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RESEARCH ARTICLE

MODERN TRENDS IN MODERNIZATION OF THE ARCHITECTURAL ENVIRONMENT OF PRESCHOOL INSTITUTIONS

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Abstract. *The article explores current trends in the development of preschool architecture and identifies key challenges associated with the design of modern preschool educational institutions. Special attention is given to architectural solutions aimed at creating a diverse play environment and improving fire safety in kindergartens located in the northern regions of Kazakhstan. A set of design techniques is proposed, including approaches that are relatively new to domestic practice. These solutions allow outdoor play spaces to be adapted for seasonal use, providing opportunities for summer playgrounds and winter ice facilities, as well as incorporating modernized architectural elements such as inclined planes, ramps, and straight or spiral tubular slides. The growing demand for preschool education is driven by demographic changes, the expansion of educational needs, and the increasing role of early childhood development in modern society. Under conditions of social transformation, economic complexity, and continuous technological progress, the formation of cognitive and adaptive abilities from an early age becomes particularly important. As a result of ongoing socioeconomic changes, the typological diversity of preschool educational institutions in northern Kazakhstan is evolving. These institutions differ in operational models, ownership forms, sources of funding, educational programs, and their integration into the urban structure. Preschool education represents a foundational stage in the development of a child's basic knowledge, skills, competencies, and personal qualities, forming a basis for further lifelong learning and development.*

Keywords: *artistic solutions, functional zoning, kindergartens, architectural techniques, planning solutions.*

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МЕКТЕПКЕ ДЕЙІНГІ МЕКЕМЕЛЕРДІҢ СӘУЛЕТТІК ОРТАСЫН ЖАҢҒЫРТУДЫҢ ЗАМАНАУИ ҮРДІСТЕРІ

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Аңдатпа. *Мақалада мектепке дейінгі мекемелердің архитектурасын дамытудың заманауи тенденциялары қарастырылады және қазіргі мектепке дейінгі білім беру мекемелерін жобалауға байланысты негізгі проблемалар анықталады. Қазақстанның солтүстік өңірлерінде орналасқан балабақшаларда түрлі ойын ортасын құруға және өрт қауіпсіздігін арттыруға бағытталған архитектуралық шешімдерге ерекше назар аударылады. Отандық тәжірибе үшін салыстырмалы түрде жаңа тәсілдерді қоса алғанда, жобалық тәсілдер кешені ұсынылады. Бұл шешімдер ашық ойын алаңдарын маусымдық пайдалануға бейімдеуге мүмкіндік береді, жазғы ойын алаңдары мен қысқы мұз құрылымдарына мүмкіндік береді, сонымен қатар көлбеу жазықтықтар, пандустар және түзу немесе спиральды құбырлы слайдтар сияқты жаңартылған сәулет элементтерін біріктіреді. Мектепке дейінгі білімге деген сұраныстың артуы демографиялық өзгерістерге, білім беру қажеттіліктерінің кеңеюіне және қазіргі қоғамдағы баланың ерте дамуының рөлінің артуына байланысты. Әлеуметтік өзгерістер, экономикалық күрделілік және үздіксіз технологиялық прогресс жағдайында танымдық және бейімделу қабілеттерін қалыптастыру ерте жастан бастап ерекше маңызға ие болады. Әлеуметтік-экономикалық өзгерістердің жалғасуы нәтижесінде Солтүстік Қазақстанда Мектепке дейінгі білім беру мекемелерінің типологиялық әртүрлілігі дамуда. Бұл мекемелер жұмыс істеу үлгілері, меншік нысандары, қаржыландыру көздері, білім беру бағдарламалары және оларды қалалық құрылымға біріктіру бойынша ерекшеленеді. Мектепке дейінгі білім беру-бұл баланың негізгі білімін, дағдыларын, құзыреттілігі мен жеке қасиеттерін дамытудың негізгі кезеңі, өмір бойы одан әрі оқыту мен дамудың негізін құрайды.*

Түйін сөздер: *көркемдік шешімдер, функционалды аймақтандыру, балабақшалар, сәулет әдістері, жоспарлау шешімдері.*

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НАУЧНАЯ СТАТЬЯ

СОВРЕМЕННЫЕ ТЕНДЕНЦИИ МОДЕРНИЗАЦИИ АРХИТЕКТУРНОЙ СРЕДЫ ДОШКОЛЬНЫХ УЧРЕЖДЕНИЙ

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Аннотация. *В статье рассматриваются современные тенденции развития архитектуры дошкольных учреждений и определяются ключевые проблемы, связанные с проектированием современных дошкольных образовательных учреждений. Особое внимание уделяется архитектурным решениям, направленным на создание разнообразной игровой среды и повышение пожарной безопасности в детских садах, расположенных в северных регионах Казахстана. Предлагается комплекс проектных приемов, включая подходы, относительно новые для отечественной практики. Эти решения позволяют адаптировать открытые игровые площадки к сезонному использованию, предоставляя возможности для летних игровых площадок и зимних ледовых сооружений, а также интегрируя модернизированные архитектурные элементы, такие как наклонные плоскости, пандусы и прямые или спиральные трубчатые горки. Растущий спрос на дошкольное образование обусловлен демографическими изменениями, расширением образовательных потребностей и возрастающей ролью раннего развития ребенка в современном обществе. В условиях социальных преобразований, экономической сложности и непрерывного технологического прогресса формирование познавательных и адаптивных способностей с раннего возраста приобретает особое значение. В результате продолжающихся социально-экономических изменений происходит развитие типологического многообразия дошкольных образовательных учреждений в северном Казахстане. Эти учреждения различаются по моделям функционирования, формам собственности, источникам финансирования, образовательным программам и их интеграции в городскую структуру. Дошкольное образование представляет собой основополагающий этап в развитии базовых знаний, навыков, компетенций и личностных качеств ребенка, формируя основу для дальнейшего обучения и развития на протяжении всей жизни.*

Ключевые слова: *художественные решения, функциональное зонирование, детские сады, архитектурные приемы, планировочные решения.*

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CONFLICT OF INTEREST

The authors state that there is no conflict of interest.

