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ARCHITECTURAL AND PLANNING SOLUTIONS FOR SUSTAINABLE URBAN DEVELOPMENT

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Abstract. Architectural and planning solutions that support sustainable urban development are crucial for modern urbanism in the context of sustainable development goals. This study systematises approaches to spatial planning that balance functionality, safety, aesthetic quality, and adaptability. A qualitative analytical methodology was applied, including regulatory analysis of Ukrainian urban planning documents and a case study of the Fayna Town residential complex. Key findings include strategies for interactive public spaces, flexible residential units, and psychologically comfortable environments. The study highlights that urban design should integrate physical, social, environmental, and technological dimensions to ensure long-term viability, environmental responsibility, and quality of life.

Keywords: adaptive zoning, visual identity, contemporary urbanism, architectural environment, residential development, public buildings, modern architecture.

Introduction

Architectural and planning solutions in the context of sustainable urban development are becoming a defining element of modern urbanism, where safety, flexibility, interactivity and aesthetic quality of the environment are of key importance. This trend is particularly noticeable in the context of growing social demands for comfortable living, the challenges of climate change and the need to restore damaged areas. In the light of sustainable development strategies that integrate spatial planning with environmental and social aspects, architectural solutions should take into account not only regulatory constraints but also dynamic changes in residents' lifestyles, mobility, resource use and digital interaction. Planning approaches that combine the functions of zoning, adaptive development, inclusive infrastructure and micro-urban interventions are shaping a new architecture of urban space, in which flexible scenarios for the use of the territory, integration of green and blue zones, and psychological comfort are substantial. In the context of rising

population density and infrastructure burden, classical urban planning principles are exhausting their potential, giving way to approaches based on the concept of a 'living' city prioritising people, social cohesion and spatial justice.

In particular, Hniloskurenko et al. (2021) emphasised the relevance of interactivity in the architectural design of historic areas, which combines the preservation of cultural heritage with the openness and comfort of the urban environment for the public. The study emphasised that the preservation of authentic architectural fabric should be combined with innovative approaches to the use of space that engage residents and tourists in cultural practices, create an environment for communication and the development of local identity. In turn, Derkach (2024) substantiated comprehensive approaches to the renovation of panel housing in the context of Ukraine's post-crisis recovery, incorporating the requirements of energy saving, increased density, creation of a barrier-free environment and the formation of mixed-use zones. The study emphasised the need to revamp the typology of residential neighbourhoods, introduce modern design solutions and transform mono-functional living space into a living environment with elements of recreation, service and social infrastructure.

A study by Bezlyubchenko et al. (2022) emphasised the importance of integrating new architectural solutions into the existing environment when renovating outdated residential areas. In particular, the study considered the possibilities of rational redevelopment of courtyards and inter-building spaces, creation of accessible green infrastructure, and reconstruction of facades and entrances in accordance with modern barrier-free standards. Lialiuk and Lialiuk (2023) addressed the creation of rental housing for young families, where the key aspects are the flexibility of planning models, adaptability to changes in household composition and accessibility of social infrastructure At the macro level, Bazylevych (2023) emphasised that sustainable development of Ukrainian cities in the period of post-war recovery is impossible without changes in the principles of spatial planning, in particular, incorporating such categories as psychological safety, visual harmony and architectural integrity.

In the international context, Puchol-Salort et al. (2021) proposed a systematic framework for the implementation of blue-green design as part of environmentally oriented planning. This approach includes the integration of water elements (canals, ponds) and green areas (parks, green roofs), which simultaneously serve as aesthetic and environmental regulators of the urban environment. Xia et al. (2022) demonstrated the potential of digital twins as an effective tool for simulating sustainable development scenarios, which can be used for modelling the behaviour of cities under different climatic, demographic, and functional conditions. Such technologies ensure the predictability of solutions and reduce the risk of errors at the design stage. The expansion of digital capabilities, according to Rane (2023) is determined by the introduction of artificial intelligence, the Internet of Things, and big data, which is changing the methodology of urban planning to be more adaptive, flexible, and contextually sensitive to local needs.

Anthony et al. (2021) emphasised the need for digital transformation of the architectural environment, which should be based on the use of flexible digital urban management platforms that can be used by residents to engage in planning processes, vote on projects, and jointly solve micro-level problems. Rosso et al. (2022) proved that even local and inexpensive interventions such as the creation of pocket parks can significantly improve the quality of urban life by creating areas for recreation, socialisation and psychological relief in densely built-up neighbourhoods. Such small architectural forms act as catalysts for sustainable urban transformation.

Thus, modern architectural and planning solutions should incorporate not only building codes, but also socio-psychological, environmental and technological requirements, which is the subject of this theoretical study.

The study aimed to formulate a systemic vision of architectural and planning solutions aimed to ensure sustainable urban development, incorporating the principles of safety, flexibility, interactivity, psychological comfort and aesthetic quality of the urban environment.

Materials and Methods

This study was of a review and analytical nature and was devoted to the study of architectural and planning solutions in the context of ensuring sustainable development of the urban environment. Its methodological basis was a comparative analysis of regulatory and legal documents, modern strategic approaches to spatial planning, typological models of development, as well as the applied experience of implementing sustainability principles in the practice of Ukrainian housing construction. The study included an analysis of the legislative and regulatory framework of Ukraine, European recommendations, academic publications, and the functional characteristics of specific objects.

