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## **Current problems of arranging shelters in educational institutions in Ukraine**

**Abstract.** This study covered the issue of creating safe conditions for all participants of the educational process in educational institutions in conditions of potential danger. The topic has become particularly relevant since 2022 as a result of the armed aggression of the Russian Federation against Ukraine. The arrangement of simple shelters (fortifications) in existing school buildings is decided by state authorities, legislative structures, regional institutions, and school administrations. The purpose of this study was to comprehensively examine the problem of creating a safe learning environment, identify indicative research areas, establish legislative guidelines, and preventively assess the real needs of protective structures to ensure the educational process at school. The study used the initial analysis of legal provisions, general scientific methods, systematisation and generalisation of special information, empirical methods, the method of expert assessments, factor analysis (for consideration of architectural solutions), and an interdisciplinary review of the provisions of the educational process security. The stages of solving the problem of designing and building shelters in educational institutions of Ukraine were outlined. The main factors in the formation of architectural solutions for shelters and the safety of the educational process were identified as follows: legislative; organisational; architectural and planning; engineering and technical; pedagogical; and daily. The scientific and pedagogical principles were addressed, the study highlighted the modern trends and innovative models of school education that influence the architectural organisation of school buildings. Planning solutions should provide for variant ergonomic organisation of the educational process, open educational, communication, and recreational spaces. It was emphasised that the educational environment of a school should consider security requirements. The study examined the case of a newly built school with a shelter for pupils and teachers that has adequate conditions for learning. The practical value of the study lies in the possibility of applying certain aspects and conclusions in the real design of educational institutions based on a comprehensive consideration of security requirements

**Keywords:** civil security; school shelter; school architecture; educational space

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## INTRODUCTION

The main prerequisite for quality education is safety and compliance with all measures to preserve the lives of participants in the educational process. Law of Ukraine No. 2145-VIII (2023), state programmes for the development of the sector solve the strategic task of integration into the European Education Area, and a systemic transformation of Ukrainian education is underway to ensure its new quality from pre-school education to higher education and adult education. The education system faces global challenges in creating safe learning environments. The Ministry of Education and Science of Ukraine engages in organisational and informational activities, receiving significant support from various international organisations and institutions, such as the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the United Nations Children's Fund (UNICEF), the World Bank, public and private organisations from different countries, international foundations and communities.

Currently, scientific and practical positions have been established for ensuring a safe school environment. There have been significant developments in the educational sector of Ukraine aimed at optimising the activities of educational institutions in cooperation with the authorities, in line with European traditions of public administration (Danylenko & Larina, 2022). Additionally, pedagogical teaching technologies have been updated (Palamarchuk & Baranovska, 2018). The proposal of a holistic educational space as the foundation for constructing a strategy aimed at the advancement of contemporary Ukrainian education is presented by R. Pavelkiv & I. Petrenko (2021). This concept will offer pupils social, emotional, and behavioural assistance in critical situations. A comparable comprehensive view of a secure academic environment is supported in R. True's (2020) thesis at both the school and city district level. The key elements of a safe school environment were identified as follows: adherence to legislative norms, professional safety standards, adequate training for staff, sufficient financial resources for safety activities, heightened awareness among all participants in the educational process, appropriate school architecture and facility design, and regular maintenance of facilities.

The architectural design of schools ought to comprehensively shape the educational environment, considering safety measures, contemporary practices of innovative pedagogy and child-orientedness, as well as adapting appropriate space for the full development of children. The study conducted by N. Wright *et al.* (2021) focuses on the significance of establishing communication between architects and teachers when designing educational spaces. The study emphasizes the concept of "flexible learning", adequate free space, incorporation of areas for both group and individual activities, and the potential for functional transformation of premises. The design of school space is important for the organisation of the educational process and the health of pupils.

In Ukraine, conditions are being created to promote the experimental construction of new types of school buildings and alternative educational institutions that embody the latest pedagogical concepts of integrated child development. A condition for the functioning of a school under increased external threat, for conducting classes in a face-to-face format, is the provision of protective structures in educational institutions. An analysis of statistics (Ministry of Education and Science of Ukraine, 2022a) showed that the network of general education institutions numbered 13,834 (as of 22.08.22), as a result of Russia's military aggression in Ukraine, the number decreased by 157, and 929 institutions were damaged. At the end of the 2022/23 academic year, 74.7% of secondary schools were equipped with protective structures. All possible measures are being taken to organise the educational process under martial law; specifically, the security of school buildings and grounds has been strengthened, the existing fund of civil defence structures is being gradually brought into readiness, and new facilities are being designed and built.

The Civil Protection Code (2023) serves as the primary document governing the relationships aimed at safeguarding the populace, the natural environment, and buildings from emergencies. This Code outlines the proper functioning of the state's civil protection system, defines the duties and responsibilities of government and local authorities, and stipulates the rights and obligations of citizens, institutions, and organizations. In the field of architecture and construction, there exist regulatory documents such as the State Building Regulations of Ukraine (SBR), State Standards, and Rules for the implementation of engineering and technical methods of civil protection, which consider inclusiveness requirements, especially in the design of protective facilities for educational institutions.

Designing and modernizing schools to meet safety requirements is a significant area of development in the architecture of Ukrainian secondary schools. Significant practical experience has been gained in determining optimal functional parameters, flexible layout, and design of common spaces and classrooms. In studying the problem of safety of the educational process, it is necessary to consider scientific and pedagogical positions: patterns and content of school education; school science, education management. The newest areas of updating school education in Ukraine, in terms of integration into the European educational sphere, are important, namely, the concept of "Education 4.0: Ukrainian Dawn" in line with the level of technical development of society (Ministry of Education and Science of Ukraine, 2022d), the Concept of the New Ukrainian School (NUS) (Reform formula, 2017).

The purpose of this study was a comprehensive analysis of the factors that form a safe educational environment and influence the modern architecture of school buildings. It is necessary to determine the successive stages of investigating the problem of educational safety, establish a regulatory framework for school design, collect



and systematise empirical data, and analyse architectural, and scientific and pedagogical practices in organising a non-threatening school space.

## MATERIALS AND METHODS

The study systematically applied certain steps: consideration of the current security situation in Ukraine; clarifying the urgency of the problem of arranging school shelters; identifying the components of subsystems; determining the structural elements of the research process; and considering possible ways and prototypes for designing shelters in educational institutions. The research methodology was determined by the legal provisions set out in the Laws of Ukraine and some state documents adopted during martial law. During the hostilities in Ukraine, state services and authorities have developed several recommendations for the safety of participants in the educational process (Ministry of Education of Ukraine, 2022b, 2022c; State Education Quality Service of Ukraine, 2022). The Educational Ombudsman of Ukraine (2022b) is responsible for school shelters.

