Architectural Studies
International Journal about Architecture

Volume 10, No. 2

UDC 711; 712; 719; 72.01; 721
DOI: 10.56318/as/2.2024.55

Iryna Ryzhova
Doctor of Philosophy, Professor
National University "Zaporizhzhia Polytechnic"
69063, 64 Zhukovskyi Str., Zaporizhzhia, Ukraine
https://orcid.org/0000-0002-9562-200X

Tetiana Pavlenko
PhD in Architecture, Associate Professor
National University "Zaporizhzhia Polytechnic"
69063, 64 Zhukovskyi Str., Zaporizhzhia, Ukraine
https://orcid.org/0000-0001-8374-554X

Liudmyla Hnes*
PhD in Architecture, Associate Professor
Lviv Polytechnic National University
79013, 12 Stepan Bandera Str., Lviv, Ukraine
https://orcid.org/0000-0001-5594-2474

Yevgen Antypenko
Doctor of Technical Sciences, Professor
National University "Zaporizhzhia Polytechnic"
69063, 64 Zhukovskyi Str., Zaporizhzhia, Ukraine
https://orcid.org/0000-0001-8048-0144

Olga Pavliuk
PhD in Philosophy, Associate Professor
National University "Zaporizhzhia Polytechnic"
69063, 64 Zhukovskyi Str., Zaporizhzhia, Ukraine
https://orcid.org/0000-0003-2099-3743

Principles of barrier-free formation of "green" architecture in the contemporary spatial-object environment

Abstract. The relevance of the chosen topic lies in the necessity of developing barrier-free architecture that incorporates the principles of inclusivity. This study examined the trends in leading architectural and urban planning areas, specifically "green" architecture, through the lens of addressing the needs of all population groups, including those with limited mobility. The purpose of this study was to analyse the key trends in barrier-free "green" architecture and to determine their role in shaping modern accessible urban environments. In conducting this study, the philosophical level included principles of objectivity, a holistic approach, and the consideration of processes in development and interaction with other systems. The study employed general scientific methods such as the comparative-historical method, modelling, and a systemic approach. The special scientific methods involved a structural-functional approach. Each of these methods was implemented through distinct approaches, methods, and tools. The study found the key issues and prospects for developing the barrier-free "green" architecture concept. In identifying the main issues, the relevance of the study in the contemporary

Suggested Citation:
Ryzhova, I., Pavlenko, T., Hnes, L., Antypenko, Ye., & Pavliuk, O. (2024). Principles of barrier-free formation of "green" architecture in the contemporary spatial-object environment. *Architectural Studies*, 10(2), 55-63. doi: 10.56318/as/2.2024.55.

Journal homepage: https://arch-studies.com.ua/en
Architectural Studies, 10(2), 55-63
Received: 02.06.2024 Revised: 30.09.2024 Accepted: 18.12.2024

*Corresponding author

spatial-object environment was determined. Through an in-depth analysis of the current state of barrier-free "green" architecture formation, it was found that the barrier-free "green" architecture is multifaceted and encompasses inclusive energy-efficient, ecological, and economic aspects with minimal impact on the environment. The principal trends in developing barrier-free "green" architecture were identified, which helped to determine their role in shaping the modern accessible urban environment not only in terms of sustainable development but also in modern aspects of accessibility and inclusion. Based on the conducted research, the key principles of barrier-free "green" architecture were determined – the principle of energy efficiency, the principle of solar orientation, the principle of inclusivity, the principle of ecological sustainability, and the principle of autonomy. The practical value of this study lies in the systematisation of the "green" architecture developing process, wherein principles of accessibility and inclusion are applied at all stages of its formation

Keywords: inclusion; "green" roof; energy efficiency; solar energy; vertical greening; "green" surfaces

INTRODUCTION

As the 20th century drew to a close, many nations began to focus on issues concerning environmental preservation and sustainable development. Accessibility and inclusion, as leading trends in the architecture and urban planning development, are increasingly being integrated into global practices. "Green" architecture and the specifics of its implementation necessitate investigating it through the lenses of safety, accessibility, and inclusion, among other factors.

Many researchers have explored the concepts of sustainable development and building energy efficiency. S.E. Bibri & J. Krogstie (2020) found that smart technologies are pivotal in shaping the development of sustainable cities. Z. Sun *et al*. (2023) concluded that the impact of advancing "green" technologies is rapidly expanding, increasingly becoming a critical determinant of energy efficiency. The advent of the "sustainable development" concept signified not a mere re-evaluation of the interplay between the anthropogenic and natural milieus, but the evolution and deepening of contemporary ecological paradigms within a cultural context. I. Ryzhova & O. Pavliuk (2023) noted a pronounced emphasis on orienting "sustainable development towards protracted temporal horizons, a departure from analogous environmental trajectories in antecedent epochs". As of 2024, "green" architecture, as a facet of "sustainable development", delineates equilibrium between human activities and ecological systems as a foundational tenet for advancement, construing urbanised zones as integral components of natural landscapes. This engenders a re-evaluation among architects and urban planners, compelling them to adeptly integrate their practices within the extant environmental frameworks.