The comparative analysis was structured in several consecutive stages: (1) identification of normative and strategic planning requirements; (2) selection of evaluation criteria based on sustainability principles; (3) comparative assessment of regulatory provisions and applied architectural solutions; and (4) synthesis of results to identify key planning patterns and best practices.

The key legal and regulatory sources governing planning requirements for the urban environment in Ukraine are the State Building Standards (SBS): DBN B.2.2-12:2019 "Planning and development of territories" (Ministry of Regional Development, Construction and Housing and Communal Services of Ukraine, 2023), which define the principles of zoning, building density, organisation of public spaces, accessibility and landscaping; DBN V.2.2-5:2023 "Civil defence protective structures" (Ministry of Development of Communities, Territories and Infrastructure of Ukraine, 2024), which establishes mandatory requirements for safe sheltering of the population within residential neighbourhoods; and Law of Ukraine No. 525-V "On Comprehensive Reconstruction of Quarters (Microdistricts) of Outdated Housing Stock" (Law of Ukraine, 2006), which outlines the legal framework for the modernisation of urban areas. Additionally, the provisions of Law of Ukraine No. 2780-XII "On the Fundamentals of Urban Planning" (Law of Ukraine, 1992), Law of Ukraine No. 3038-VI "On Regulation of City Planning Activity" (Law of Ukraine, 2011), as well as updates on civil protection during the development of territories, as stipulated in Law of Ukraine No. 2486-IX "On Amendments to Certain Legislative Acts of Ukraine Regarding Ensuring Civil Protection Requirements During Planning and Development of Territories" (Law of Ukraine, 2022), were incorporated. Separately, the industry standard SOU Housing and Utilities 75.11-35077234.NNNN:2009 (Ministry of Housing and Communal Services of Ukraine, 2009) was used, which regulates the assessment of physical deterioration of residential buildings.

The study also applied the National Strategy for the Creation of a Barrier-Free Space in Ukraine for the Period Until 2030 (Cabinet of Ministers of Ukraine, 2021), supplemented by practical recommendations on "Barrier-free recovery"(Ministry of Development of Communities, Territories and Infrastructure, 2025), which became sources for assessing social inclusiveness, accessibility and adaptability of architectural solutions. The analytical part of the study is based on a typological analysis of modern residential development projects, in particular the residential complex Fayna Town (2025) in Kyiv, compiled by Popov, Vasyliev, Bebeshko, Morozov and Pohodenko, as an example of the implementation of sustainable planning principles adapted to the post-industrial urban environment and the needs of socially oriented development of territories (Archmatika, 2025).

The selected case study was analysed in comparison with normative and strategic requirements in order to identify the degree of their practical implementation.

The criteria for comparison included: functional flexibility of residential units; integration of social infrastructure; organisation and hierarchy of public spaces; level of safety and civil protection; accessibility and inclusiveness; access to green areas; spatial zoning and density; apartment isolation and ergonomics; pedestrian orientation; and tools for visual and psychological orientation in space.

The effectiveness of architectural and planning solutions was assessed following criteria adapted from the provisions of the regulatory framework and sustainable development strategies of the European Union (EU) (indicators of accessibility, zoning, landscaping, isolation, social integration, etc). In particular, the study incorporated the provisions of the Biodiversity strategy for 2030 (EC, 2025a), which emphasises the need to return nature to the urban environment through the integration of green and blue infrastructures into planning practices. The EU Climate Change Adaptation Strategy (EC, 2025b) addressed design solutions that create cities that are resilient to extreme weather conditions and promote adaptive zoning to meet climate challenges. The Nature Restoration Regulation (EC, 2025c) stipulated quantitative benchmarks for the share of green space in the urban environment, which directly correlates with the requirements for new housing construction and reconstruction (EP, 2023). The defining principles of an integrated approach to sustainable urban development are also set out in the New Leipzig Charter – The transformative power of cities for the common good (EC, 2020), which emphasises the need for social equity, functional mixing, community participation and environmental responsibility as fundamental elements of modern urban design. Thus, a comprehensive analysis of regulations, strategic approaches, and applied experience has made it possible to form a holistic model of the methodological basis for assessing architectural and planning solutions in the paradigm of sustainable urban development.

Results and Discussion

Security in the context of architectural and planning design is a fundamental criterion that determines the viability and sustainability of urban environments, especially in the context of armed conflict, man-made risks and climate challenges. The requirement of security covers both the physical protection of the population and ensuring the functional reliability of the spatial organisation of territories. At the regulatory level, safety is regulated, in particular, by Ministry of Regional Development, Construction and Housing and Communal Services of Ukraine (2023), which defines the rules for zoning, building density, placement of social infrastructure and provision of sanitary protection zones, as well as Ministry of Development of Communities, Territories and Infrastructure of Ukraine (2024), which contains requirements for the design of shelters, their accessibility and integration into residential structures.