During the preparation of this manuscript, the authors used artificial intelligence tools (ChatGPT) solely for editorial assistance, such as improving phrasing and checking grammar, spelling, and punctuation. All ideas, interpretations, and conclusions are the responsibility of the authors, who take full accountability for the content of the article.

АЛҒЫС / ҚАРЖЫЛАНДЫРУ КӨЗІ

Зерттеу жеке қаржыландыру көздерін пайдалана отырып жүргізілді.

МҮДДЕЛЕР ҚАҚТЫҒЫСЫ

Авторлар мүдделер қақтығысы жоқ деп мәлімдейді.

Мақаланы дайындау барысында авторлар жасанды интеллект құралдарын (ChatGPT) тек редакциялық көмек мақсатында пайдаланды: тұжырымдарды жетілдіру, грамматикалық, орфографиялық және тыныс белгілеріндегі қателерді тексеру үшін. Барлық идеялар, интерпретациялар мен қорытындылар авторларға тиесілі, және олар мақаланың мазмұнына толық жауапты.

БЛАГОДАРНОСТИ/ИСТОЧНИК ФИНАНСИРОВАНИЯ

Исследование проводилось с использованием частных источников финансирования.

КОНФЛИКТ ИНТЕРЕСОВ

Авторы заявляют, что конфликта интересов нет.

При подготовке рукописи авторы использовали инструменты искусственного интеллекта (ChatGPT) исключительно для редакторской поддержки: корректировки формулировок, проверки грамматических, орфографических и пунктуационных ошибок. Все идеи, интерпретации и выводы принадлежат авторам, которые несут полную ответственность за содержание статьи.

1 INTRODUCTION

Socioeconomic changes occurring in the northern territories of Kazakhstan have reshaped the approach to organizing preschool education, affecting both the structure and classification of preschool institutions. Modern preschool facilities demonstrate a wide range of organizational models, which vary in terms of ownership, financing strategies, educational orientation, operational formats, and their spatial relationship with the urban fabric.

In contemporary conditions, early childhood education plays a key role in preparing individuals for life in an information-driven and technologically complex environment. Continuous social change and the growing complexity of production and economic systems make it essential to form the ability to learn, adapt, and respond to intellectual and technical challenges starting from preschool age.

The preschool stage lays the groundwork for long-term personal development, initiating the formation of essential competencies, cognitive abilities, and individual characteristics. As modern society undergoes accelerated cultural, technological, and international change, preschool institutions gain strategic importance. In this regard, the architectural and spatial organization of preschool buildings plays a decisive role, since the quality of the built environment shapes the educational context and affects a child's potential for future growth and self-realization.

The development of preschool architecture frequently lags behind ongoing transformations in social life, culture, and education. Evaluating the quality of the architectural environment in preschool institutions demands an integrated approach that reflects current societal demands, innovations in pedagogy, and scientific and technological progress. Nevertheless, renovation strategies for existing kindergartens often fail to account for present-day social conditions, behavioral patterns of users, and the functional requirements of modern teaching practices.

A limited use of creative design strategies in the architecture of preschool facilities has resulted in inflexible and repetitive planning solutions. These approaches generate uniform spatial configurations with minimal typological diversity, failing to support contemporary pedagogical practices. Economic constraints and cost-reduction policies have also diminished the architectural identity of preschool buildings, producing visually homogeneous urban surroundings. The lack of distinctive spatial accents and recognizable visual reference points within such environments indicates an insufficient quality of architectural conditions for early childhood education and can adversely affect children's emotional well-being, potentially influencing behavioral patterns later in life.

The design of modern preschool facilities calls for a holistic architectural model capable of combining spatial adaptability, construction efficiency, and a clearly articulated architectural character. Taking into account future development tendencies, this approach allows functional requirements to be met while preserving the originality and uniqueness of the built form.

2 LITERATURE REVIEW

The article looks at features of coordinating architectural planning solutions as well as structural factors connected to lost possibilities to educate kids active physical workouts. The essay also looks at recent advancements in the design and production of these items.

The features of the subject-spatial environment for active motor activity within the framework of a preschool educational institution are taken into consideration, depending on the age range of students and the functional focus of the programs, according to conclusions drawn from the theoretical knowledge and practical experience studied in the works of N.V. Lamekhova **(Lamekhova, 2019)**.

The study by Lamekhova N.V. **(Lamekhova, 2011)** examines materials from literary and electronic sources of knowledge on construction and architecture, as well as materials on the design of preschool educational institutions and buildings for recreational activities, including zones targeted at preschoolers.

The findings of social and psychological research are examined in Potapova T.V. works **(Potapova, 2004)**. The key components of designing areas in preschools that encourage vigorous motor loads are noted. The vector of sustainable development of architecture becomes more important within the framework of organizing and using zones of active motor activity.

According to M.B. Glaudinova's research **(Glaudinova, 2024)**, the outdoor area of a preschool institution functions as an educational environment in its own right; accordingly, the greater the diversity and structural complexity of this space, the wider the range of stimuli it provides, thereby enhancing children's cognitive engagement and intensifying the overall educational process.