O. Filonenko *et al*. (2022) also deliberated on the concepts of sustainable development and building energy efficiency, while investigating solar architecture as an alternative to mitigating greenhouse gas emissions. However, within this paradigm, yet another imperative emerges – environmental settings must not solely be ecologically sound but also universally accessible across the demographic strata. Moreover, most developed nations are actively engaged in the pursuit of establishing a secure, comfortable, convenient, and information-rich environment. Z. Al Taweel *et al*. (2020) emphasised the significance of considering and analysing architecture in terms of the safety and accessibility requirements of urban infrastructure. The use of smart parking spaces in the city's infrastructure increases the accessibility of low-mobility population groups to basic city services. The significance of incorporating principles of accessibility and inclusion in architectural and urban planning projects is also discussed in the studies of researchers in this field. M. Ward & J. Bringolf (2018) and T. Pavlenko *et al*. (2024) underscore the importance of integrating the needs of individuals with limited mobility at every stage of building design and implementation.

Consequently, the purpose of this study was to analyse the key trends in the development of barrier-free "green" architecture, focusing on identifying the core principles of its formation within the contemporary spatial-object environment and to assess the significance of these principles in shaping a modern, accessible urban environment.

MATERIALS AND METHODS

The methodology comprised the following structure: philosophical level, general scientific level, and special scientific level, each implemented through its specific approaches, methods, and tools. The methodology was defined by fundamental (philosophical) and general scientific principles of scientific cognition. Special scientific principles are inherent to concrete disciplines or scientific fields. A system of special methods and tools was used to address particular objectives of this study.

The philosophical level of the methodology for investigating barrier-free "green" architecture included the general principles of cognition as follows:

- Objectivity and the formation of barrier-free "green" architecture under specific conditions, factors, and causes.
- A holistic approach to investigating the phenomena and processes in the formation of barrier-free "green" architecture.
- Examining the formation of barrier-free "green" architecture in its connections and interactions with other phenomena.
- Studying the organisation of barrier-free "green" architecture in its development.

Accordingly, the relevant methodological principles ensured the systematic direction of this scientific research and practical understanding of barrier-free "green" architecture – the general scientific level of investigating barrier-free "green" architecture included methods such as the comparative-historical method, modelling method, and systemic approach. The patterns of the functional and planning organisation of barrier-free "green" architecture were determined by applying a unified approach to the research object and analysing its spatial transformations over time, which involved the comparative-historical method. This method helped to identify the features of dynamic development in chronological order, discern similarities and differences among research objects, and determine the general and specific aspects of dynamic development. The study employed this method to investigate the theoretical experience and analyse the chronology of scientific thought in barrier-free "green" architecture.

The modelling method was an indirect and mediated method of scientific research on barrier-free "green" architecture based on using a model as a research tool. The essence of the modelling process involved replacing the research object with another specifically created for this purpose. Either conceptual or materially implemented, the model represents the barrier-free "green" architecture system. It mirrors the research object, making the model itself a source of information about the barrier-free "green" architecture. The graphical drawings of barrier-free "green" architecture considered in this study were created using this method.

Systemic approach was applied to the study of barrier-free "green" architecture. This approach involved investigating barrier-free "green" architecture as a system – a coherent whole where all components and elements function harmoniously. Analysing barrier-free "green" architecture as a system involved methods resulting from the research of many leading researchers in this field. For instance, T. Mukha *et al*. (2016) and T. Pavlenko *et al*. (2022) addressed the issues related to creating effective research methods and optimising the agro-recreational eco-complexes. The concept of urban planning was reinterpreted – not merely as an environment for human activity but as a demo-ecosystem, a system of interrelations and interactions between the population and its living environment. The urban planning level (special scientific methodology) encompassed a set of special methods of scientific cognition on urban planning, forming the basis for addressing the research problem of forming barrier-free "green" architecture (BREEAM certification…, n.d.; LEED rating system, n.d.). These were the scientific concepts that the study relied on.

RESULTS AND DISCUSSION

As of 2024, the prevalent ecological issues exert a significant impact on the environment globally. Urbanised areas warrant considerable attention in particular, serving as primary zones for the active utilisation of natural resources such as land, materials, water, and energy, while concurrently acting as sources of noise, waste, and environmental pollution. Inefficient energy and water usage rank among the most pressing eco-economic challenges due to the operational characteristics of buildings and infrastructure (Dolinsky *et al*., 2020).