This is supported by the Law of Ukraine (2011), Law of Ukraine (2022), which requires mandatory consideration of protective infrastructure facilities when planning development. A safe urban environment should include accessible evacuation routes, logical traffic management, minimisation of risk areas (e.g., intersections with heavy traffic), and adaptation of buildings to natural and man-made threats. Figure 1 shows a conditional zoning scheme of the territory, incorporating the location of protective structures that serve as shelters, as well as the planned evacuation routes. This can be used to visualise how security components are integrated into the overall planning structure of the residential area.

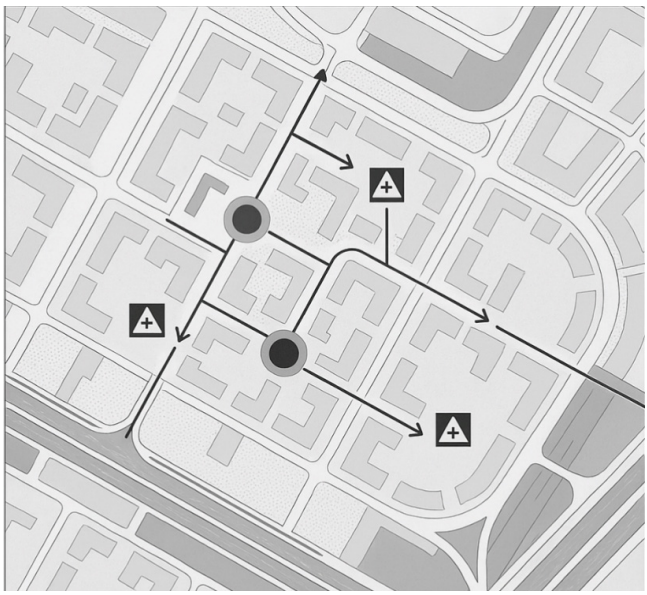

Figure 1. Zoning scheme of the territory, incorporating protective structures and evacuation routes
Source: compiled by the authors based on Ministry of Development of Communities, Territories and Infrastructure of Ukraine (2024).

Following Table 1, which summarises the key regulatory requirements for civil protection facilities within urban residential areas, these requirements have direct implications for spatial planning decisions. The mandatory presence of shelters within a radius of 500 metres influences the layout of buildings, public spaces, and circulation routes, particularly in dense residential areas where space is limited. The defined area per person – 0.6 m² for residential buildings, 1.0 m² for educational and medical institutions, and 0.75 m² for offices and shopping centres – needs to be balanced with other urban functions to ensure both safety and functionality. In addition, the standards stipulate technical parameters of shelters: basement placement, direct access, backup power supply, ventilation, sealing, and protection against blast waves and chemicals, which shape opportunities and constraints for architectural integration and infrastructure planning. Overall, these figures are not mere formalities; they guide the design of resilient neighbourhoods where civil protection infrastructure is seamlessly integrated into the urban environment.

Interactivity as a principle of the modern architectural and planning approach involves creating an environment that not only meets basic functional needs, but also actively engages residents in interaction with space, stimulates social practices and supports local communities (Cherkes et al., 2024; Shymko & Slipych, 2024). In the context of sustainable urban development, this means designing architectural solutions that are open to change, flexible to use scenarios, adaptive to the needs of different social groups, and foster a sense of engagement and belonging. The example of the Fayna Town residential complex in Kyiv (Fig. 2) shows how interactivity is implemented through a combination of architectural, landscape, and socio-organisational elements (Archmatika, 2025).

Figure 2. General plan of the residential complex Fayna Town
Source: compiled by the authors based on Fayna Town (2025).

Following Figure 2, the spaces between the buildings of the residential complex are not enclosed but open for shared use, including playgrounds, sports areas, recreation spaces, mini-gardens, integrated landscaping elements, and small architectural forms with communication functions (e.g., information boards, smart benches, interactive lighting). Visually and functionally, the interactive environment promotes horizontal connections between residents, the formation of social capital and increased security through the effect of natural surveillance (Huseynova et al., 2022; Shults et al., 2025). Pedestrian orientation, multi-level isolation, environmental navigation, and tactile diversity of surfaces all ensure a high level of engagement and comfort in the outdoor space. Table 2 illustrates the typology of elements that form the basis for interaction between residents and the space within a residential complex.

Table 2. Spatial elements that provide social activity in the open environment

Environment element	Functional purpose	Examples of implementation in the residential complex Fayna Town
Public courtyards	Communication between residents and children's play activities	Intra-quarter spaces without parking
Places for meetings	Holding events, activities, and presentations	Urban spaces with benches and pavilions
Sports zones	Physical activity, maintaining a healthy lifestyle	Mini-football fields, workout areas
Outdoor furniture	Rest, accommodation, short-term stay	Benches, tables, mobile seating
Information stands	Spatial orientation, communication with residents	Maps of the area, notice boards, digital displays
Green rooms/squares	Natural integration into the urban environment	Landscape compositions with navigation and lighting

Source: compiled by the authors based on Fayna Town (2025).

Following Table 2, the interactive structure of the living space is based on the systematic implementation of various types of open elements that not only serve as comfort, orientation and leisure, but also form an integral social ecosystem. The peculiarity of the layout of the Fayna Town residential complex is that each spatial component, from public courtyards to green squares, is not isolated but included in the overall scenario of interaction between residents and the environment.