Experts stress that the primary suggestions outlined in Efimov A.V. works **(Efimov, 2005)** call for considering the psychophysiological elements of development. An analysis of preschool educational institutions' practices reveals that children start spending a lot of time in front of televisions and other technologies, which unintentionally causes them to walk less throughout the course of a typical day.

Belyaeva E.L. **(Belyaeva, 1977)** investigates the contemporary issue of human visual perception of the urban environment. The particular and circumstances of this perception are examined, along with theoretical preconditions for researching how architecture is seen. Visual aspects of the city's architectural environment that have been objectively evaluated are examined. Architects and art historians are the target audience for this book.

According to L.P. Bannikova's research **(Bannikova, 2007)**, the general information of society and the population's expanding educational potential, which aims to increase the volume of knowledge of a modern person, dictate the urgent need to provide preschool education services for children on a large scale.

As Kuznetsova A.A. **(Kuznetsova, 2012)** demonstrates in her report, it becomes relevant for the forecast and development of a comprehensive model for the construction of a preschool educational institution, taking into account the parameters of compliance with the functional and flexibility of planning, constructive rationality, individuality and uniqueness of the architectural appearance. The study's goal is to provide techniques, plans, and guidelines for organizing the architectural layout of contemporary preschools using scientific data.

Arnheim emphasizes the unique characteristics of the cognitive process involved in the perception of art **(Arnheim, 1954)**. He starts out by stressing that aesthetic perception is an active, creative process rather than a silent, reflective one. It may be applied constructively, such as in the production of visual models, in addition to the restoration of items.

When incorporating life essentials into the general educational preschool program, thematic reserves may emerge in the design of all kinds of group spaces as an addition to the general educational and educational goals. As a result of the study, Lamekhova N.V. **(Lamekhova, 2007)** states that the idea may be used as the foundation for both the design of the subject environment and the architectural and planning structure.

The significance of Miklyaeva N.V.'s study **(Miklyaeva, 2011)** demonstrates that continuity in education is a novel concept. It has to do with learning continuity until recently. It was thought that the prior stage ensured the child's preparedness for learning at the subsequent level in terms of acquiring knowledge, skills, and capacities. Furthermore, learning at a new level depends on the student's amount of subject preparation. This attitude of continuity appears to be constrained in the current level of the educational system's growth and does not encompass all aspects of the educational process, including interactions between parents and teachers and between students and instructors. Because of this, talking about continuity in education – rather than merely learning – is becoming more and more common.

As shown in report of A.S. Kaidarov **(Kaidarov, 2024),** due to suitable sanitary and hygienic conditions, pedestrian accessibility to all city components, and environmental factors, architectural design solutions for pre-school educational institutions are becoming more and more appealing. All of this calls for the creation of an architectural planning framework that embodies all the benefits of urban living, accounting for building density and number of stories as well as the level of upkeep and enhancement of educational facilities.

Environmental events and human behavioral events in the environment are not the same thing, according to study by N.A. Loginova **(Loginova, 2006)**. occurrences that take place in a person's life without that person's awareness or permission are referred to as environmental occurrences. Events in human conduct are those that suggest the acceptance or rejection of any ideals.

Practical training should be regarded not as a supplementary component of the educational process, but as its essential element, ensuring the formation of applied competencies, strengthening students' motivation, and facilitating their adaptation to real professional conditions, according ro researches of K.O. Yun **(Yun, 2025)**.

Gvozdikova T.A. **(Gvozdikova, 2024)** demonstrates in her report, the current shift toward a human-centered educational paradigm has led to the strengthening of humanitarian principles within academic curricula, which increasingly incorporate general cultural disciplines. The humanitarization of education addresses two key objectives: the development of the individual and the fulfillment of social needs. As a social institution, education functions to prepare competent professionals capable of meeting the demands of contemporary society.

In addition to the planning solution, the proper choice of building materials should consider the need to adapt international experience to Kazakhstan's conditions: as Zh.Moldamuratov **(Moldamuratov, 2025)** writes in his works, the choice of technology should be based not only on the type of defect but also on a thorough analysis of climatic loads and long-term economic efficiency.

3 MATERIALS AND METHODS

Contemporary preschool architecture is shaped by educational reform, social transformation, and the growing importance of information processes. As a result, the design of preschool facilities increasingly focuses on typological diversity, functional expansion beyond basic educational tasks, and the creation of emotionally supportive environments. The use of modern compositional techniques and architectural strategies allows preschool buildings to respond to urban social demands while promoting children's well-being and supporting families in the educational process.

The methods currently employed for organizing architectural planning solutions for preschool institutions had to be analyzed in order to ascertain the paths of evolution and transformation of sanitary standards for the design of spatial environments for educational institutions as a form of organizing learning spaces and areas of social life. This was accomplished by an analytical assessment of trustworthy data, a comparison of variables, and a comprehensive analysis and systematization of existing foreign design experience.

A deep understanding of how contemporary preschool architecture balances local identities with global influences forms the basis of the research. It examines scientific literature, architectural projects, and publications in addition to examining creative and architectural methods and stylistic trends used in preschool design. The goal is to identify conceptual approaches and trends in architectural planning solutions used nationwide. To achieve these objectives, a set of analytical and comparative research methods was employed, as described below.

In order to achieve the research objectives, a set of complementary methods was applied, combining theoretical analysis with comparative and graphical techniques. The methodological framework of the study is based on a systematic approach, which made it possible to consider preschool educational institutions as complex architectural systems formed under the influence of social, functional, environmental, and psychological factors.

The research employed methods of comparative analysis to examine architectural and planning solutions of preschool educational institutions implemented in different climatic, socio-cultural, and urban contexts. This made it possible to identify both common design patterns and region-specific features influencing the formation of preschool environments. Particular attention was given to the relationship between functional zoning, spatial flexibility, and the aesthetic qualities of architectural solutions.

