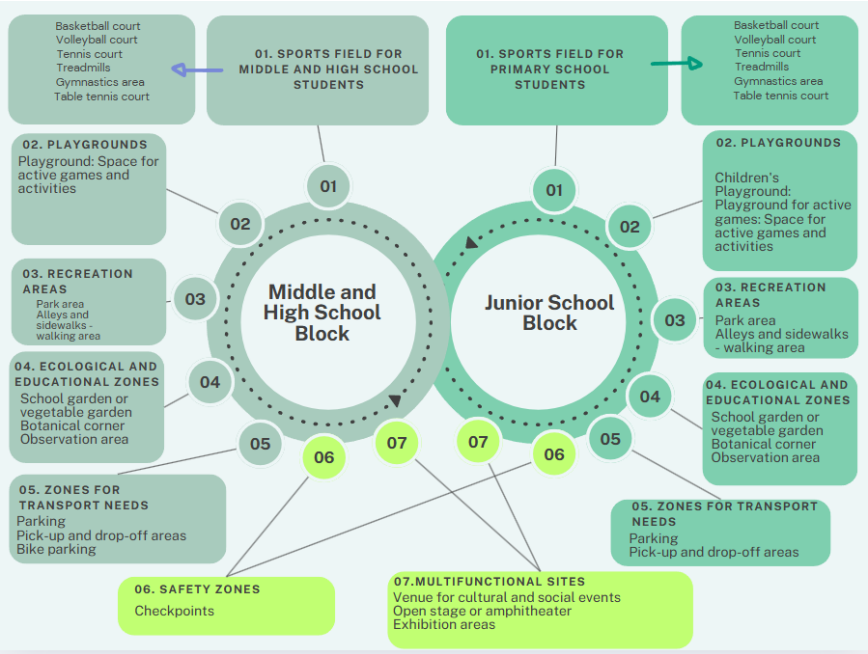

Figure 5 – Conceptual diagram No. 2 of the functional zoning of the school general plan (**authors' material**)

When designing the school grounds, it is important to ensure their safety. This can be accomplished through proper landscaping that takes into account the architectural features of the school and its surroundings. For example, the creation of a buffer zone separating the school territory from outside buildings, using dense hedges of shrubs, serves as a fence and at the same time serves as a noise barrier. In addition, the use of environmentally friendly materials such as paving tiles and safe soft surfacing for playgrounds and sports fields not only creates a safe space, but also takes into account environmental aspects, which is an important part of the general plan. Thus, through thoughtful design and architectural solutions, it is possible to ensure high safety standards in the school grounds as well as comfort for its users (**Figure 6**)

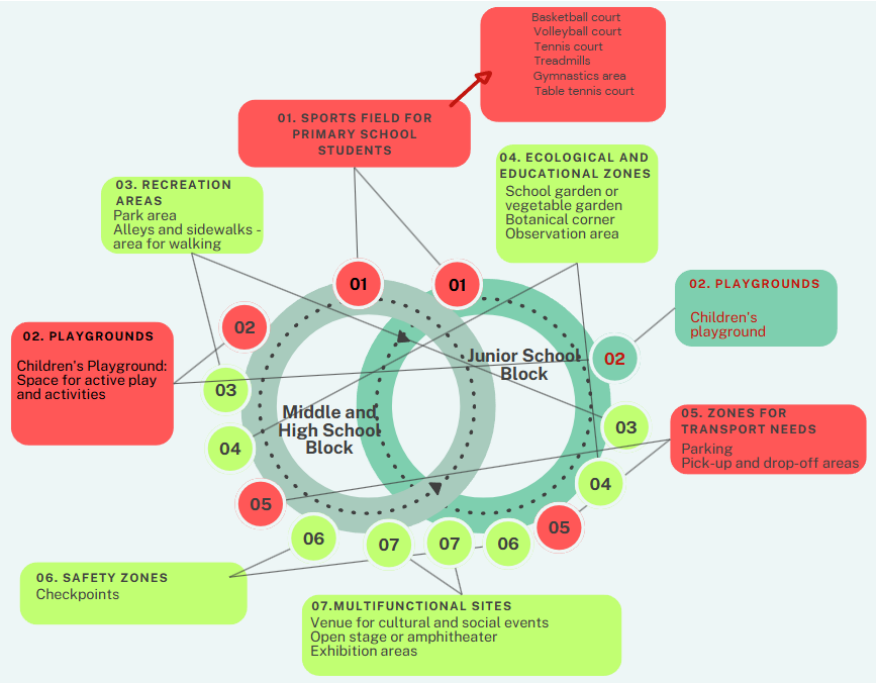

Figure 6 – Conceptual scheme No. 3 of functional zoning of the general plan of the school (**authors' material**)

5. CONCLUSIONS

The study of the world experience in designing school buildings allowed us to identify several key trends in the transformation of architectural and planning solutions of modern schools.

1. The principle of block functional zoning, in which administrative, sports and leisure facilities form an external block oriented towards the street, leaving in the depth of the site study areas for different levels of education - junior, middle and high school. These blocks can be connected through courtyards, warm or open passages, as well as common recreational spaces such as libraries, assembly halls, design studios and workshops, which defines an integrated approach to the improvement of the school grounds.

2. Creating a central creative space that plays an important role for both collective and individual learning activities. The most common way of doing this is to use a hall layout, which becomes an active learning space for students. This approach allows the space to be easily adapted to future changes, using partitions, mobile furniture and mobile equipment.

3. The flexibility of the planning scheme, especially in the context of transforming individual zones and blocks of the school into public socio-cultural facilities accessible to the local community, represents an important aspect of modern approaches to the architecture of educational institutions. Connections between different zones and blocks can be organized through courtyard recreations, warm passages and information facilities such as a library. A combination of open and closed, accessible and isolated spaces for play and learning activities is becoming characteristic of many alternative schools abroad. This diversity promotes the free organization of students' learning and leisure activities, which in turn fosters a sense of responsibility.

4. An important aspect is the application of new technologies, including energy-saving and energy-efficient solutions, which not only can have a favorable impact on the economy, but also serve as educational material for students and the entire local community.

5. Active implementation of green architecture principles, as well as integration of landscape architecture elements into the design of the school grounds (depending on natural and climatic conditions) can create additional opportunities for the educational process.

6. The informational content of recreational, communication and learning spaces, including textures, colors and fonts, also has learning potential. Thoughtful interior design of school buildings and facilities has a direct impact on students and community members, contributing to more effective learning and interaction.

Thus, the general plan of modern schools is based on the principles of flexibility and convenience, providing comfortable conditions for the educational process in new generation buildings and facilities.

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