Among these elements, public courtyards and places for meetings are the most critical, as they directly enable daily social interaction, community cohesion, and natural surveillance. Sports zones and green rooms/squares play a secondary role, enhancing wellbeing and environmental quality but not being essential for core social functions (Cherkes et al., 2023). Outdoor furniture and information stands function effectively when integrated with primary spaces; however, their impact diminishes if located in isolated or underutilized areas. The success of each element depends on accessibility, visibility, and connectivity to pedestrian routes, as well as the density and demographics of the residents. In dense or high-rise areas, for instance, courtyards and meeting spaces must be carefully sized and positioned to avoid underuse, while interactive lighting and landscaping can amplify engagement.

The use of such solutions meets the requirements of modern European architecture, where interactivity is viewed as a prerequisite for social cohesion, increased safety and support for sustainable urban development (EC, 2020). In modern urban planning, the principle of adaptability is becoming increasingly relevant, which is viewed as the ability of the living environment to respond to dynamic changes in the socio-economic landscape of the city, transformations in the lifestyle of residents, changes in the demographic structure of households, as well as the impact of external factors, such as environmental, security or market challenges (Dyomin et al., 2021; Gojaeva et al., 2024). This approach reflects the evolution of the urban paradigm from static models of functional zoning to flexible, open, modular systems that can be used for constant change and multi-scenario use of space. Flexible architectural and planning solutions can be used for the transformation of living space without the need for a complete reconstruction of the infrastructure, reducing maintenance and modernisation costs, reducing the man-made impact on the environment and extending the life cycle of buildings. This is especially relevant for the post-crisis recovery of urban areas in Ukraine, where the need for a quick and effective response to population growth or change, as well as the demands of a mobile lifestyle, is high (EC, 2020).

In this context, planning for multifunctionality, changeability of use scenarios and the possibility of modular reconfiguration of spatial solutions without compromising the structural integrity of a building or neighbourhood is recognised in EU regulations as a fundamental feature of sustainable residential design (EC, 2025a, 2025b). Adaptive zoning, variable planning typologies, variable ground floor occupancy, and infrastructure readiness for functional changes are prerequisites for the long-term efficiency of urban structures (Zotsenko & Vinnikov, 2016; Smailov et al., 2025).

Similar principles are being implemented both in programmes for the comprehensive reconstruction of outdated neighbourhoods and in the practice of new residential development, such as the Fayna Town residential complex in Kyiv, where planning decisions include the possibility of combining smart apartments, transforming public spaces, flexible functional filling of buildings and the inclusion of social infrastructure capable of adapting to changes in the number of residents (Law of Ukraine, 2006). Figure 3 shows schematic models of residential unit transformation that demonstrate the potential for variable reconstruction in accordance with changes in household composition or family life cycle. Such approaches mitigate functional deterioration of the housing stock in the medium and long term.

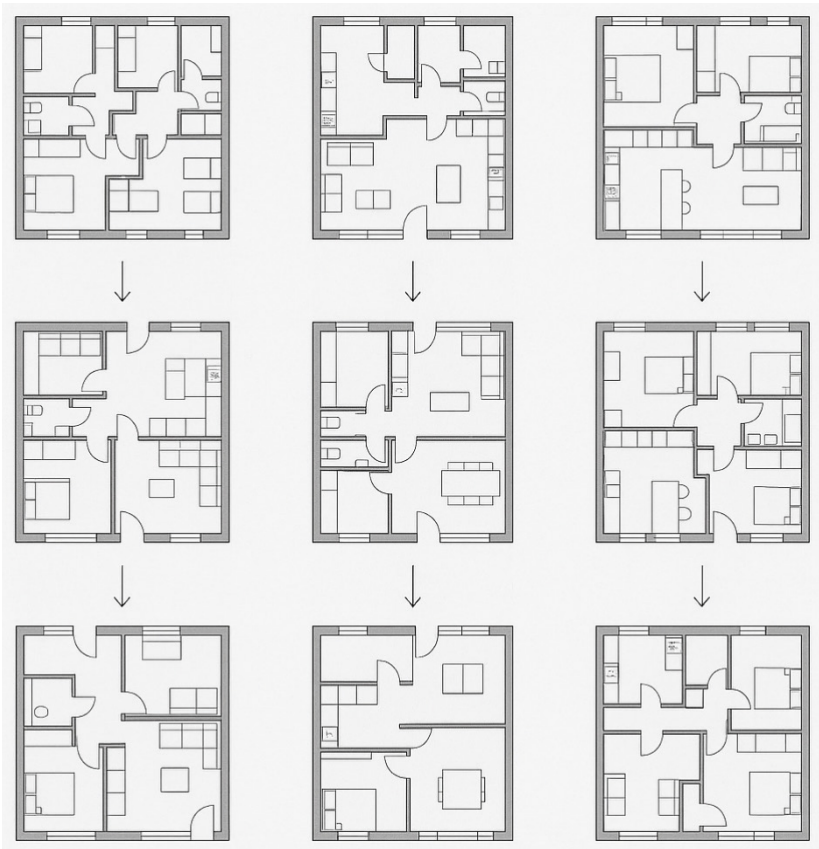

Figure 3. Models for transforming a housing unit to meet the changing needs of households
Source: compiled by the authors based on EC (2020) and Fayna Town (2025).