The distinct adverse effects of urbanised areas on the environment are identified in the implementation of sustainable development and barrier-free concepts. According to some experts (Asfaw *et al*., 2016; Ryzhova & Pavliuk, 2023), this constitutes the primary challenge of urban areas' inaccessibility, which increasingly confront limited capabilities to fulfil their core functions without significant adverse effects on the natural environment. Other professionals (Gamache *et al*., 2018; Bibri & Krogstie, 2020) add that implementing environmental oversight over architectural and urban planning activities is a crucial necessity for effective economic levers of development in the 21st century's architectural sector. Consequently, new concepts and methodologies emerge in industrialised nations to achieve the set objectives. A field termed "sustainable architecture", or "green architecture", emerges, reflecting architectural and urban development trends intertwined with economic and ecological aspects (reduced energy consumption, optimised use of natural resources, and effective solutions for renewable energy sources).

Sustainable architecture is an eco-oriented high-tech architectural approach that aims to minimise the adverse environmental impacts through the efficient and rational use of modern materials, energy, and space within the ecosystem of urbanised areas. The design and implementation of sustainable architecture are based on energy conservation and environmental protection principles (Dolinsky *et al*., 2020; Filonenko *et al*., 2022; Vilinska *et al*., 2023). The development of "green" architecture is quite multifaceted. In the 1970s, ecological thought rapidly evolved, driven by the intensive construction of high-rise buildings – skyscrapers in the United States. The increase in energy production and consumption led to problems in the use of natural resources, especially minerals, triggering an oil crisis (Bibri & Krogstie, 2020). This crisis spurred the development of ecological activities aimed at preserving the environment.

The creations of Frank Lloyd Wright are considered the first examples of "green" architecture. His projects are organically integrated into the landscape environment. One notable example of the successful interaction between the natural and built environments is the "Fallingwater" house, where the architectural object is harmoniously integrated into its natural surroundings. Wright's projects and landscapes are unified through the use of natural materials, which creates an inseparable connection between the building, viewed as part of a system, and the exterior, contrasting with the functionalist architectural approach that was also developing at the time. Architectural harmony in Wright's work is associated more with "naturalness" than with "bionic" forms, which are characterised by geometric shapes, unlike the projects of the German architect Hugo Häring. "Green" architecture and organic architecture as concepts have become popular among European architects, each with distinct characteristics depending on the region. An example of the interaction between functionalism and organic architecture is the work of the Finnish architect Alvar Aalto. The eclectic and polymorphic compositional structure of his projects blends with the surrounding environment.

In the 1990s, international "green" standards were implemented: Energy Star in the United States and BREEAM (Building Research Establishment Environmental Assessment Method) in the United Kingdom, along with the LEED (Leadership in Energy and Environmental Design) rating system. The BREEAM standard was proposed in 1990 by the British Building Research Establishment (BRE), a multidisciplinary research organisation in the field of construction. BREEAM is the oldest "green" standard for the environmental assessment of buildings of any purpose. As of 2024, it is adopted by companies in more than 80 countries. BREEAM's assessment criteria have served as the foundation for the development of other certification systems for environmentally friendly buildings, including LEED. LEED standards aim to create a more environmentally friendly environment and increase building efficiency with greater economic benefits. These standards are provided to architects, engineers, developers, and investors. They consist of a straightforward list of criteria that evaluate a building's compliance with environmental requirements.

The formation of the "naturalness" of "green" architecture has taken on an urban, industrial nature, aimed at creating buildings and structures that cause minimal harm to the environment. An example of this is the "House in the Hill" (architect Arthur Quarmby, United Kingdom), where the unity of lines and forms of the project with the environment, the organic blending of the building's silhouette with the morphology of the landscape, and the use of local ecological materials create harmony between the architectural complex and the environment. In industrially developed countries, many large buildings embody the concept of sustainable "green" architecture, which reduces environmental impact, including the Conde Nast Tower (48 floors) in Times Square, New York. This tower is one of the earliest instances of applying sustainable "green" architecture principles, utilising the latest technologies of its time to maximise energy savings (Daradkeh *et al.*, 2021). However, in most cases, "green" architecture does not address the issues of inclusivity, and thus does not fully meet all accessibility requirements, resulting in the creation of uncomfortable and inefficient urban environments.

Analysis shows that barrier-free "green" architecture is multi-faceted. This approach encompasses inclusive, energy-efficient, ecological, and economic aspects while minimising the environmental impact. Identification of the main trends in barrier-free "green" architecture (Pollo *et al.*, 2021) allows determining their role in shaping a modern, accessible urban environment in the following aspects: improving the energy efficiency of buildings; employing alternative energy sources, "green" technologies, and innovative materials while considering the barrier-free aspect.

1) Improving building energy efficiency. This aspect encompasses rational energy consumption and energy saving. Applying various design standards and/or retrofitting buildings (low-energy buildings, "passive houses", "zero-energy buildings", "positive-energy buildings") significantly enhances the energy efficiency of both new and existing architectural structures. Here, the concept of energy efficiency is intricately linked to alternative energy sources: wind, tidal, geothermal, and solar energy (solar power), among others. Solar power, specifically, has the closest interaction with "green" construction.