The study of the problem of creating a safe space of an educational institution is based on general scientific methods. The study applied theoretical analysis and synthesis, systematisation and generalisation of facts about the specifics of the functioning of civil defence structures and their classification. The study required the identification of key concepts such as safety, safe educational environment, protective structures and facilities, and the educational process. An analytical review of the regulatory positions on the construction, arrangement, and operation of school shelters in Ukraine was carried out to determine the design principles and features of shelters in educational institutions.

The methodological basis included a factor analysis for the formation of architectural solutions for shelters and the safety of the educational process. The general issue of educational environment safety is divided into various factors: legislative, organizational, architectural and planning, engineering and technical, pedagogical, and daily. The legislative factor integrates the norms of the Laws of Ukraine in the security, educational, architectural and construction sectors. The organizational factor determines the administration's role in educational institutions, as well as the rules and norms of behaviour for participants during dangerous situations, including security methods and means. This is compared with Israeli security practices and Ukrainian experience. The architectural and planning aspect of designing the school's structure to meet safety requirements aims to optimize functional areas, consider contemporary forms of education, and provide comfortable learning and recreational spaces for pupils.

The general classification of shelters includes five main types of civil protection structures: shelter, radiation shelter, dual-purpose structures, rapidly constructed structures, and simple fortifications. To determine their compliance with the specific features of organising the educational process in schools under conditions of danger, the study uses the method of expert evaluation. Several independent

experts from the architectural and educational sectors were involved:

- V. Nikolaichuk, chief architect of BUD-KONTUR projects in Khmelnytskyi. (BUD-KONTUR, n.d.);
- T. Hazda, principal of Primary school No. 1 of Khmelnytskyi City Council (Primary school No. 1..., n.d.);
- R. Harasym, Director of Secondary Comprehensive School No. 48 in Lviv (Secondary comprehensive school..., n.d.).

All individuals gave permission to be interviewed and to disseminate the information provided during the interview. Empirical data was important for determining the real state of the school shelter at Primary School No. 1 of the Khmelnytskyi City Council: photographs collected by one of the authors, the results of interviews with teachers, pupils, and their parents in the 2022/23 school year. The experimental basis of the study is the project of a secondary school for 1,440 schoolchildren in Khmelnytskyi.

The suggested study constitutes the preliminary phase of examining the issue of constructing shelters in Ukrainian educational facilities. The study aims to comprehensively analyse the problem, identify potential research avenues, establish legislative recommendations, and evaluate the proactive requirements for protective structures to secure the academic process at school. The next stages of the research are planned as follows:

- detailed classification and assessment of the suitability of protective structures for educational institutions in terms of safety requirements, structural, planning, aesthetic, and other characteristics;
- comparative analysis of architectural prototypes of protective structures and measures to ensure the safety of the educational process;
- developing a conceptual model of the school repository, considering the impact of external and internal factors of influence, pedagogical and psychological aspects;
- substantiation of design models of shelters for educational institutions of different types and categories of protection.

Open sources and publications on social media confirmed the importance of the safety factor in the school's architecture, clarified the difficulties and practices of organising children's stay in the shelter, and revealed the specifics of conducting classes during air raids.

## RESULTS

The safety of citizens is guaranteed by the Law of Ukraine No. 2469-VIII (2023), and civil defence structures are defined as engineering facilities for protecting the population from the impact of various hazards (emergencies, military operations or terrorist acts) (Civil Protection Code of Ukraine, 2023). Depending on the nature of the origin of events that can cause emergencies (anthropogenic; natural; social; military), the classification of protective structures is presented:

- A shelter is a sealed structure designed to protect the public from hazards for an extended period. It enables





the creation of conditions that safeguard against potential dangers;

- A radiation shelter is a non-hermetic protective structure that can guard against ionising radiation in the presence of radioactive contamination in the area, as well as against conventional weapons;
- Dual-purpose structures (above or below ground, comprising separate parts) are designed or adapted to provide temporary shelter for the population.
- Prefabricated defences that can be constructed quickly from specific structures in compliance with building regulations.
- Basic shelter (fortification) involves utilizing a cellar or underground location as a temporary refuge for individuals to decrease the potential for collateral harm.

In current practice, educational establishments usually have basic shelters located in basements and on the ground floor. Enclosed shelters are only found in exceptional cases, such as in newly-built premises or when refurbishing former industrial sites. Shelters located directly in the educational institution will provide effective protection for participants in the educational process. This is confirmed by the conclusions of scientists and practitioners, as well as the recommendations of experts (Shelter in an educational institution, 2022).

A well-designed and well-equipped shelter offers an opportunity to conduct in-person training according to organizational requirements. This includes conducting necessary briefings, training evacuations to the shelter,

and checking fire and engineering systems. If the shelter is located in another building or next to a school, there are risks to the life and health of children depending on the time it takes to evacuate. The evacuation process should be planned depending on the number of teachers, pupils, school staff, and the nature and conditions of the security situation.

The issues of equipment, conditions of functioning of civil protection structures are important, and they are regulated by the established norms (Shelter in an educational institution, 2022) and the passport of the protective structure. It should take 12-24 hours to make them ready for their intended use. In times of danger, the following can be used to shelter the population as dual-purpose structures and basic shelters: underpasses, subway stations, all types of tunnels; constructed underground facilities of the pit type; inactive defence facilities and bases; underground cavities for various purposes; basements, ground floors, and first floors of buildings; other facilities suitable for sheltering the population (Order of the Ministry of Internal Affairs of Ukraine No. z0879-18, 2022; Resolution of the Cabinet of Ministers of Ukraine No. 138, 2023).

The problem of architectural solutions for shelters and the safety of the educational process should be considered as a system of identifying current needs, considering the experience and best practices of various industries and institutions in the interaction of the following factors (Fig. 1): legislative; organisational; pedagogical; daily; architectural and planning; engineering and technical.