Analytical methods were used to study regulatory and normative documentation governing the design of preschool educational institutions, including sanitary, hygienic, and safety standards. This

analysis allowed the identification of contradictions between existing regulatory frameworks and contemporary educational and architectural requirements, as well as the determination of potential directions for their transformation.

The study also applied a structural–functional analysis of architectural spaces, focusing on the organization of interior and exterior environments, their interconnections, and their adaptability to changing educational scenarios. This approach made it possible to assess the effectiveness of planning solutions in terms of spatial variability, multifunctionality, and the comfort of users of different age groups.

In addition, graphical and modeling methods were used to visualize conceptual design proposals and to illustrate the interaction between architectural elements at different spatial levels, including urban planning, site organization, and interior layout. The synthesis of the obtained results formed the basis for developing design recommendations aimed at improving the architectural quality, adaptability, and sustainability of preschool educational institutions.

4 RESULTS AND DISCUSSIONS

Despite ongoing changes in social life, culture, and educational practices, a significant number of preschool facilities continue to be designed and reconstructed on the basis of obsolete architectural principles. Under conditions of educational reform, increasing societal expectations, and accelerated technological development, the issue of evaluating the quality of the architectural environment in preschool institutions becomes particularly relevant. In many cases, renovation strategies fail to reflect contemporary social realities, everyday activity patterns of users, and the specific requirements of the educational process, which leads to spatial solutions that do not correspond to current needs.

Insufficient integration of modern design concepts that emphasize the specificity of preschool architecture has resulted in the widespread use of inflexible and repetitive planning schemes with limited typological diversity. Such spatial configurations are poorly adapted to contemporary pedagogical approaches and innovative educational models. At the same time, economic limitations and the demand for fast and cost-efficient construction have contributed to the simplification of architectural expression, the loss of individual features of preschool buildings, and the formation of visually monotonous environments. The lack of expressive architectural elements and clear visual reference points reduces the overall quality of the preschool environment and may adversely affect children’s emotional perception of space, with possible long-term consequences for behavioral development.

Figure 1 – Kindergarten in Vinh, Vietnam, recreational open space (a), classroom (b) (**N.Ledeneva, 2022**)

Visual perception plays a dominant role in early childhood, as the majority of information about the surrounding environment is acquired through sight. Children demonstrate heightened sensitivity to visual stimuli due to their natural activity and emotional openness. For this reason, the development

of aesthetic criteria for preschool architecture and the formulation of evaluation indicators that correspond to children's psychophysiological characteristics are essential components in shaping contemporary approaches to the design of preschool educational facilities. A striking example of a modern approach to organizing the interior space of a kindergarten is found in Vinh, Vietnam, as shown in **Figure 1.**

In preschool environments, children perceive and explore surrounding objects not only through direct physical interaction but also through emotional responses to form, color, and spatial composition. Ongoing transformations in preschool education, together with broader social changes, emphasize the growing importance of architectural design as an active component of the learning process. The expansion of informational demands and the focus on comprehensive child development have led to increased complexity in the functional organization of preschool institutions, while simultaneously generating new forms of social services and modes of interaction.

In addition to their primary educational role, preschool institutions that incorporate social functions exert a noticeable influence on the surrounding urban district and contribute to the formation of related subsystems. These include leisure-oriented activities-such as creative, cultural, and educational events-as well as service-oriented functions aimed at addressing social needs, supporting parents, and conducting consultations or seminars. The spatial organization of these subsystems allows for use beyond standard operating hours, including evenings and weekends. Integrating social services into the preschool building promotes multifunctionality, spatial flexibility, and more efficient use of resources.

At the same time, the implementation of such an approach presents certain challenges, as contemporary patterns of children's behavior-characterized by greater independence and mobility-require a reconsideration of traditional closed and rigid planning schemes. To accommodate diverse developmental activities, preschool facilities incorporate thematic zones equipped with a wide range of games and educational tools. An analysis of functional and spatial layouts shows that these zones are typically included within each group unit. However, the duplication of equipment and materials often leads to excessive density and visual overload.

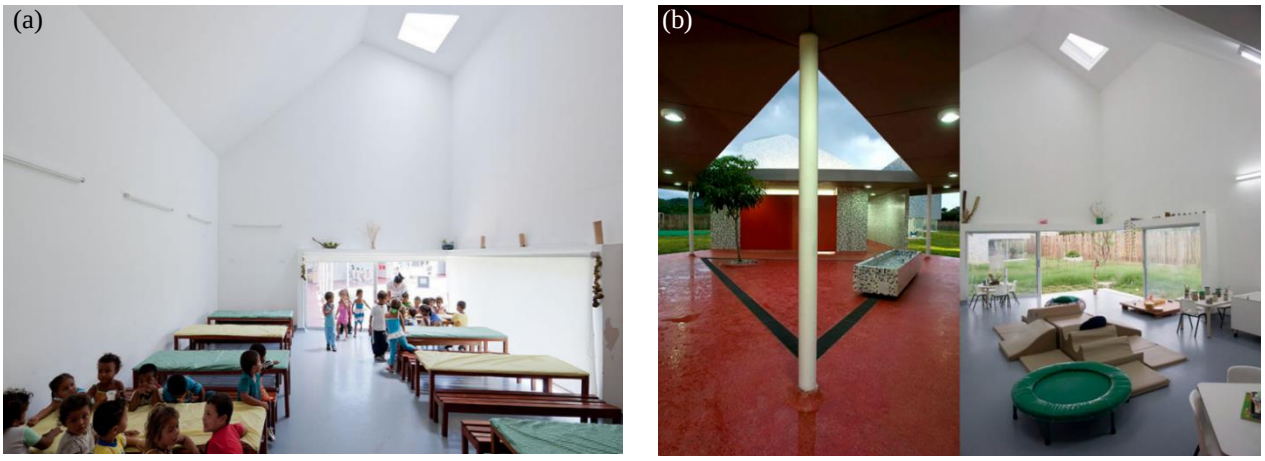

Figure 2 – Kindergarten "Timayui" in Santa-Marta, Columbia, dinning room (a), recreational area (b) (**N.Ledeneva, 2022**)