Figure 3 presents a graphical model of the transformation of a residential unit according to changes in household composition and space use scenarios. The model is based on the principle of modularity and flexible organisation of housing units, which can be used for the redevelopment of interior spaces without interfering with the supporting structures. The options presented demonstrate how the basic unit can be adapted to the needs of a family with children, people with reduced mobility, the elderly or the transition from individual to collective living.

The model emphasises the changeability of functional areas: the kitchen area can be transformed into an office or a bedroom, and additional bathrooms into technical or storage rooms. There is also a possibility of horizontal or vertical combining of apartments, which adapts the living space to the growth or reduction of the family size. Such solutions correlate with the principles of sustainable development set out in the New Leipzig Charter (EC, 2020) and the EU recommendations on adaptive housing in the context of changing social demands and demographic trends (EC, 2025b). Table 3 presents examples of architectural and planning solutions with increased adaptation potential implemented in Ukrainian housing construction and correlating with approaches adopted in European cities.

Table 3. Architectural and planning solutions with high adaptability potential

Solution type	Examples in Ukraine (Fayna Town residential complex)	European counterparts	Adaptive potential
Modular apartment layout	Combining or dividing smart units within a block	Mehr als Wohnen (Zurich, Switzerland)	Changing the size of housing according to needs
Flexible communal spaces	Transformed lobbies, coworking spaces, and children's rooms	Vrijburcht residential complex (Amsterdam, the Netherlands)	A variety of functions according to the needs of residents
Variable functional zoning	A combination of residential, office and cultural space	Nya Krokslätt (Gothenburg, Sweden)	Adaptation to changes in the labour market and everyday life
Temporary superstructures	Projected possibilities of completing floors or blocks	Incremental Housing (Berlin, Germany)	Responding to demographic growth

Source: compiled by the authors based on Aravena & Iacobelli (2012), Luo (2015), EC (2020), City of Gothenburg (2025), Fayna Town (2025), Mehr als Wohnen (2025).

Following Table 3, the adaptability of planning structures is ensured by a combination of architectural modularity, functional variability and infrastructural openness. The Ukrainian context, represented by the Fayna Town residential complex, demonstrates the beginning of the implementation of such approaches, which is in line with European standards of sustainable urban development, particularly the provisions of the New Leipzig Charter (EC, 2020), where flexibility is viewed as a prerequisite for the long-term viability of the urban environment.

The psychological quality of the architectural environment is a determining factor in shaping the subjective sense of safety, orientation, aesthetic pleasure and general well-being of residents (Moura et al., 2012; Iskenderov et al., 2024). In the contemporary urban discourse, parameters that are not limited to technical norms but relate to the perception of space in terms of its openness, rhythm, scale, colour palette, acoustics and sensory content are becoming increasingly relevant. These characteristics determine how comfortable the environment is for different categories of people: people with high anxiety, children, the elderly, and people with sensory impairments. Figure 4 shows the zoning of the territory of the Fayna Town residential complex, considering visual, tactile and sound landmarks that ensure safe navigation and emotional comfort within the neighbourhood. The scheme identifies zones for entrances, passages, recreation areas and playgrounds, incorporating sight lines, the visual rhythm of the facades, lighting and illumination, as well as the presence of tactile surfaces.

Following Figure 4, visual and tactile landmarks in the Fayna Town neighbourhood form a multi-level navigation system that covers both public transit routes and local spaces near residential entrances. Elements numbered 1 (contrasting marking of pedestrian routes) create visual guidelines that promote safe movement and intuitive orientation. Area number 2 (tactile tiles and lowered kerbs) provides accessibility for people with visual or mobility impairments. Components numbered 3 (information boards and district maps) provide cognitive support and promote spatial awareness of the neighbourhood structure. Zone 4 (illumination of routes at night) enhances the sense of safety and reduces the psychological stress of residents. This approach to shaping the environment correlates with the principles of sensory comfort and orientation inclusiveness laid down in barrier-free strategies (Cabinet of Ministers of Ukraine, 2021; Ministry of Development of Communities, Territories and Infrastructure of Ukraine, 2025).

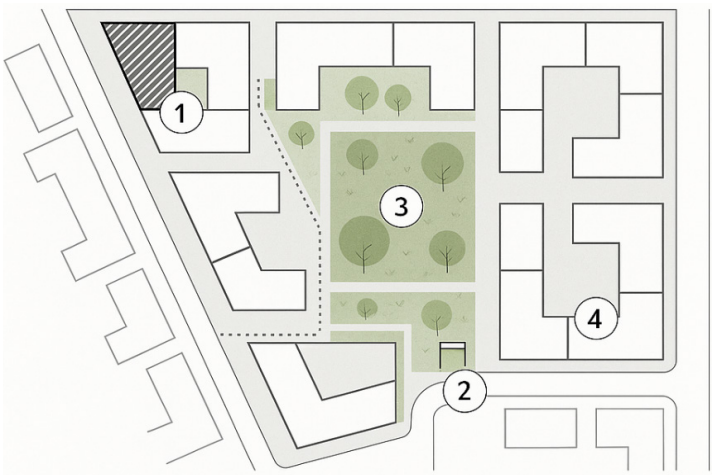

Figure 4. Zones of visual and tactile orientation in the Fayna Town neighbourhood
Note: 1 – visual dominants, 2 – tactile surfaces, 3 – zones of psychological calm, 4 – navigational information elements.
Source: compiled by the authors based on Fayna Town (2025).