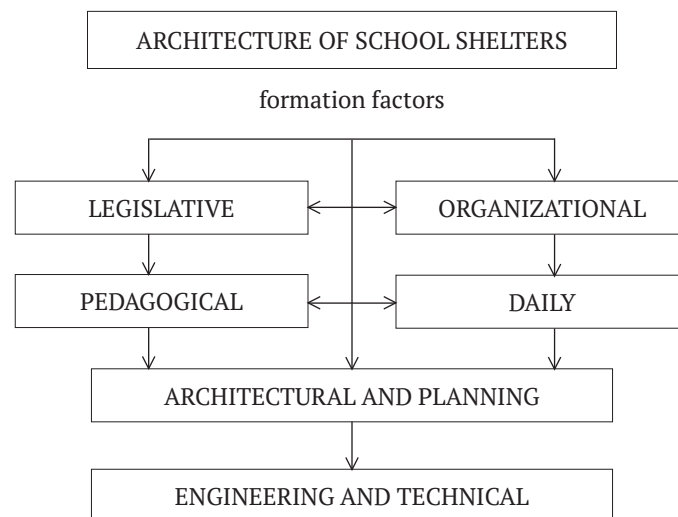


Figure 1. Structuring the problem of school shelter architecture

Source: compiled by the authors of this study

**Legislative factor.** It establishes norms and procedures for all participants in the educational process. The situation of a state of emergency and military operations is regulated by the Civil Protection Code of Ukraine (2023), Law of Ukraine No. 2145-VIII (2023) and regulatory documents that cover important tasks of ensuring the safety and health of the population (Decree of the President of

Ukraine No. 392/2020, 2020). The norms for regulating the educational process of the school are set out in Law of Ukraine No. 2145-VIII (2023), Law of Ukraine No. 463-IX (2023), specifically, the right of pupils to safety in education. The safe educational environment of an educational institution is defined as a set of conditions for excluding the possibility of physical, property and/or moral harm to



pupils, and the head of the institution is responsible for this (State Education Quality Service of Ukraine, 2022).

The financial issues of equipping shelters under the state decentralisation programme can be resolved at the expense of the budget of the communities that are the founders of educational institutions. An educational subvention of UAH 1.5 billion from the state budget was allocated to local budgets exclusively to provide safe conditions in general secondary education institutions (Resolution of the Cabinet of Ministers of Ukraine No. 419, 2023), and rules and procedures for obtaining funds for the repair or construction of school shelters were established (Creation of shelters..., 2023). At present, funding for upgrading the material and technical base, which does not include routine repairs and the construction of shelters, is a problem.

The design and construction of civil defence structures for educational institutions is subject to the provisions of urban planning legislation, State Building Regulations and legislative documents on safety and accessibility of facilities for people with limited mobility, high-quality engineering and technical civil defence measures, and compliance with fire safety requirements:

- State Building Regulations of Ukraine V.2.2-3:2018 (2018) regulate the design and reconstruction of buildings of all types of educational institutions and contain requirements for the development and functional zones of sites, requirements for space-planning solutions for all groups of premises, a set of engineering, technical and sanitary-hygienic standards;
- State Building Regulations of Ukraine V.2.2-5-97 (1998) substantiate the design and reconstruction of protective facilities as the main means of collective protection of the population, and specify the design standards for dual-purpose protective facilities;
- State Building Regulations of Ukraine V.1.2-4:2019 (2019) define the scope and content of measures for various defined categories of facilities according to the zoning of the territory by the level of potential danger (means of mass destruction, possible accidents and anthropogenic disasters);
- State Building Regulations of Ukraine V.2.5-56:2014 (2015) and State Building Regulations of Ukraine V.1.1.7-2016 (2017) establish general fire safety requirements for houses, buildings and structures of any purpose aimed at limiting the spread of fire between and within buildings, ensuring evacuation and rescue of people, extinguishing fire, and applying fire protection systems.

The norms for providing educational institutions with shelters were established by Ukrainian legislation only in 2018 (Order of the Ministry of Internal Affairs of Ukraine No. z0879-18, 2022), before that there were no direct instructions in the regulatory documents. The design of protective structures was envisaged in buildings in potentially hazardous areas, e.g., near nuclear power plants.

**Organisational factor.** Determines methods and ways to ensure the functioning and requirements for the arrangement of shelters, appropriate actions of the

administration of educational institutions, involvement of necessary services and technical services. It is important to create the safest possible conditions for all participants in the educational process, which is facilitated by joint efforts of the authorities and the administration of educational institutions. For this purpose, an algorithm of actions for preparing protection facilities and training the population in the event of emergencies was introduced (Resolution of the Cabinet of Ministers of Ukraine No. 444-2013-p, 2023).

The main tasks to be solved by the heads of educational institutions are identified (State Emergency Service of Ukraine, 2022): 1) to make the existing protective structures ready for use; 2) to calculate the full quantitative need for shelter for all participants in the educational process; 3) in the absence of protective structures on the balance sheet of the educational institution or when an additional need for them is established: to initiate a survey of existing structures and premises; to ensure the creation and arrangement of the simplest shelters on the territory of educational institutions; to determine the possibility of using the protective structures of other business entities for shelters.

To organise in-person training, the capacity of the shelter must be considered. Schools draft the appropriate timetable, adjusting the number of children, and some classes attend school on different days. Various forms of education are combined – full-time, distance (using IT technologies and online access in areas close to the combat zone), family and external; multi-times and mixed modes of attendance. The requirements for the organisation of training of educational institutions emphasise that participants in the educational process should receive full information about the location of protective structures and know the rules of conduct while in the shelter (Ministry of Education of Ukraine, 2022c). Each educational institution should develop an individual algorithm for dealing with the air raid alert. The security situation at a school depends on the territorial location, number of people, location of the shelter, age of pupils (primary/secondary school), etc. It is recommended to set up a universal communication channel and provide instructions. It is proposed to use preventive measures to identify possible risks, an individual approach to pupils (Hamilton-Ekeke, 2017), and strive to create a positive school climate with relationships of trust and respect between pupils and staff.

The Specialist in Security project was launched in Ukraine to improve the safety of the educational environment, including the prevention of possible negative phenomena and any dangerous incidents. A security specialist in the educational environment is an official of the executive body of a village, town, city, or regional council whose knowledge and skills correspond to current security challenges. When performing official duties in educational institutions, the specialist directly interacts with public authorities, police and rescuers, school administrators and staff; parental self-government bodies; public organisations, monitors the state and compliance with safety





standards at school. Requirements for a specialist – a citizen of Ukraine over 21 years of age, higher education, specialised training (Ministry of Internal Affairs of Ukraine, 2021). It is worthwhile to examine Israel's approach to school security where schools are well-protected against armed and terrorist attacks due to clear organizational guidelines amidst the country's conditions of war, weapon legalization and use. The administration's actions to ensure the security of educational institutions are guided by the 2012 Circular (Education Ombudsman of Ukraine, 2022a), specifically, to protect against possible explosive devices in the building or on the school grounds, shooting or seizure of the educational institution.

Schools with more than one hundred pupils are provided with a professional security guard, whose functions are much broader than those of similar school guards in Ukraine. Schools and other educational institutions in Ukraine can have two types of security guard positions. The first is to protect and prevent damage to school property, maintain order, and prevent the introduction of explosive devices and other suspicious objects. However, such guards (positions of security guard, janitor, duty officer, etc.) are not responsible for the complete safety of pupils and teachers, and in problematic situations they are obliged to call the police. The second type is an employee of a security company who works directly to protect children and school staff. The educational institution concludes a relevant agreement (Law of Ukraine No. 4616-VI, 2022).