A more effective solution involves relocating rarely used equipment to a shared multifunctional cultural center, where organized activities can be conducted under teacher supervision. This approach provides children with additional space for free movement and creative expression, while reducing redundancy within group units. The shared center may also accommodate play equipment suitable for different age groups, including children temporarily attending from other institutions. The intention is not to eliminate thematic areas within group spaces, but rather to optimize their distribution and alleviate congestion in playrooms, sleeping areas, and changing rooms.

The introduction of contemporary educational programs and innovative teaching methods has necessitated adjustments to functional layouts, spatial interconnections, and aesthetic principles within preschool environments. Evaluating the architectural aesthetics of modern preschool facilities involves improving the quality of the informational environment, understood as a system of spatial and visual elements that respond to children's perceptual needs, support balanced development, and stimulate creative activity. Children are naturally drawn to expressive and visually engaging stimuli, and architectural elements play a decisive role in capturing attention, encouraging curiosity, and fostering imagination. Accordingly, both interior spaces and adjacent outdoor areas should be designed with equal consideration of their educational and aesthetic potential.

Figure 3 – Kindergarten in Moscow, Russia, assembly hall (a), classroom (b) (**N.Ledeneva, 2022**)

Despite the achievements of educators and researchers, architectural interventions are sometimes implemented hastily, resulting in solutions that do not fully correspond to users' needs. This is reflected in the frequent use of lightweight partitions, vivid finishes, or mobile furniture to subdivide limited spaces, which often fails to create a comfortable and effective environment. A more justified approach involves the clear differentiation of active zones and quiet areas, based on studies of the psychophysiological characteristics of children in various age groups. Sensory richness can be enhanced through the inclusion of tactile surfaces, color accents, large-scale graphic elements, and diverse textures.

An analysis of socio-cultural and natural factors influencing preschool architecture made it possible to develop an integrated concept of early childhood education that addresses the psychophysiological needs of children across all age groups and strengthens the relationship between humans and the natural environment. On the basis of this concept, a set of recommendations was formulated, structured according to three interconnected levels of architectural and spatial design.

At the urban planning scale, the formation of a distributed network of preschool institutions is proposed as a means of responding to contemporary social and spatial demands. This approach focuses on ensuring universal accessibility and expanding the range of services provided, while allowing for flexible modes of operation. Preschool facilities may function as independent buildings, be attached to residential or public structures, or be integrated into existing urban developments. Within this framework, preschool institutions are considered as elements of a broader system of social centers that support family interaction, parental assistance, and leisure activities. Particular attention is given to improving the architectural expressiveness of buildings in harmony with the surrounding environment, maintaining safety and security standards, and designing outdoor spaces that perform educational and didactic functions.

Table 1

Architectural and spatial recommendations for preschool institutions, structured by three interconnected levels of design (author`s material).

Level	Recommendations	Key actions
Urban planning level	- Create a distributed network of preschool institutions; Integrate universal accessibility and flexible operational modes; - Integrate social functions for family support and parental activities; - Ensure safety, architectural expressiveness and landscape harmony.	- Ensure universal accessibility and flexible operational modes; - Integrate preschools with residential and public buildings; - Expand social functions for family support and parental activities; - Ensure safety, architectural expressiveness and landscape harmony.
Site level (preschool area)	- Enhance ecological and functional qualities of outdoor spaces; - Integrate access routes, parking and pedestrian paths; - Ensure safety and clear spatial separation of at sus times; - Use durable, contemporary materials for playgrounds, sport zones and landscaping.	- Integrate green roofs, living hedges and diverse planting to regulate climate and improve aesthetics; - Organize access routes, parking and pedestrian paths, ensure safe, clear spatial separation; - Use durable, contemporary materials for playgrounds, sport zones and landscaping.
Interior level	- Enhance the aesthetic quality of interior environments; - Introduce tactile surfaces, natural materials and large-scale graphic elements; - Offer dynamic, sensory-rich learning environments, adaptable modules.	- Create a balances environment of quiet and active zones considering psychophysiological characteristics of children; - Improve indoor climate stability for green roofs and microclimate controls.

The proposed design recommendations are systematized in Table 1, which presents a structured overview of architectural and spatial strategies for preschool educational institutions across three interconnected levels: urban planning, site organization, and interior environment. To enhance clarity and demonstrate the interdependence of these levels, **Figure 4** illustrates a conceptual model of an adaptive preschool environment, highlighting the hierarchical relationship between planning decisions, environmental quality, and functional flexibility. Together, the table and the diagram provide a comprehensive framework for understanding how integrated architectural solutions contribute to the formation of a safe, flexible, and development-oriented preschool educational environment.

Figure 4 – Strategies for forming an adaptive architectural environment for preschool institutions (author`s material)

Ensuring that all children in north regions of Kazakhstan have access to preschool education carries substantial social implications. The development of a flexible, multifunctional network of preschool institutions depends on expanding facilities with diverse operational models and incorporating intra-block centers that provide comprehensive social services, such as childcare placement, parenting programs, seminars, joint activities, and recreational opportunities.