2) Solar energy. The 1950s saw the emergence of the first solar panels, and by the 1970s and 1980s, they were being used in residential construction (Sikora & Nazarenko, 2018). The eco-settlement "Iliako-Horio", created by Alexandros Tombazis and called the Solar Village, was built using various sources of solar energy. In the early 21st century, skyscrapers, stadiums, public, and residential buildings began to be equipped with solar panels (e.g., Conde Nast Building in New York, National Stadium of the World Games in Kaohsiung, HELIOS, and the headquarters of the National Institute of Solar Energy in Savoy, designed by Michel Remon and Frédéric Nicolas).

3) "Green" technologies. This area of "green" architecture is often used in urban planning solutions. Key types of implementation include creating additional accessible "green" spaces for primary and special purposes and establishing additional accessible functional spaces (Fig. 1).

Based on maintenance needs, "green" roofs come in two types: extensive (a multi-layered cover with hardy, lightweight, low-maintenance grass plants) and intensive (requires proper maintenance with the planting of flowers, shrubs, trees, etc). Examples include the rooftop garden of Villa Savoye, designed in 1929 by French architect Le Corbusier, and the "green" roofs of the Big House residential complex in Copenhagen. "Green" roofs offer several advantages: improving the local environment; providing additional accessible space for human activities; enhanced thermal insulation; high sound insulation; and solving rainwater drainage issues. The technology for constructing "green" roofs (Mukha *et al.*, 2016; Sun *et al.*, 2023) is quite complex. Such roofing includes multiple layers: structural decking, vapor barrier, insulation, waterproofing, protective layer, drainage layer, filter, soil, and vegetation. Modern technologies reduce the weight of the roofing structure by using high-strength waterproofing layers. Thus, "green" roofs are aesthetically pleasing and environmentally friendly.

"Green" surfaces, both vertical and horizontal, can be directly integrated into building structures, encompassing balconies, walkways, and even entire floors. These technologies are rapidly advancing and being implemented in many countries. Notable examples of this trend include the high-rise Oasia Hotel Downtown in Singapore, the multifunctional complex One Central Park in Sydney, the residential skyscraper Bosco Verticale in Milan, the Agora Garden Tower in Taiwan, which boasts a LEED Gold+ certification, the Japanese office centre Pasona Group, and the Athenaeum Hotel in England, which features an eight-storey "green" wall by Patrick Blanc's Vertical Garden System.

Among the examined examples, the main types of vertical greening were identified as follows (Fig. 2): vertical gardens, energy-efficient "green" walls, and the use of decorative ivy.

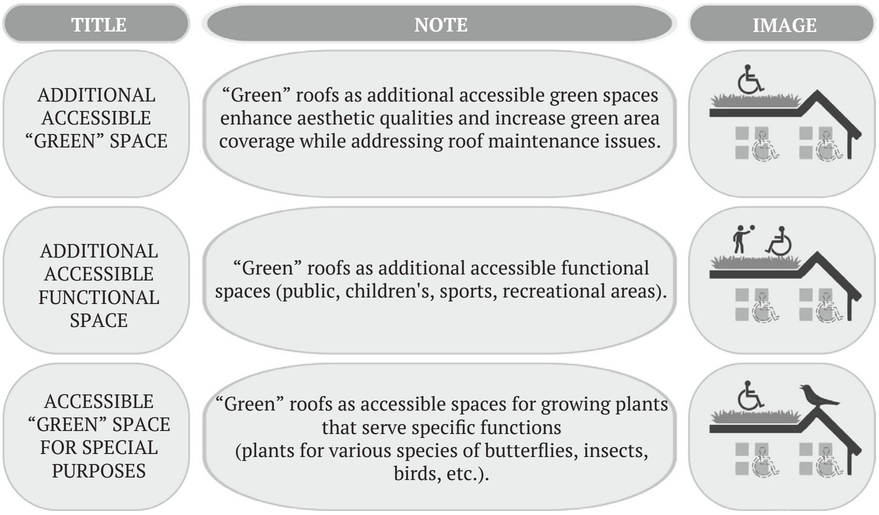

Figure 1. Types of accessible "green" roof space formation
Source: developed by the authors of this study