In Israel, security guards are trained according to police standards, and their main responsibilities include: morning checks of the school grounds before classes to identify suspicious persons, objects, and vehicles; regular checks of the school during school hours; control of the area near the entrance gate and response to emergencies; and control of access routes to the school. No unauthorised access is allowed, and the entrance gate is locked. The security guard registers unauthorised persons and cars entering the territory (Education Ombudsman of Ukraine, 2022a).

The Israeli police establish three states of security in educational institutions and security enhancement (Education Ombudsman of Ukraine, 2022a):

- standby mode, in which daily security activities are performed;
- alert mode during the preparation for the holiday season, which requires additional instruction of the guards;
- lert status in a situation when the security system is preparing to prevent hostile subversive activities, additional measures are to be taken, and police patrols are to be increased.

During martial law in Ukraine, clear instructions and rules of conduct for participants in the educational process during air raid alerts in various situations have been developed and are being implemented. The shelter should be left in an organised manner after the air raid warning signal or in case of a sudden life-threatening emergency (Education Ombudsman of Ukraine, 2022b; Ministry of Education of Ukraine, 2022). If the air raid alarm catches parents and

children on their way to or from an educational institution, it is important to plan and follow a specific route in advance and identify shelters along the route that can be used in the event of a danger signal.

Schools in Ukraine often organise meetings between pupils and the military, military volunteers and doctors to discuss possible dangerous situations and answer children's questions. The soldiers (often graduates of this school) lecture on behaviour in dangerous situations, first aid rules in case of need, self-preservation practices; ways to overcome panic, maintain a stable emotional state in dangerous situations; and handling dangerous objects. Apart from telling stories, a military officer or veteran can also conduct classes on tactical medicine in middle and high schools (Lykhovyd, 2023).

A separate topic is explaining the rules of conduct in a shelter. Evacuation is carried out along an established safe route (with preliminary training) to a particular designated location, and the same rules apply to the return evacuation back to the classrooms. Teachers accompany pupils to the shelter, prevent panic, check the number of pupils, ensure that they are seated in the designated places, and offer various activities in the shelter. It is forbidden to: move around the room unnecessarily; enter technical rooms; unauthorisedly switch on or off special equipment units (State Education Quality Service of Ukraine, 2022; Presentation "Rules...", 2023).

The educational institution develops all possible trajectories for different age groups of children to move to the shelter from different parts of the territory, accompanied by teachers and responsible persons – from classrooms, the school yard, classes are suspended. The school health worker must be able to reach the designated location quickly and be prepared to provide all types of first aid and psychological support.

**Pedagogical factor.** The project is aimed at creating a comfortable educational space, integrated modern design according to current trends in school pedagogy. The benchmark is the NUS Concept, which envisages the introduction of a person-centred model of education based on the ideology of child-centredness, aimed at new quality results: the acquisition of competences, the ability to acquire and use knowledge in solving educational and life problems, and the unlocking of pupils' individual potential to form a successful, independent personality (Reform formula, 2017).

It is planned to change the spatial and subject environment, programmes, and teaching aids. The school space should be maximally adapted to the introduction of new approaches to teaching based on the pedagogy of partnership in organising dialogue communication, interaction and cooperation between teachers, pupils, and parents. There is a variant ergonomic organisation of the classroom space, open educational spaces (Scott, 2010; Dudek, 2012). The author outlines the introduction of innovative educational technologies for activating the pupil's cognitive independent activity, learning through research, preference is given to teaching methods based on cooperation and



joint activities (games, projects – social, research, experiments, group tasks, etc.), the possibility of studying in multi-age subject or interdisciplinary groups (Shchekatunova, 2013). The implementation of the school education reform is ensured by the New Educational Space social project based on the following principles: motivating space and creativity; technological efficiency; energy efficiency; and inclusiveness (New educational space, 2019).

In planning school shelters, it is important to combine flexibility and stability through appropriate zoning to allow for effective education in the shelter. The flexible organisation of the space will allow for rapid changes depending on educational situations and include various forms of work (Ernst, 2007). The principle of stability provides the basis for learning activities, and in space planning it means the presence of stable zones and elements. The mobile elements of the arrangement will provide the possibility of quick reorganisation, first of all, the arrangement of pupil workplaces in the shelter, not only as standard tables and chairs, but also a variety of group and individual work (sitting, standing, even lying down), communication and rest. Conventional forms of teaching should be supplemented by conversations and discussions in a circle, free arrangement of pupils, which can be on the floor; for group work, furniture can be grouped. This method will reduce stress levels and provide positive emotions during the children's forced stay in the shelter.

The newest concept Education 4.0: Ukrainian Dawn (2022/23) is designed to meet the contemporary challenges as a poly-model lifelong education based on personalised content that meets the human resource requirements of the Generation 4.0 industry (Ministry of Education and Science of Ukraine, 2022d). It envisages the transformation of educational institutions in the integration of technical achievements and experience of innovative pedagogy – independent, accessible and inclusive learning, problem-based and collaborative learning, and pupil-centred learning. The priority tasks are to provide schools with functional infrastructure and shelters, and to reconstruct educational institutions.

The development of Ukraine's education system in the post-war period envisages the transformation of the security sector of education according to the North Atlantic Treaty Organisation (NATO) doctrine, the development of educational infrastructure with the mandatory construction of shelters during the restoration of damaged and construction of new schools, the creation of modern educational institutions that will provide appropriate conditions for obtaining quality education at the level of world standards (Education of Ukraine..., 2022).

**Daily factor.** Determines the necessary equipment for the organisation of school shelters, equipment for their operation in times of danger, to ensure the possibility of continuous stay in them for at least 48 hours according to the estimated number of all employees, teachers, and pupils of the institution. Regulatory documents and recommendations provide a list of property needed to equip a protective

structure, a minimum list of medical supplies for primary care, etc. (Ministry of Education of Ukraine, 2022c). An additional requirement is the availability of special items for evacuation, sealed buckets for faeces and waste, and hygienic toilet bags. Each pupil has their own evacuation backpack, which will contain an information tab: surname, child's name, date of birth, address, parents' contacts, child's photo, family photo with signatures, blood type and Rh factor. Parents pack the necessary things according to the recommendations provided, as a rule, these are warm clothes, long-term storage products, and water.

**Architectural and planning aspect.** Updating the school's structure to comply with safety requirements involves improving functional areas while creating comfortable and healthy conditions for pupils to learn and relax. Modern trends in school architecture should be considered, including free space planning, mobile distribution of learning, communication, and recreation areas, modern interior design tools, and active interaction between the building and natural elements (Kovalska, 2010; Shmelova, 2021).