It is recommended to explore various approaches across ecological, functional, hygienic, and psychophysiological domains to enhance both the aesthetic qualities of the interior and exterior environments of preschool institutions and the architectural form of the buildings themselves.

To enhance the interior conditions of urban preschool facilities and improve the aesthetic quality of their surrounding environment, environmentally sustainable design strategies should be implemented. The integration of features such as green roofs and living hedges contributes to the formation of visual landmarks and enriches the emotional and spatial experience of the preschool environment within residential developments. In addition to reducing the impact of extreme climatic conditions-such as heat accumulation in summer and heat loss in winter-green roof systems contribute to the stabilization of indoor microclimate parameters, including temperature and humidity. At the same time, they enhance the visual perception of the residential environment when viewed from elevated points. The integration of climate-regulating elements into the building structure allows interior conditions, architectural form, and the surrounding landscape to be considered as a unified system.

The spatial organization of the adjacent territory plays a decisive role in ensuring safety within preschool facilities. A well-structured arrangement of access routes and parking areas minimizes the likelihood of traffic conflicts and emergency situations. To achieve this, the design should incorporate clear spatial orientation and protective elements, such as designated parking zones for service and private vehicles, architectural and landscape buffers, and the functional separation of pedestrian and vehicular movements. An integrated lighting strategy further enhances safety and spatial clarity, combining general illumination with accent lighting that emphasizes key architectural elements and pathways. The use of energy-efficient and autonomous lighting solutions, including solar-powered fixtures, becomes particularly important during autumn and winter periods, when reduced daylight affects visual perception and color balance as shown in **Figure 5**.

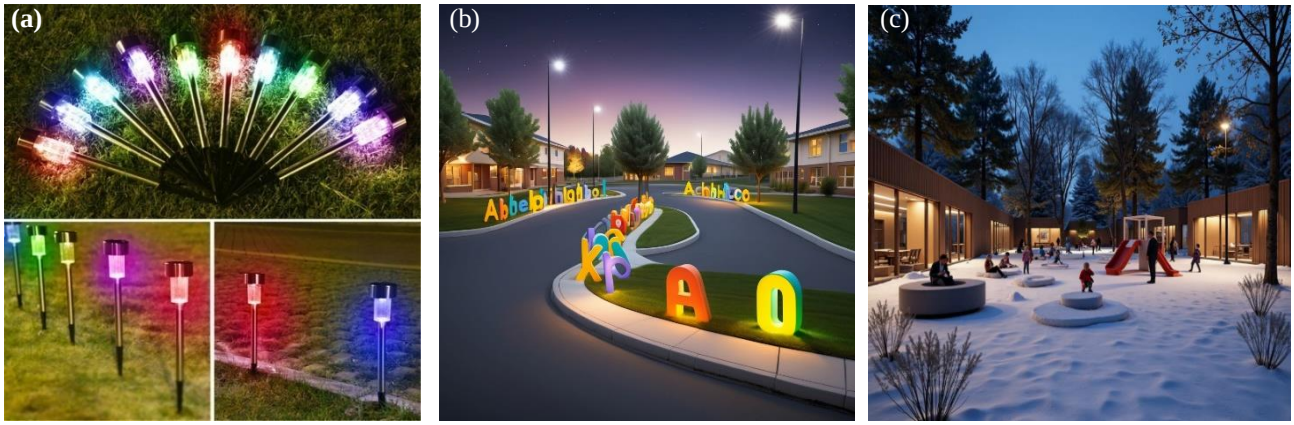

Figure 5 – Outdoor lighting fixtures powered by alternative energy sources, low position (a), lighted letters (b), high position (c) (author`s material)

Improving the quality of outdoor spaces in preschool institutions can be achieved through a comprehensive approach that combines spatial planning, landscaping, and the use of contemporary materials. The expansion of pedestrian routes, including those partially integrated into the building structure in the form of verandas or terraces, enhances spatial continuity and comfort. Thoughtful selection of plant species and their combinations, together with modern landscape design techniques, contributes to the formation of a favorable microclimate. The use of durable, high-quality materials for playgrounds, sports areas, and pedestrian surfaces further supports climatic regulation and functional efficiency.

Visual diversity within outdoor areas can be reinforced through the application of color contrasts and geometric patterns in surface treatments, such as sand, gravel, elastic paving elements, and natural stone. These techniques help attract children’s attention, structure space, and clearly define functional zones. In addition, the integration of energy-efficient solutions such as sun and rain

protection systems and elements oriented toward interaction with nature, including living corners and winter gardens, plays an important role in enhancing the internal microclimate and overall environmental quality of preschool facilities.

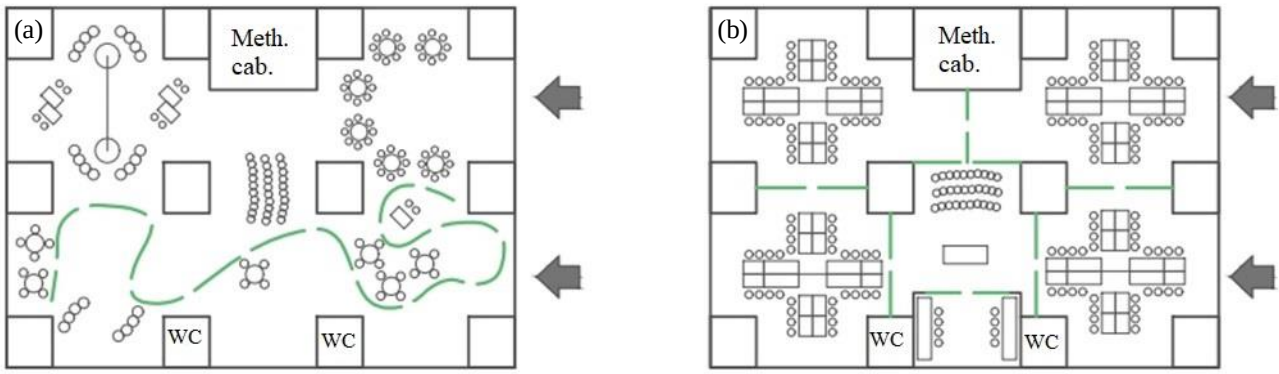

Figure 6 – Examples of section arrangement, open planning (a), sectional planning (b) (author`s material)