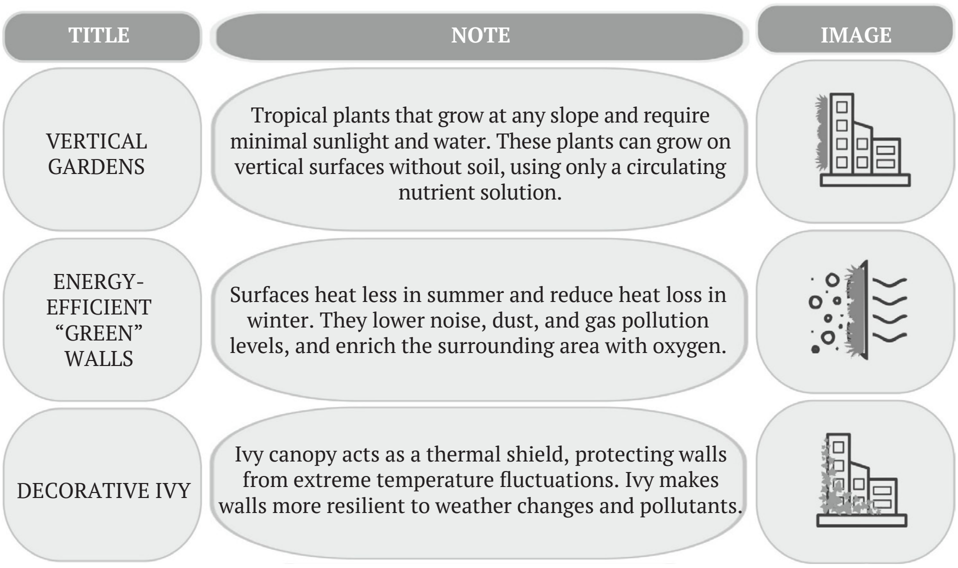

Figure 2. Main types of vertical greening
Source: developed by the authors of this study

Advantages of vertical facade greening include aesthetic appeal, durability, thermal regulation, ecological benefits, maintenance of the building's microclimate, sound insulation, and energy efficiency. Additionally, the main types of vertical greening were identified. Felt type (hydroponic) – this is one of the most popular types of vertical greening. The main structure consists of a metal frame with attached felt pockets, fixed to the facade of the architectural object. This setup allows for the installation of a drainage system with automated drip irrigation. Modular type – this relatively new method involves the installation of vertical structures on a special facade frame, where modules with greening elements are fixed. This type enables the integration of essential greening systems into the structure of any shape. Container type – this is one of the most used types for forming "green" facades. The construction consists of a large network of hollow pipes for irrigation combined with containers for various greening elements. This type also includes its own lighting, water supply, and drainage systems.

A comprehensive examination of the subject matter addressed in this study necessitates an analysis of the micro-level components of the barrier-free "green" architecture system, particularly focusing on eco-friendly building materials. ETFE membranes (ethylene tetrafluoroethylene) are an innovative building material that is significantly lighter than glass, has insulating properties, and is comparable in quality to other building enclosures. ETFE membranes can be used as solar energy accumulators to reduce the energy consumption of a building. The advantages of ETFE membranes include light weight; high strength; low flammability; resistance to hot temperatures; resistance to ultraviolet radiation; self-cleaning ability; and a wide range of material sizes (Sun *et al.*, 2023). Wooden hollow blocks (WHB) are a new type of building material made from wood, which helps save timber and reduce deforestation. WHB elements create a vacuum layer in the walls of a building, significantly reducing heat loss. The benefits of wooden hollow blocks include high thermal retention; timber savings; lightweight elements; material eco-friendliness; reduced structural shrinkage; the ability to combine with other building materials and technologies; high readiness of the material during manufacturing; and energy savings on heating. Wood-polymer composite (or liquid wood) has similar characteristics to regular wood but with enhanced mechanical properties. It is often used for wall cladding, balconies, flooring, and the production of paints that mimic real wood. The advantages of wood-polymer composite include eco-friendliness; high moisture resistance and resistance to biological impact; surface uniformity; high plasticity and strength; durability; ease of installation. Aerogel, also known as "frozen air", is an innovative material with the highest insulation performance among all materials. It has been recognised in the Guinness Book of Records for its exceptional properties. Structurally, aerogel consists of nano-cells that are indistinguishable even under a microscope. The advantages of aerogel are as follows: eco-friendly, being composed of over 95% air; durability; fully recyclability; economical; high strength, water repellence, and sound insulation; low flammability (extinguishes quickly when ignited); lightweight, making it easy to transport. The principles of barrier-free "green" architecture are ensured through the integration of natural environmental components into the architectural and urban planning structure, accommodating the needs of all population groups (Fig. 3).

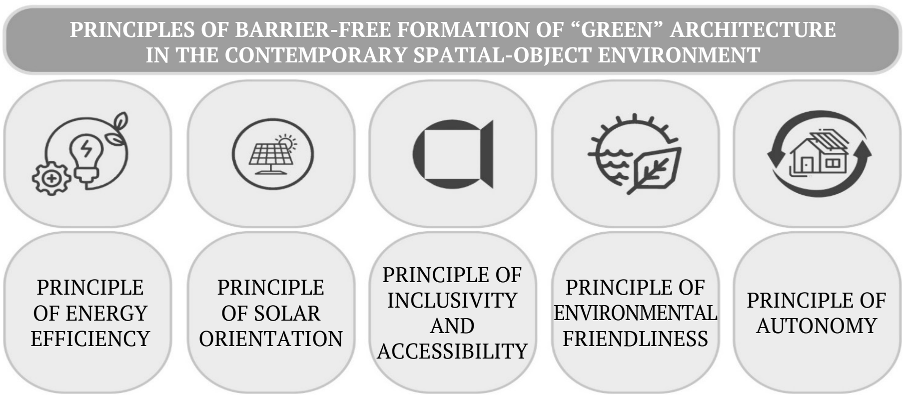

Figure 3. Principles of barrier-free formation of "green" architecture in the contemporary spatial-object environment
Source: developed by the authors of this study