The functional organisation of the school space embodies the latest forms and methods of organising the educational process:

- multifunctional use of school premises, integration with other institutions – sports facilities, food outlets, leisure centres, etc;
- Individualisation of education requires the creation of specialised premises for various educational services in the school structure – a cluster spatial organisation consisting of separate premises united by a common communication space into a single object is advisable;
- group method of teaching in a constant change of the size of educational groups – micro groups (1-3 pupils), medium groups (class), large groups of pupils;
- Intensification of the educational process using modern technical teaching aids.

The school's educational functions are expanding and modifying alongside the increasing role of research and experimental learning, and the use of latest technical means. This reflects a new type of universal open space, consisting of open lecture halls, coworking spaces, laboratories, and media libraries. These spaces form the core of the school's planning structure and can be combined with the learning areas situated around it through transformation. The variable construction of the educational process requires maximum flexibility of the planning structure of the school building in the ability to quickly change the size and shape of classrooms, and mobility of functional links (Almeida *et al.*, 2015; Chuhai, 2021). The inclusion of shelter space in the educational process and the development of different ways of using it on a daily basis have significant potential in this regard. The prospect of using school shelters in peacetime can be based on various functions, such as sports activities, labour or artistic training, and creative activities. The standard procedure is to organise a shelter on the ground floor or basement, or alternatively, on the first floor of the building if there are surrounding





structures. This must consist of at least two emergency exits, one of which must be designated specifically for emergency use. Other requirements relate to engineering networks, bio-toilets in the absence of sewage, and the geometry of the premises with the calculation of the area, necessary things and items.

Fire safety regulations for educational institutions in Ukraine are crucial, particularly regarding adherence to maintenance requirements for the premises and determining the quickest evacuation routes and exits to the designated safe zones (Order of the Ministry of Education and Science of Ukraine, 2016). Primary fire extinguishing equipment, external and internal fire water supply systems, fire automation and alarm systems are required. The location of fire extinguishing equipment and the plan for evacuation from the shelter should be visible and accessible. Non-flammable, secure materials should be used in the furniture and equipment situated within the shelter. It sets out the rules for organising evacuation, preventing panic, and the priority actions to evacuate people.

Universal school design should establish equitable use of space by all user groups in the physical accessibility of school elements; attractive design of premises and surrounding area; ensuring safety in the school for all children, teachers, visitors (Ford, 2007; Dudek, 2012). Accordingly, greater attention should be paid to the entrances to the protective structure, which should provide free access, sufficient capacity, inclusive requirements, and door tightness. The school management should ensure that: prominent and clear fire safety instructions are posted, evacuation plans and signs are clearly visible; and that evacuation through windows is possible (free opening, no bars).

**Engineering and technical factor.** The safety architecture of schools combines the positions of regulatory documents of state structures and organisations of Ukraine on the design, maintenance of communications of protective structures, engineering networks, engineering and special equipment, life support systems, and flood protection. Recommendations for the maintenance and operation of storage facilities define the rules for the arrangement of ventilation systems, diesel power plants and electrical equipment, water supply, sewerage and heating systems, communication and warning systems (Order of the Ministry of Internal Affairs of Ukraine No. z0879-18, 2022).

The design of engineering and technical civil protection measures in case of emergencies is guided by the State Building Regulations of Ukraine according to the zoning of the territory by the nature and scale of possible anthropogenic accidents and disasters, as well as military situations (State Building Regulations of Ukraine V.1.2-4:2019, 2019). The project documentation includes a separate section on these measures for planning and development projects and individual architectural objects. To ensure normal living conditions for the population, it is necessary to maintain acceptable levels of air gas composition, ionising radiation and protection against hazardous chemical and biological substances in the storage facilities. To protect

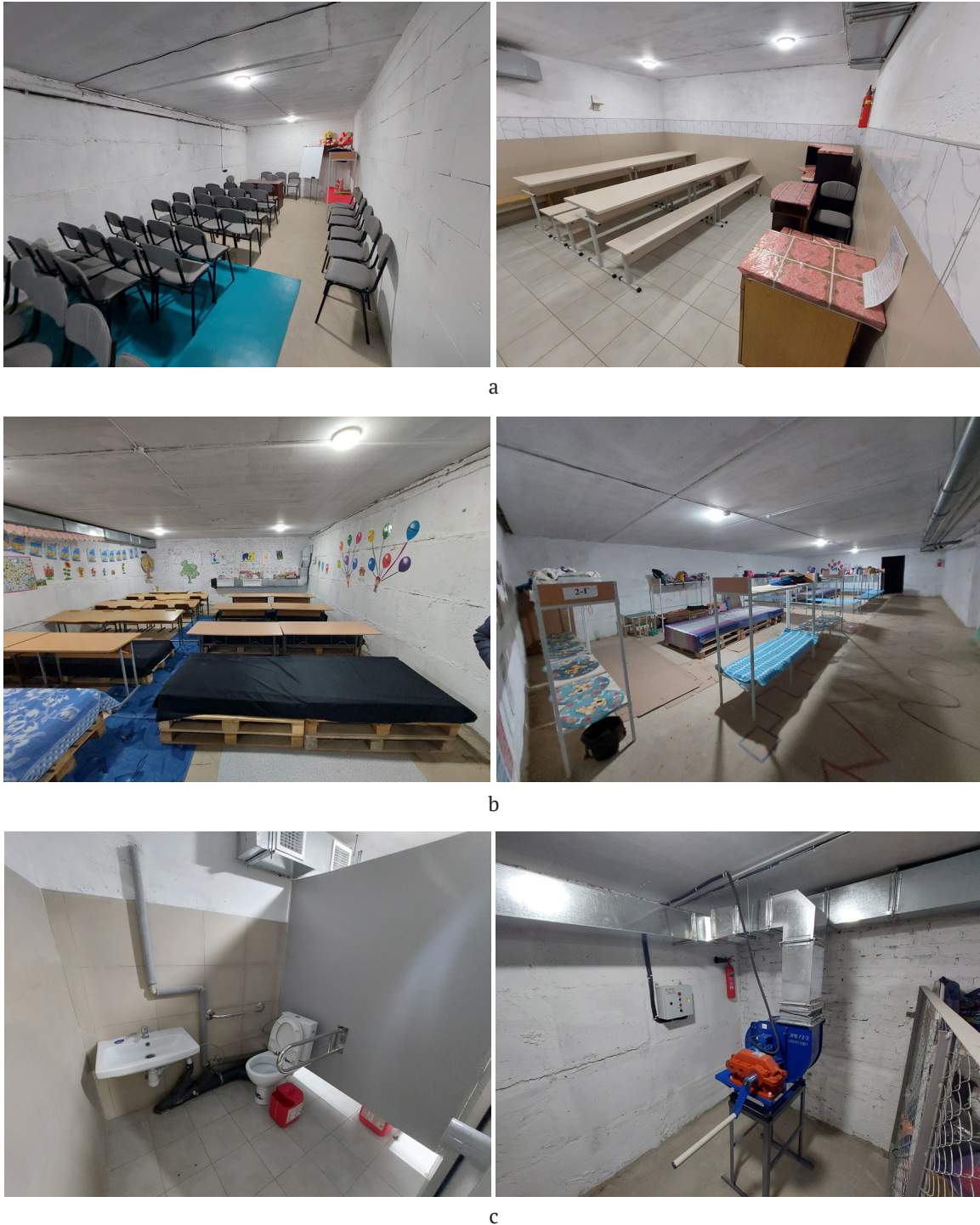
against airborne shock waves during military events, shelters should be equipped with additional protective devices: shutters, protective partitions, overpressure valves, etc. The defence structure must be equipped with high-quality lighting, and there are certain requirements for electric lamps.