The architectural environment of preschool facilities can be designed both internally and externally, taking into account children's active engagement with play areas and the importance of facilitating physical activity. This approach broadens the possibilities for employing architectural and artistic elements. Accordingly, before transforming functional walkways into stimulating and educational zones for sports and recreation, these areas should be integrated with the building's structural components, as illustrated in **Figure 6.**

Figure 7 – Proposal for roofing use for skating (a), roller coaster riding (b), throwing snowballs (c) (author`s material)

Figure 7 demonstrates how the configuration of ground surfaces and intersecting slopes organizes the architectural space of the site, creating an irregular open layout where planes flow seamlessly into one another. This design approach supports the recreation of traditional winter sledding activities and summer landscape arrangements. While such strategies are effective in northern regions, they are not commonly applied locally, though they appear in international projects. The presence of slopes and inclined planes within the volumetric-spatial composition reflects the climatic conditions of northern areas, characterized by long, snowy winters and short, hot summers. Incorporating ramps, sloped surfaces, and roofs that smoothly merge with the ground significantly enhances the architectural environment, allowing the space to accommodate both winter sledding and summer activities without affecting the interior climate.

Preschool sleeping areas are designed with varying levels of visual separation to promote undisturbed rest. As shown in **Figure 8**, the room layouts subdivide the space into smaller, distinct zones, allowing children to manage their personal areas and cultivate an early understanding of spatial organization and order.

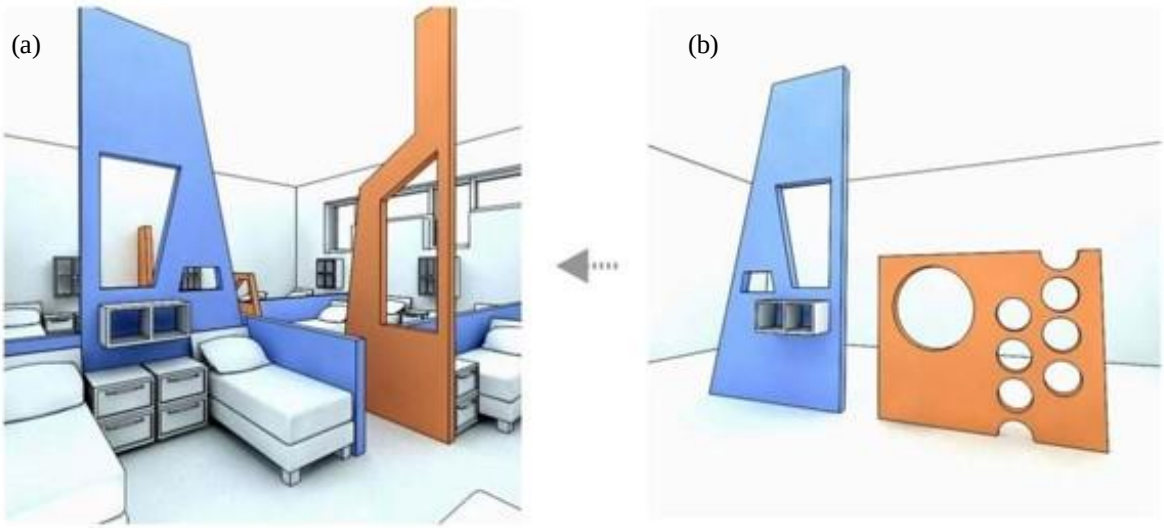

Figure 8 – Proposal for the use of age differentiation and adjustable autonomy in the dormitory of a preschool educational institution, final position (a), initial position (b) (author`s material)

Rooftops in preschool facilities, often used as additional walking or play areas, require robust perimeter fencing and shade structures to ensure children's safety. As noted by Demidova N.I. **(Demidova, 2009)**, the visual monotony and limited accessibility of surrounding architecture can be mitigated through a series of small openings that maintain a connection with nature, coordinated with planes of varying heights. These openings are protected by a vertical metal mesh. This rooftop design strategy not only expands architectural and creative possibilities but also enhances the building's aesthetic appeal in densely populated areas while serving as a practical and cost-effective compositional element.

To optimize the functional organization of preschool educational environments, Komarova I.I. **(Komarova, 2020)** emphasizes the importance of designing spaces that are adaptable and mobile, offer multifunctional capabilities, allow for spatial variability, support age-specific differentiation, and provide adjustable levels of autonomy within the planning layout of the institution. The following tactics can be utilized to put the previously discussed set of suggestions for enhancing a children's educational institution's architecture into effect.

Acceptance of both functional adaptability and geographic diversity. According to Lamekhova N.V.'s writings **(Lamekhova, 2017)**, the climatic conditions and seasonal shifts in northern regions allow for more efficient use of preschool grounds throughout the year. For instance, an outdoor amphitheater can serve as a venue for summer multimedia presentations, holiday celebrations, and children's theatrical performances. During the winter months, the same open space can be transformed into an ice-skating rink, illustrating the potential for seasonal adaptation of functional outdoor areas.