The principle of energy efficiency is achieved through measures that minimise heat loss upon heating and cooling; the application of low-energy consumption building standards (during reconstruction), "passive buildings", "zero-energy buildings" and "plus-energy buildings"; compliance with BREEAM and LEED standards allows for the creation of a more environmentally friendly environment and increases building efficiency with greater cost-effectiveness (Vilinska *et al.*, 2023). The principle of solar orientation is ensured through the generation of light and heat using solar energy. In the design of solar-oriented architecture, both active and passive solar design techniques are used. This includes the orientation of buildings according to the position of the sun during the day, the selection of materials with favourable thermal mass and light diffusion properties, and the planning of the surrounding space. The use of solar panels involves the integration of photovoltaic converters (photovoltaic cells) – semiconductor devices that directly convert solar energy into direct current electricity, unlike solar collectors that produce heat by warming a material – typically a heat-transfer fluid. The use of solar concentrators focuses on the practical application of these devices, which gather solar radiation from the sun and concentrate it into a single point. This approach, described by K. Sikora & O. Nazarenko (2018), leverages fully accessible and renewable energy sources to enhance energy efficiency and sustainability.

The principle of inclusivity and accessibility involves designing urban environments to be comfortable for people from all population groups. Means of accessibility for the exterior space elements of barrier-free "green" architecture are as follows: external ramp; ramp descent; elevated pedestrian crossing; lifting device; accessible external stairs; parking space for individuals with disabilities. Means of accessibility for the interior space elements of barrier-free "green" architecture include internal ramp; accessible internal stairs; lift; internal lifting device; escalator; lavatory for people with disabilities. Means of universal (inclusive) design for elements of both exterior and interior spaces of barrier-free "green" architecture: tactile accessibility elements (TAE); visual accessibility elements (VAE); auditory accessibility elements (AAE) (Pavlenko *et al.*, 2024).

The principle of environmental friendliness focuses on minimising harmful impacts when integrating urbanised and natural environments by using energy-efficient technologies; eco-friendly materials (local building materials, environmentally clean building materials); application of high-tech, innovative materials (ETFE membranes, wooden hollow blocks, wood-polymer composite or liquid wood, aerogel or frozen air); adoption of ecological mobility strategies (reducing the need for cars, promoting alternative modes of transport); ecological planning techniques (reducing building heights, integrating greenery into various building planes); resource conservation practices (preservation and development of "green" spaces); minimisation of non-renewable resource consumption; minimisation of waste production; implementation of "green" technologies ("green" roofs, "green" surfaces, vertical greening). The principle of autonomy refers to the ability of architectural and urban planning objects to function independently in critical situations. Ensuring buildings with alternative power sources entails incorporation of solar panels, rainwater harvesting systems, recycling and filtration of greywater, heat recovery ventilation systems, ground heat exchangers, inverters, batteries, generators, and other alternative power solutions.

Over its course, this study identified the following key discussion points: integration of the fundamental principles of "green" architecture with the requirements of barrier-free accessibility and inclusion; and definition of the primary principles of barrier-free formation of "green" architecture in the contemporary spatial-object environment. The term "barrier-free environment" is most often used in reference to people with physical disabilities. Barrier-free accessibility typically includes the presence of standard ramps and pathways with suitable surfaces, paths and passageways of sufficient width, doors, and other elements of the built environment to facilitate the movement of people with limited mobility. However, M. Ward & J. Bringolf (2018) examined similar assertions within the context of residential construction. These assertions should be applied to all types of development based on the principle of isomorphism in the systemic approach. For these groups, the presence of a barrier-free environment significantly affects their quality of life.

G.W. Bascom & K.M. Christensen (2017) note that a sufficient level of mobility ensures a comfortable barrier-free environment. According to K. Carr *et al.* (2013), at any given time, up to a quarter to a third of the population uses elements of the barrier-free environment. The accessibility of "green" architecture should ensure unobstructed movement within spaces and the ability to enjoy communal resources and amenities. Many countries have reviewed best practices and developed accessibility standards (Gamache *et al.*, 2020). Consequently, the unified standards developed and refined by civilised nations should be actively introduced in the design and implementation of urbanised environments, specifically for "green" architecture projects. Barrier-free "green" architecture, barrier-free "green" construction, and barrier-free ecological design are integral components of the primary ecological approach to barrier-free planning and construction.

Thus, the conducted study focused on the core principles of "sustainable development" over the long term. Barrier-free "green" architecture, as a branch of "sustainable development", embodies the intelligent integration of the built and natural environments while considering the requirements of accessibility and inclusivity.