According to the information provided by experts during the interviews, the main area of reconstruction of basements and equipment of shelters in them is engineering networks – repair of water and sewage systems, ventilation systems, electrical networks, thermal modernisation, and waterproofing of foundations. Additionally, generators are installed, and the basement's power supply network is changed to switch to an additional source during power outages. A frequent problem is the lack of windows in the basement, which requires additional installation of ventilation equipment. The vast majority of basements did not have sanitary rooms – they were either completed or bio-systems were installed.

**The practice of implementing school shelters in Ukraine.** It is illustrated on the example of the general secondary education institution “Primary School No. 1 of the Khmelnytskyi City Council”, commissioned in 2021 on the eve of Russia's military invasion of Ukraine (the BUD-KONTUR project). The school is designed for 810-820 pupils in grades 1-4 and has a shelter for 960 people, which meets the requirements of the time (Primary school No. 1..., n.d.).

Architectural solutions are integrated with the system of educational activities of pupils, which develops skills and abilities in all educational areas, applies active teaching methods, introduces information technology, and combines learning and life skills. Safe and comfortable conditions for studying and working were created in the building and on the territory of the institution (Fig. 2). The school's layout is in keeping with the nature of the site and its surroundings, combining classrooms, a gym, a food block, a medical block and other regulatory areas and premises. For active developmental learning, the school has computer labs, language rooms, an assembly hall and a choreography room, a gym, club rooms, a library, and a media library. The classrooms are of a larger size (80 m<sup>2</sup>) and are equipped with modern multimedia facilities. The facility has three floors, two lifts. Inclusivity requirements were met, and as of 2023, 17 pupils with special needs are able to study freely.

The basement floor contains a specially equipped shelter that allows the educational process to continue in the face of danger. For first-graders, there are stationary classrooms, while other pupils are free to use the play and recreational areas. For longer stays, there are two-level bunk beds. The dining hall offers serving meals to pupils in rotation. The shelter has a first-aid post, bathrooms and a bathroom for people with limited mobility. All the engineering and technical requirements for power supply and ventilation, including offline, have been met. One of the disadvantages is the lack of a heating system for a comfortable stay of schoolchildren in winter, which is planned to be completed.



**Figure 2.** School in Khmelnytskyi

**Notes:** a – training areas; b – areas of long-term stay; c – sanitary, technical areas

**Source:** photo by P. Dumnych (2022)

**An example of a school project with a shelter.** The projected school in Khmelnytskyi (BUD-KONTUR project with the participation of one of the authors) has a capacity of 1,470 pupils and consists of a gymnasium (750 pupils) and a lyceum (720 pupils). According to the State Building Regulations, the following functional groups are provided for (Fig. 3): educational and educational-production

premises, a sports and fitness block with changing rooms, a library, a media library, club and entertainment facilities, a catering unit, medical care rooms, administrative and service premises, auxiliary and utility rooms (State Building Regulations of Ukraine V.2.2-3:2018, 2018). According to the project, the school has four floors, full inclusivity, four lifts, and a sufficient number of communications.



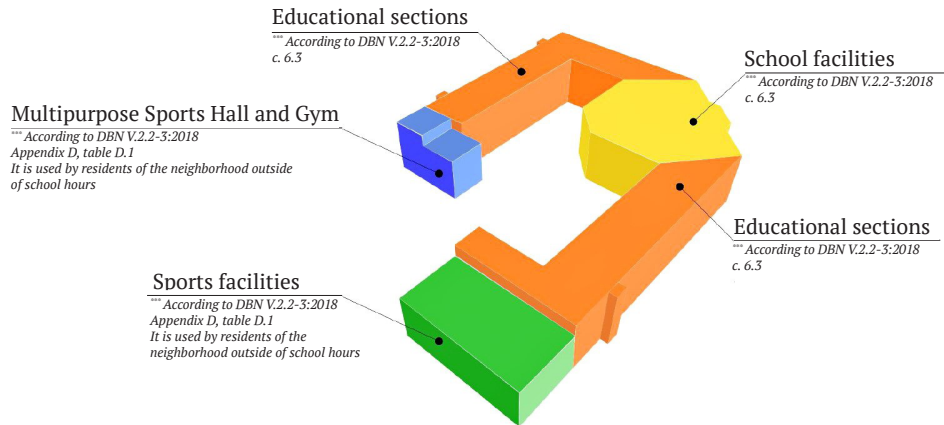


Figure 3. Functional diagram of the designed school

Source: materials from BUD-KONTUR (n.d.)

The basement floor houses a radiation shelter for 2,500 people for pupils and teachers, and additional areas for residents of the surrounding residential buildings. The entire basement space is divided into five separate fire compartments, and six external exits are equipped with special gateways with safety doors. The shelter's layout is based on a corridor scheme that combines common spaces, classrooms, food and cooking areas, storerooms, and storage for

contaminated outerwear. Six sanitary blocks with toilets, three medical posts and a separate medical centre with a treatment room were designed. In peacetime, the shelter can be used as a training range (Fig. 4). A separate technical unit for the diesel power plant, additionally isolated in case of an anthropogenic disaster, makes it possible to provide the school with electricity for 48 hours. All the necessary engineering solutions are provided.