Table 4 summarises the key spatial characteristics that influence psychological comfort in the living environment. These include the transparency of the ground floors (reducing the 'wall' effect, i.e., the visual and psychological barrier created by uninterrupted, solid building facades that can make outdoor spaces feel enclosed or uninviting), the presence of visual corridors, three-dimensional transitions, quiet acoustic structure in courtyards, richness in natural textures (wood, greenery, water), harmonious colour scheme of facades and street furniture, availability of places for short-term rest, and the creation of 'quiet zones' without intense traffic. Among these characteristics, transparency of ground floors, visual openness, and sound comfort appear to be the most influential in directly affecting residents' stress levels and sense of security. Other aspects, such as tactile navigation, colour schemes, and landscaping, are more context-dependent: their impact varies depending on building type, courtyard layout, resident demographics, and local environmental conditions. Taking these aspects into account in design directly correlates with reduced stress levels, increased social cohesion, and the formation of an emotional connection between the resident and the place of residence, which is also confirmed by the provisions of the New Leipzig Charter (EC, 2020) and the concepts of humane design in urban planning.

Table 4. Spatial characteristics that affect the psychological comfort of residents

Spatial characteristics	**Impact on psychological comfort**
Insolation and natural light	Reduces stress levels, improves circadian rhythms
Visual openness and orientation	Facilitates orientation, reduces anxiety
Sound comfort (noise protection)	Promotes concentration, reduces irritation
Tactile navigation and barrier-free accessibility	Provides confidence in movement
The presence of landscaping and natural elements	Creates a positive emotional background
Traffic safety (including at night)	Increases the subjective sense of security
Spatial characteristics	Impact on psychological comfort

Source: compiled by the authors based on EP (2023) and EC (2025a, 2025b).

Following Table 4, the spatial characteristics of the living environment are key in shaping the psychological comfort of residents. High levels of isolation, the presence of green spaces, ergonomic organisation of courtyards, clear zoning, reduced visual and acoustic noise, and predictable navigation not only reduce stress levels but also increase the sense of security, spatial orientation and emotional engagement (Schults et al., 2016; Timchenko et al., 2023). Recognising which characteristics are primary and which are context-dependent allows designers to prioritise interventions, ensuring that the most critical elements – such as visual openness and sound comfort – are implemented effectively, while secondary elements can be adapted based on local conditions. This approach not only optimises organisational processes but also increases the efficiency of management decisions (EC, 2025a, 2025b). At the same time, the implementation of these strategies contributes to the formation of sustainable competitive advantages in a changing environment (EC, 2020; EP, 2023).

In the context of sustainable urban development, modern residential architecture requires not only technical functionality but also a high level of aesthetic quality, which creates a positive perception of space, emotional comfort of residents and recognisability of the environment. Compositional integrity in the design of residential complexes involves coordinating the scale, proportions, rhythms and textures of facades, which contributes to the formation of a harmonious architectural ensemble where each element supports the visual unity and logic of the overall planning solution. It is especially necessary to implement architectural dominants that not only structure the space, but also perform a navigational function, indicating key points of attraction, activity zones and orientation.

In the modern urban context, the techniques of facade rhythm, volume contrast, alternating heights, colour zoning and facade landscaping are used to achieve aesthetic diversity without losing compositional integrity (Naydenova & Velev, 2012, 2014). Another substantial principle is the visual identity of the building, which is based on the introduction of distinctive architectural techniques that reinforce the residents' sense of belonging to a particular space. This approach is in line with the New Leipzig Charter (EC, 2020), which emphasises the need to create a visually attractive, emotionally comfortable and recognisable environment as part of urban sustainability. For a systematic analysis of modern residential architecture as a space for sustainable development, it is necessary to rely on several aesthetic criteria that can be used to assess its impact on the environment and the user. The criteria, summarised based on conceptual documents and practical examples, are presented in Table 5.

Table 5. Aesthetic criteria for evaluating modern residential architecture

Evaluation criterion	Functional value
Harmony of materials and textures	Ensures visual integrity and the perception of a unified environment
Facade rhythm and proportions	Supports the compositional logic of the building, creates a rhythm of perception
Colour scheme	Shapes the mood and strengthens the identity of the neighbourhood
Architectural dominants	Structures the space, serves as a focal point and an accent
Integration into the landscape	Emphasises the natural component, creates a sense of connection with the environment
Visual orientation and navigation	Facilitates the orientation of residents, increasing ease of movement
Emotional effect (aesthetic impact)	Promotes a positive emotional background and aesthetic pleasure

Source: compiled by the authors based on EC (2020, 2025a, 2025b) and EP (2023).