CONCLUSIONS

This study identified the primary issues and future prospects of the barrier-free "green" architecture concept by combining the fundamental principles of "green" architecture with the requirements of accessibility and inclusivity. A thorough analysis of available research on the subject matter was conducted, focusing on key areas such as the formation of "green" architecture, trends in solar architecture, environmental preservation and sustainable progress, and the safety and accessibility requirements of urban infrastructure. The principles of accessibility and inclusivity in architectural and urban planning were also considered.

Using a comprehensive methodological approach, the study identified the principal vectors in the formation of barrier-free "green" architecture, namely: inclusivity, energy efficiency, environmental sustainability, and cost-effectiveness. Barrier-free "green" development represents a promising avenue for sustainable growth, enhancing environmental protection, conserving natural resources, and mitigating anthropogenic impacts on the natural environment while addressing the needs of all population groups. Barrier-free "green" architecture facilitates the creation of new types of accessible buildings that are integrated into innovative urban planning solutions. Adhering to the principles of barrier-free "green" architecture enables the development of energy-efficient, solar-oriented, inclusive, ecological, and autonomous solutions to contemporary challenges.

The study identified the fundamental principles for the barrier-free development of "green" architecture within the modern spatial and material environment (principle of energy efficiency, principle of solar orientation, principle of inclusivity and accessibility, principle of environmental friendliness, principle of autonomy) provide a foundation for further in-depth exploration of the topic, including the identification and detailed analysis of the main techniques and tools that ensure the implementation of these principles. Additionally, it is crucial to develop a methodology for designing barrier-free "green" architecture within the modern spatial and material environment. Thus, a systemic investigation of ecological and inclusive processes facilitates the development of more sustainable, barrier-free solutions and technologies that safeguard natural resources while addressing social demands for living environments.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

None.

REFERENCES

[1] Al Taweel, Z., Challagundla, L., Pagan, A., & Abuzneid, A. (2020). Smart parking for disabled parking improvement using RFID and database authentication. In *IEEE 6th world forum on Internet of Things (WF-IoT)* (pp. 1-5). New Orleans, LA: Institute of Electrical and Electronics Engineers. doi: 10.1109/WF-IoT48130.2020.9221069.

[2] Asfaw, B., Azage, M., & Gebregergs, G.B. (2016). Latrine access and utilization among people with limited mobility: A cross sectional study. *Archives of Public Health*, 74(1), article number 9. doi: 10.1186/s13690-016-0120-5.

[3] Bascom, G.W., & Christensen, K.M. (2017). The impacts of limited transportation access on persons with disabilities' social participation. *Journal of Transport & Health*, 7(B), 227-234. doi: 10.1016/j.jth.2017.10.002.

[4] Bibri, S.E., & Krogstie, J. (2020). Environmentally data-driven smart sustainable cities: Applied innovative solutions for energy efficiency, pollution reduction, and urban metabolism. *Energy Informatics*, 3, article number 29. doi: 10.1186/s42162-020-00130-8.

[5] BREEAM certification from BRE. (n.d.). Retrieved from https://bregroup.com/products/breeam/.

[6] Carr, K., Weir, P.L., Azar, D., & Azar, N.R. (2013). Universal design: A step toward successful aging. *Journal of Aging Research*, article number 324624. doi: 10.1155/2013/324624.

[7] Daradkeh, L., AlGharaibih, S., Shawaqfeh, R., & Gharaibeh, A. (2021). Green spaces and environmental justice: Measuring the accessibility and fair distribution of public green spaces in the town of Al-Mughayyer. In F. Trapani, N. Mohareb, F. Rosso, D. Kolokotsa, S. Maruthaveeran & M. Ghoneem (Eds.), *Advanced studies in efficient environmental design and city planning* (pp. 293-306). Cham: Springer. doi: 10.1007/978-3-030-65181-7_24.

[8] Dolinsky, A., Chalaev, D., Pereyaslavtseva, O., & Silnyagina, N. (2020). Prospective directions for use of geothermal resources in Ukraine. *Energy and Automation*, 5, 42-56.

[9] Filonenko, O., Yurin, O., Magas, N., Rudenko, V., Semko, P., & Tokar, B. (2022). Modern architecture and energy efficiency. *Collection of Scientific Works of the Ukrainian State University of Railway Transport*, 202, 27-35.

[10] Gamache, S., Routhier, F., Morales, E., Vandersmissen, M.-H., & Boucher, N. (2018). Mapping review of accessible pedestrian infrastructures for individuals with physical disabilities. *Disability and Rehabilitation: Assistive Technology*, 14(4), 410-422. doi: 10.1080/17483107.2018.1449018.

[11] Gamache, S., Routhier, F., Morales, E., Vandersmissen, M.-H., Boucher, N., McFadyen, B.J., & Noreau, L. (2020). Methodological insights into the scientific development of design guidelines for accessible urban pedestrian infrastructure. *Journal of Urban Technology*, 27(1), 87-105. doi: 10.1080/10630732.2019.1632677.