The application of the proposed approaches contributes to the creation of an adaptive architectural framework for preschool institutions, capable of responding to current educational demands and future transformations. From an architectural perspective, the formulated recommendations provide a basis for assessing the adaptability and long-term effectiveness of spatial and structural elements under changing functional, social, and environmental conditions.

The main conclusions of the study are systematized in Table 2, while **Figure 9** presents a conceptual model illustrating the interaction between societal factors and architectural principles in the formation of an adaptive preschool environment.

Table 2

Key conclusions and directions for the formation of an adaptive architectural environment of preschool educational institutions (author`s material).

№	Direction/principle	Content of the conclusion	Architectural significance
1	Interconnection with social changes	The architecture of preschool institutions is closely linked to social, scientific, economic, and technological transformations.	Requires continuous updating of architectural approaches and rejection of rigid design models.
2	Need for adaptive architectural solutions	Buildings with inflexible planning structures become functionally and conceptually outdated under modern educational conditions.	Justifies the transition to flexible, transformable, and adaptive spatial solutions.
3	Revising design methodologies	Improving the quality of preschool architecture depends on reconsidering traditional methods of forming the educational environment.	Forms the basis for developing contemporary design strategies aligned with educational reforms.
4	Formation of an adaptive architectural framework	The proposed approaches allow preschool institutions to respond to current educational needs and future transformations.	Ensures long-term efficiency and resilience of spatial and structural elements.
5	Assessment of adaptability and sustainability	Architectural recommendations provide criteria for evaluating the adaptability of buildings under changing functional, social, and environmental conditions.	Enables systematic analysis of the long-term performance of preschool facilities.
6	Flexibility of the planning structure	Transformable environments allow rapid adaptation to evolving learning scenarios and organizational requirements.	Supports multifunctionality and efficient use of space.
7	Systematization of organizational structure	Clear spatial organization regulates movement and interaction between children and staff.	Enhances functional clarity, communication, and diversity of spatial use.
8	Integration of architecture and composition	Human-centered design ensures physical and psychological comfort through proportions, biophilic forms, and color solutions.	Improves aesthetic quality, emotional perception, and communicative potential of the environment.

The diagram illustrates the relationship between external societal factors and key architectural principles that determine the formation of a flexible, human-centered, and functionally sustainable preschool environment. The model reflects the conclusions summarized in Table 1 and demonstrates how adaptability, spatial variability, and organizational structure contribute to the long-term effectiveness of preschool educational facilities.

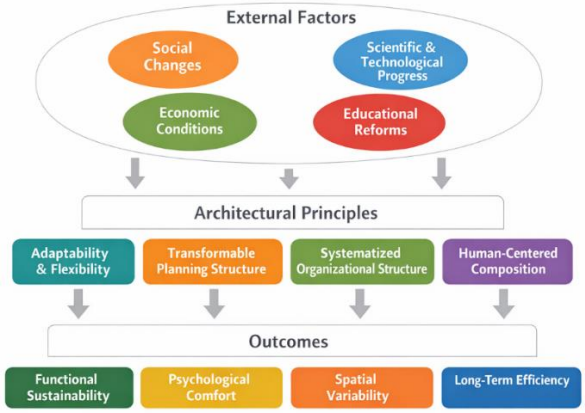

Figure 9 – Conceptional model of an adaptive architectural environment for preschool educational institutions (author`s material)

Yakhno **(Yakhno, 2022)** emphasizes that the interior of a preschool facility should follow an “open” planning concept, characterized by the presence of flexible, movable thematic areas designed to accommodate children of different age groups. They are dispersed throughout the structure to generate a variety of thematic zones that enhance the visual attractiveness of communication zones and stimulate children's cognitive abilities. The availability of extra sporting items enhances students' health, lowers the risk of sickness, and boosts enthusiasm in outdoor activities.

5 CONCLUSIONS

Summarizing in conclusion, it is important to emphasize that the architecture of preschool educational facilities is deeply interconnected with ongoing transformations across multiple societal domains, including social, scientific, and economic spheres.

Due to social, scientific, and technological progress, coupled with the modernization and strengthening of the preschool education system, facilities with inflexible designs quickly become outdated both functionally and conceptually. Revisiting and refining the methods used to create architectural environments for preschool education is essential for advancing and enhancing the design quality of these institutions.

To raise the communicative relevance of preschool institutions, a theoretical model for creating such a space by defining norms for the ideal conditions must be devised.

1. The flexibility of the transformable structure is one of these needs. the ability of a school to swiftly adapt its surroundings to suit changing learning circumstances. The workplace, as a systematically organized activity, is always evolving, as are the rules and requirements for lesson planning.

2. Systematization of organizational structure. The structure is responsible for two fundamental tasks: dividing the space into discrete sections and guiding the children's movements. The appropriate design of a preschool is ensured by interaction and the exchange of knowledge and information between staff and child groups. A contemporary preschool institution needs close relationships between all of its constituent pieces to provide diversity and avoid ambiguity.

3. Combining architecture with composition. Humanity, which ensures both internal and external communication, should be the defining characteristic of the communicative production environment of the modern period. "Humanity" in this sense refers to creating the most pleasant physical and psychological settings for various preschool institution groups. This includes aesthetic comfort, which is achieved through design techniques including the proportions of architectural and design elements to the human body, biophilic shapes, and carefully selected colors. The development of a visual solution for the space should take into account the objectives of information dissemination, corporate self-identification, the creation of an aesthetically pleasant environment that engages the teacher and child, and a representational function.

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