Following Table 5, the key criteria for the aesthetic evaluation of modern residential architecture include the harmony of materials, the logic of the facade rhythm, the colour palette, integration into the surrounding landscape, and the ability of the environment to generate positive emotional reactions. The requirements for modern residential complexes include a tendency to rethink facade solutions: from monotonous buildings to multi-layered, individualised facade structures that contribute to improving the quality of the environment (Akbarova & Akbarli, 2023). Accordingly, aesthetics in architecture is not a secondary factor, but a systemic category that combines artistic, social and urban aspects. Thus, the aesthetic quality of the modern living environment is formed as a result of integrated design thinking, where the harmony of form, texture, colour and scale is combined with the logic of functional zoning and the psychological needs of users. This created not just a building, but a complete living environment with high visual appeal and sustainable architectural value.

Thus, the results of the study showed that ensuring the sustainable development of the urban environment is directly related to the implementation of architectural and planning solutions based on the principles of safety, interactivity, flexibility, psychological and aesthetic quality. A comprehensive consideration of current regulatory requirements, typological features of buildings, as well as strategies for adapting to climate, social and security challenges, created an urban environment that is not only physically convenient, but also emotionally comfortable and visually harmonious. The scalability of architectural solutions, their ability to adapt to the changing needs of the population, the integration of interaction zones and inclusive spaces, as well as the use of the principles of identity and aesthetic coherence, create the basis for the design of new generation residential areas (Bugayevskiy et al., 2017; Cajamarca Dacto et al., 2025). Thus, architectural and planning models based on the principles of sustainable development have not only functional but also cultural and social potential to transform Ukrainian cities into sustainable, safe, and resilient urban structures.

The structured analysis of architectural and planning solutions based on the principles of sustainability was conducted through the prism of regulatory compliance, functional adaptability, integration of digital technologies, spatial identity and interaction of residents with the environment. A substantial aspect was the involvement of European concepts of urban development, through a comparative review of literature and strategies that emphasise the systemic combination of social, environmental and technological factors. This approach can be used to assess not only the compliance of Ukrainian cases, particularly the Fayna Town residential complex, with the key principles of sustainable urbanism, but also to identify opportunities for their further development, incorporating transnational experience. The following discussion presents a critical comparison of the research findings with modern scientific approaches to the formation of smart cities and resilient urban design, which lays the groundwork for consolidating architectural, digital and social dimensions in the process of urban space planning.

Zafar (2024) noted that algorithmic planning is a prerequisite for achieving sustainable development in smart urbanism, as it can be used for the dynamic adaptation of the city's spatial structure to the needs of residents and infrastructure. This approach correlates with the analysis of flexible architectural and planning solutions that are transformed to meet the needs of households. Puskás et al. (2021) substantiated the importance of deep levels of participatory design in nature-based solutions, highlighting that integrating residents into the design process promotes sustainability and increases social responsibility for space. The findings of the study confirm the relevance of including public areas and urban lawns in modern residential complexes. Hatem (2023) highlighted that cities that combine smart infrastructure with the principles of inclusive greening

are better able to adapt to the long-term challenges of sustainable development. In this context, the study proves that adaptive zoning and green rooms contribute to the formation of a stable environment in Ukrainian residential areas. Anh et al. (2021) proved that climate change significantly affects the architecture of a smart city, necessitating its transformation towards energy efficiency and adaptability. This study supports this thesis, especially in terms of the development of models of residential blocks with flexible functionality. Orsetti et al. (2022) noted that there is a close link between spatial planning, residents' health and climate change, which requires a rethinking of the principles of public space organisation. This provision was considered when modelling the visual and tactile orientation zones in the Fayna Town project. Allam et al. (2022) proposed to rethink the concept of the 15-minute city through the prism of sixth-generation mobile communication (6G) technologies, the Internet of Things, and digital twins, which, according to them, will ensure increased sustainability and efficiency of the urban environment. This approach forms the basis of the present assessment of the digital integration of the urban environment through spatial visualisation tools. Judijanto et al. (2023) emphasised the need to consider cybersecurity in urban design as a factor in reducing risks and enhancing reliability in the digital environment. This provision is especially relevant for the development of information navigation elements in the interactive space of residential neighbourhoods.

Jiang et al. (2024) proved the effectiveness of generative urban design as a way to combine generative thinking, digital tools and multi-stage decision-making in planning practice. In the study, this is correlated with the concept of adaptive housing modules and the possibility of multifunctional use of space. Bahalul Haque et al. (2022) highlighted that the successful implementation of smart city architecture depends on a clear structuring of requirements, system architecture, security mechanisms, and flexible IT platforms. The presented model of interface interaction within the housing estate confirmed the feasibility of a structural approach to building an intelligent environment. The use of fuzzy and interval assessment methods, as shown in the study by Milošević et al. (2021), demonstrated high sensitivity to environmental changes, which proved effective in the context of assessing psychological comfort and perception of space in this paper. The issue of coherence in strategic planning for sustainable cities, raised by Bibri (2021) through the prism of urban computing and big data analytics, is reflected in our approach to the multilevel interaction of social, architectural and digital components of the environment. The concept of the 15-minute city, as described by Khavarian-Garmsir et al. (2023), is close to the principles of multifunctionality and localised interactivity studied in the study of residential design.