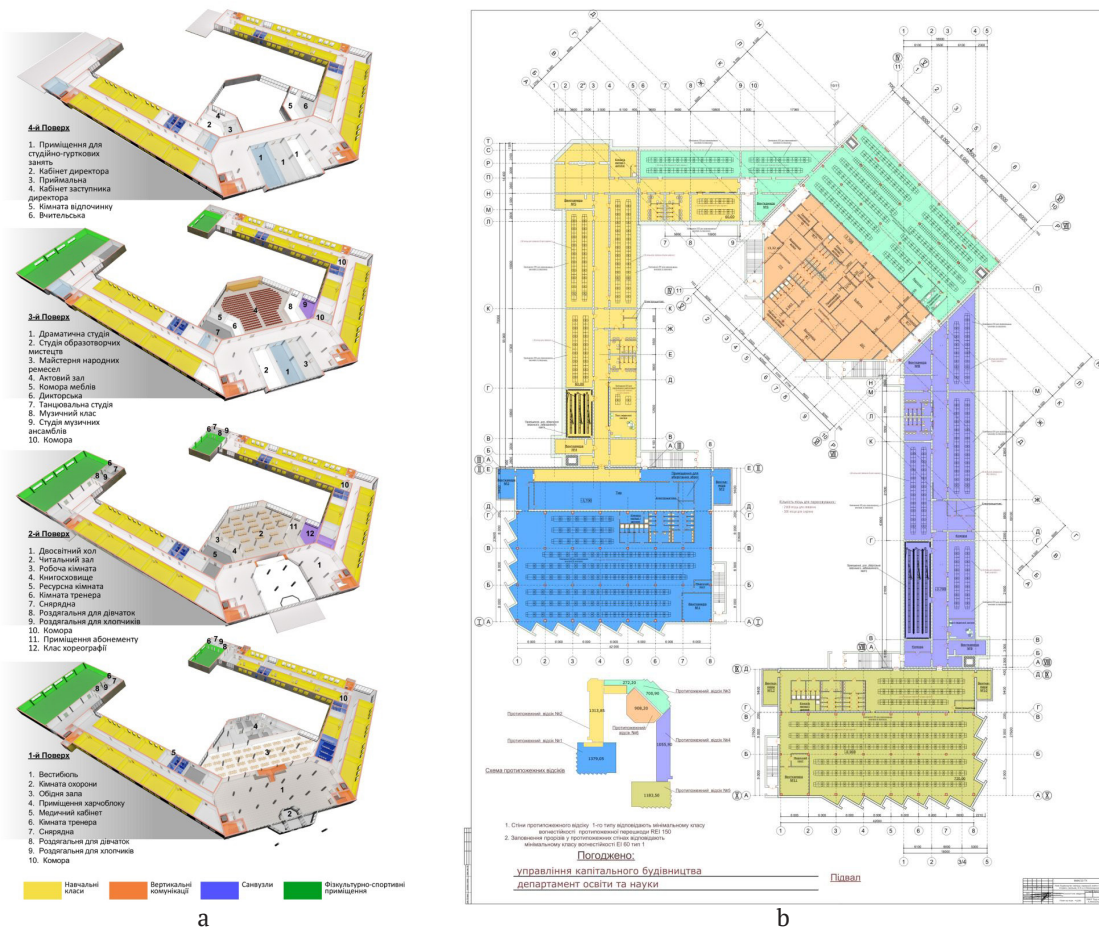


Figure 4. Planning of the projected school

Notes: a – floor plans; b – basement shelter plan

Source: materials from BUD-KONTUR (n.d.)



The structural design of the building ensures the strength, rigidity, and stability of the building. The shelter's reinforced strength is provided by pile foundations, monolithic reinforced concrete floor and column elements, and precast concrete walls of the underground part. In the world practice of shelter architecture for educational institutions, different approaches are used depending on the current security needs of the region: free-standing concrete ground shelters of various capacities (Israel, bombing protection); reinforcement of enclosing structures with metal (USA, tornado protection). In the event of natural disasters (floods, earthquakes, storms), schools often serve as temporary shelters for residents.

Schools in Europe and the United States built in the second half of the 20<sup>th</sup> century often had built-in bomb shelters. One example is the Abo Elementary School in Artesia (New Mexico, USA), built in 1962, most of the building is underground, as a shelter for pupils and citizens in case of nuclear war or other disaster for 2,160 people, with the possibility of holding classes (Abo School, 2013). The building's concrete walls and structures were reinforced, the reinforced concrete floor serves as the basis for an outdoor sports ground on the roof, and three external exits were equipped with steel security doors. Inside, there are classrooms, rest rooms, and storage rooms for food and water supplies, all the necessary things, air filtration systems, emergency power supply, disinfection, and fire protection. The school's layout is rectangular, with two corridors with access to classrooms and exits at the ends. There is a large multifunctional room, administrative offices, toilets, and a cafeteria. Today, the school is not functioning and is a tourist attraction.

On the territory of Ukraine, stationary bomb shelters of that time were built separately – on the territory of a university campus, often in residential areas, or integrated into industrial facilities. At present, it is possible to consider the need for their reconstruction depending on the condition of the facilities.

## DISCUSSION

It was established that the creation of a safe learning environment is an important area of architectural science and practice. The architectural principles of school space organisation have been sufficiently researched in terms of functional parameters and groups of rooms, communication zones (Curtis, 2003; Kovalska, 2010). The development of a model of territorial educational complexes for basic and additional education of children with an expanded range of services (Kovalska *et al.*, 2019) contributes to a more economical use of the territory but imposes additional security requirements.

The study by D. Domalewska *et al.* (2021) compared the individual perception of safe educational space by pupils in Poland and Vietnam. The results showed that neither gender nor family context influenced pupils' sense of safety at school. However, the feeling of safety is largely related to nationality and personal role models in a potentially

dangerous environment. This issue requires further study in terms of designing shelters in school buildings to consider cultural and regional traditions and the individual characteristics of different age groups of children.

Studies of school safety as a complex and multidimensional phenomenon are constructive (Massey-Jones, 2013). Positive outcomes can be achieved by integrating the factors of the learning environment and the risk management process (Savolainen, 2023). Additionally, the significance of fire safety in schools, specifically using non-flammable materials in the construction, providing adequately wide passages and unobstructed spaces for evacuation, is highlighted in relation to creating a secure physical learning environment. The author has built a model of safe educational institutions of a cyclic type, which shows the process of risk management, analysis of safety information to build a safer school environment. The merging of the pedagogical, psychosocial, and physical environment has interesting implications for the design of new buildings in light of online learning and new pedagogical solutions.

Clarification of the concepts of safety and security, as well as their role in creating a comfortable environment for the physical, emotional and social well-being of pupils, considering environmental safety factors (Mubita, 2021) correlates with the findings of the study on the direct impact of the school's architectural design on children's development, and the issue of school safety and security is a priority. Pupils and teachers need to feel safe, which will allow them to focus their energy on learning and creativity, and to test the latest pedagogical methods.