The idea of the need for institutional changes for the effective implementation of data-driven approaches to planning, developed by Teixeira et al. (2024), is logically supported using digital tools in the visualisation of zoning scenarios in this paper. The emphasis on the importance of quantitative monitoring of the urban environment made by Giles-Corti et al. (2022), correlates with the assessment methodology used based on a system of indicators of psychological comfort and aesthetic perception. The ideas of forming a recognisable urban environment, which are considered by Jin et al. (2024), are specified in the study through the analysis of the harmony of facades and the role of architectural dominants. The experience of adapting spatial modules to the conditions of dense development, as indicated by Adeyemi et al. (2024), is confirmed by the results of the transformation of the residential block in the study.

The position on the need for interdisciplinary integration (architecture, ecology, technology, social policy) in achieving sustainability, highlighted by Almulhim et al. (2024), is implemented in this study through the adaptation of European practices to Ukrainian realities. The possibilities of deep learning in urban tasks are demonstrated by Wu et al. (2024) created prospects for the fur-

ther development of predictive scenario modelling in the framework of urban redevelopment. As emphasised by He and Chen (2024), digital tools should be an integral element of the planning process, which is confirmed by the effectiveness of the visualisation methods used in the study. The conclusions of Hendawy et al. (2024) regarding the importance of incorporating sustainability principles into architectural education resonate with the educational potential of this paper for future designers. The consideration of architecture as a component of cyber-physical systems in smart construction, proposed by Talebian et al. (2025), confirms the feasibility of using an integrated approach to creating adaptive living environments of a new generation.

Thus, the study confirmed the relevance of modern European concepts of sustainable urbanism for the architectural and planning rethinking of Ukrainian residential areas in the post-crisis period. Algorithmic planning can provide a systemic balance between spatial, social and environmental parameters. The results obtained showed that it is the integration of the principles of safety, adaptability, interactivity, psychological comfort and visual identity that created a living environment that can meet the challenges of our time. Public complexes and buildings are also an integral part of the settlement area. Modern structural systems, building materials, façade systems and innovative engineering equipment make it possible to create architectural and planning solutions for modern public buildings in accordance with the principles outlined above (Pichugin, 2018; Knapik, 2025). The topic of searching for methods of architectural and planning organisation of modern public buildings of various functional purposes that meet the requirements of sustainable development is also a priority area of research of the author's team for this study. The results prove that safety, adaptability and flexibility, interactivity, and energy efficiency are becoming the hallmarks of modern public construction, which is reflected in the authors' scientific publications. The approach proposed in the study, based on the regulatory framework of Ukraine, supplemented by the European strategic framework and adapted to real-life examples of development, such as the Fayna Town residential complex, creates a methodological basis for transforming architectural practice in line with the goals of sustainable development. It can be used not only to assess the effectiveness of existing projects but also to set standards for future planning in the context of climate, demographic and technological change.

Conclusions

The study concluded that the effective implementation of sustainable urban development is directly related to the implementation of architectural and planning solutions based on five basic principles: safety, interactivity, flexibility, psychological and aesthetic quality. Each component performs an integrated function rather than an isolated one, forming a comprehensive approach to the architectural design of urban residential areas. The approach to safety enshrined in the national standards (DBN) provides for systematic planning of shelters, rational zoning of the territory, availability of evacuation routes, and technical integration of protective structures into the living environment. This ensures not only physical protection, but also regulatory compliance with urban development activities in the face of growing risks.

The interactivity of the environment is realised through the open structure of public spaces that stimulate social interaction, communication and active participation of residents in shaping the environment. Examples from the Fayna Town residential complex show the effectiveness of such an interactive organisation in ensuring the quality of life, safety and community cohesion. The flexibility and adaptability of architectural solutions are manifested in the ability of living

spaces to transform in accordance with changes in the socio-demographic structure and lifestyle of residents. This includes the possibility of redevelopment, modular reconfiguration of apartments, and change of functional purpose of the space, which correlates with European standards of adaptation to climate and social change. The psychological quality of the space is manifested through a design focused on barrier-free accessibility, sensory navigation, reduced acoustic load, and the creation of recreation and emotional relief areas. These parameters significantly affect the subjective sense of safety, comfort and orientation in space, which is confirmed by the relevant European recommendations. The aesthetic quality of residential architecture is recognised not only as a visual category but also as an element of urban identity. Compositional harmony, façade rhythm, colour, and architectural dominants form an environment that can evoke positive emotions and strengthen the sense of place and cultural belonging.

In general, the proposed model of the architectural and planning approach, formed based on the Ukrainian regulatory framework, European strategies and applied analysis of completed projects, creates a scientifically sound platform for the transformation of residential architecture in accordance with the principles of sustainable development. Further research should conduct empirical measurement of sustainability indices in already implemented projects, optimisation of tools for visualising architectural solutions, and development of unified indicators for assessing the quality of the living environment in the post-crisis recovery of Ukrainian cities.

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