The notion of learning safety is viewed as a responsibility of school management and educational authorities, which is based on exploring organisational and managerial practices to enhance individual and collective well-being in British schools. This study draws from the research of A.D. Vicario & J.G. Sallán (2017) and employs a comparable data collection methodology entailing structured interviews with school principals, occupational safety, and health specialists, along with teaching and non-teaching personnel, and consultation with family focus groups and experts. This study focuses on legislative norms and recommendations and their implementation in architectural practice.

The methodology of data collection is described in detail in D. Nwobodo & U.I. Maria (2017) – a checklist and questionnaire on security and security management in public secondary schools, the results were verified by three experts. The conclusion is the need for additional staff training, strengthening the material base of school protection, reconstruction of buildings with the installation of additional equipment, which coincides with the identified engineering aspect of the study.

In a study of ways to improve safety in US schools (Jagodzinski, 2019), the method of interviews with parents, teachers, and staff was also used to model safety strategies. The author offers 17 recommendations that are important for both school leaders and architects. The





recommendations include structural and technical aspects of individual building elements, specifically, ballistic resistant glazing of windows, arrangement of evacuation entrances, fencing of the territory, and other details. Special attention is paid to the organisational aspect – the development of a comprehensive emergency response plan for different types of emergencies, unique to each school. Mandatory training with simulated rescue from fire, destruction and other situations, involving professional consultants, and media information. A clear protocol for the actions of all participants in the educational process during an emergency should be developed and made available, which should be ensured by an appropriate and convenient layout of the school building and grounds.

The interdisciplinary analysis points to the importance of a comprehensive consideration of the problem of a safe educational environment at school, establishing a correlation between the planned actions of pupils in an emergency and the layout of the school building and territory, planning possible risks and methods of their elimination. To develop architectural principles for modelling an optimal school space, it is important to rely on practical experience and scientific positions from various fields – pedagogy and psychology, school administration, medicine, construction and engineering technologies.

## CONCLUSIONS

In line with the strategic objective of integrating into the European Education Area, a systemic transformation of education is occurring to guarantee its enhanced quality from pre-school to higher and adult education. The Russian Federation's military aggression towards Ukraine since 2022 has brought up the issue of establishing safe conditions for all participants in the educational process. State authorities, legislative structures, regional institutions and educational institution administrations are addressing this matter. The prospects for the development of Ukraine's education system in the security and defence sector are to comply with NATO doctrine, build educational infrastructure with mandatory bomb shelters during school reconstruction, and create modern educational institutions that meet international standards.

The study identified the stages in the design and construction of shelters in educational institutions in Ukraine: 1) comprehensive examination of the issue of establishing a secure learning environment. It identifies key areas for research and sets forth legislative guidelines. Additionally, it assesses the prevention needs of protective structures to ensure the safety of educational institutions; 2) careful classification and evaluation of the suitability of different protective structures for educational institutions; 3) an

in-depth comparative analysis on architectural prototypes of protective structures, as well as measures to guarantee the safety of the educational process; 4) development of a conceptual model of a school shelter; 5) substantiation of design models of shelters for educational institutions of various types and categories of protection. At the first stage, the problem of forming architectural solutions for shelters and the safety of the educational process is structured in the allocation of factors: legislative; organisational; architectural and planning; engineering and technical; pedagogical; and daily.

Acceptable types of civil protection structures were documented; in Ukraine, the most relevant is the provision of simple shelters in basements and ground floors of school buildings. The future plans include the design of full-fledged shelters and radiation protection shelters. Taking into consideration scientific and pedagogical principles, contemporary trends, and innovative models of school education, state initiatives for the enhancement of school education dictate that schools' architectural organization must comprehensively create an educational milieu while adhering to safety regulations. The focus is on creating a comfortable educational space, modern design and content. Planning solutions should provide for variant ergonomic organisation of the educational process, open educational, communication, and recreational spaces.

When designing school shelters, it is crucial to adhere to all regulations and guidelines set by law and the relevant authorities. It is also important to determine the most suitable functional zoning of the area to ensure a safe and comfortable environment for children, including facilities for classes, leisure activities, meals, and any other potential requirements. The results of the empirical study of the completed facility and the school project showed the importance of an integrated approach to the architectural solution of the educational institution, considering innovative methods of educational activities and current safety requirements for all participants in the educational process.

The study considers only the main aspects of shelter construction in Ukrainian schools, given the lack of experience in designing full-fledged protective structures. However, a more detailed study of the experience of the actual operation of basement spaces in schools in Ukrainian cities in 2022/23 is planned in further research on the topic.

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## CONFLICT OF INTEREST

None.

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## **Актуальні проблеми облаштування укриттів у закладах освіти України**

**Анотація.** В статті розглянуто проблему створення безпечних умов для всіх учасників навчального процесу у закладах освіти в умовах потенційної небезпеки. Тема стала особливо актуальною від 2022 року внаслідок збройної агресії російської федерації проти України. Облаштування найпростіших укриттів (фортифікаційних споруд) в існуючих шкільних будівлях вирішується державними органами влади, законодавчими структурами, регіональними інституціями та адміністраціями навчальних закладів. Метою дослідження є комплексне вивчення проблеми створення безпечного навчального середовища, визначення орієнтовних дослідницьких напрямків, встановлення законодавчих орієнтирів, превентивна оцінка реальних потреб захисних споруд для забезпечення навчального процесу школи. Використано вихідний аналіз нормативно-правових положень, загальнонаукові методи, систематизація та узагальнення спеціальної інформації, емпіричні методи, метод експертних оцінок, факторний аналіз (для розгляду архітектурних рішень) та міждисциплінарний огляд положень безпеки освітнього процесу. Окреслено етапи вирішення проблеми проектування та будівництва укриттів у закладах освіти України. Визначено основні фактори формування архітектурних рішень укриттів та безпеки освітнього процесу: законодавчий; організаційний; архітектурно-планувальний; інженерно-технічний; педагогічний; побутовий. Увагу приділено науково-педагогічним принципам, сучасним тенденціям та інноваційним моделям шкільного навчання, які впливають на архітектурну організацію шкільних будівель. Планувальні рішення повинні передбачати варіантну ергономічну організацію навчального процесу, відкриті освітні, комунікаційні та рекреаційні простори. Підкреслено, що освітнє середовище школи повинно враховувати вимоги безпеки. У дослідженні розглянуто приклад новозбудованої школи з облаштованим укриттям для учнів і вчителів, яке має належні умови для навчання. Практична цінність проведеного дослідження полягає у можливості застосування визначених аспектів та висновків у реальному проектуванні освітніх закладів на основі комплексного врахування безпекових вимог

**Ключові слова:** цивільна безпека; шкільне укриття; архітектура шкіл; освітній простір