[12] LEED rating system. (n.d.). Retrieved from https://www.usgbc.org/leed.

[13] Mukha, T., Demianchuk, A., & Savchenko, O. (2016). Analysis of experience designing vertical agricultural and recreational complexes. *Research and Production Collection: Architectural Journal of KNUBA*, 10, 312-315.

[14] Pavlenko, T., Lytvynenko, T., & Ivasenko, V. (2024). Methodological frameworks for street and road environment improvement with due regard to inclusion requirements. *IOP Conference Series: Earth and Environmental Science*, 1376, article number 012005. doi: 10.1088/1755-1315/1376/1/012005.

[15] Pavlenko, T., Lytvynenko, T., Ivasenko, V., & Zyhun, A. (2022). Design principles for inclusive environment of urban agrorecreational eco-complexes. In V. Onyshchenko, G. Mammadova, S. Sivitska & A. Gasimov (Eds.), *Proceedings of the 3rd international conference on building innovations* (pp. 535-551). Cham: Springer. doi: 10.1007/978-3-030-85043-2_51.

[16] Pollo, R., Giovanardi, M., & Mariani, A. (2021). Urban greenery as a resource for urban environment. In F. Trapani, N. Mohareb, F. Rosso, D. Kolokotsa, S. Maruthaveeran & M. Ghoneem (Eds.), *Advanced studies in efficient environmental design and city planning* (pp. 307-315). Cham: Springer. doi: 10.1007/978-3-030-65181-7_25.

[17] Ryzhova, I., & Pavliuk, O. (2023). Strategy for sustainable development of urban ecology in the modern spatial and subject environment: Challenges, opportunities, prospects. *Humanities Studies*, 15(92), 52-63. doi: 10.32782/hst-2023-15-92-06.

[18] Sikora, K., & Nazarenko, O. (2018). Solar architecture – as an alternative to the prevention of greenhouse emissions. *Communal Management of Cities. Series: Technical Sciences and Architecture*, 7, 101-105.

[19] Sun, Z., Sun, Y., Liu, H., & Cheng, X. (2023). Impact of spatial imbalance of green technological innovation and industrial structure upgradation on the urban carbon emission efficiency gap. *Stochastic Environmental Research and Risk Assessment*, 37(6), 2305-2325. doi: 10.1007/s00477-023-02395-3.

[20] Vilinska, L., Burlak, H., & Gurska, A. (2023). Energy efficiency of an apartment building. *Ukrainian Journal of Civil Engineering and Architecture*, 3(15), 28-33. doi: 10.30838/J.BPSACEA.2312.140723.28.951.

[21] Ward, M., & Bringolf, J. (2018). Universal design in housing in Australia: Getting to yes. In *Transforming our world through design, diversity and education* (pp. 299-306). Amsterdam: IOC Press. doi: 10.3233/978-1-61499-923-2-299.

Ірина Рижова
Доктор філософських наук, професор
Національний університет «Запорізька політехніка»
69063, вул. Жуковського, 64, м. Запоріжжя, Україна
https://orcid.org/0000-0002-9562-200X

Тетяна Павленко
Кандидат архітектури, доцент
Національний університет «Запорізька політехніка»
69063, вул. Жуковського, 64, м. Запоріжжя, Україна
https://orcid.org/0000-0001-8374-554X

Людмила Гнесь
Кандидат архітектури, доцент
Національний університет «Львівська політехніка»
79013, вул. Степана Бандери, 12, м. Львів, Україна
https://orcid.org/0000-0001-5594-2474

Євген Антипенко
Доктор технічних наук, професор
Національний університет «Запорізька політехніка»
69063, вул. Жуковського, 64, м. Запоріжжя, Україна
https://orcid.org/0000-0001-8048-0144

Ольга Павлюк
Кандидат філософських наук, доцент
Національний університет «Запорізька політехніка»
69063, вул. Жуковського, 64, м. Запоріжжя, Україна
https://orcid.org/0000-0003-2099-3743

Принципи безбар'єрного формування «зеленої» архітектури в сучасному просторово-предметному середовищі

Анотація. Актуальність обраної теми зумовлена необхідністю розвитку безбар'єрної архітектури з урахуванням принципів інклюзивності. У цьому дослідженні розглянуто тенденції провідних архітектурних та містобудівних напрямків, зокрема «зеленої» архітектури, через призму задоволення потреб усіх груп населення, в тому числі маломобільних. Метою дослідження було проаналізувати ключові тенденції безбар'єрної «зеленої» архітектури та визначити їхню роль у формуванні сучасного доступного міського середовища. Філософський рівень дослідження включав принципи об'єктивності, холістичного підходу, розгляду процесів у розвитку та взаємодії з іншими системами. У дослідженні використано такі загальнонаукові методи як порівняльно-історичний метод, моделювання та системний підхід. Серед спеціальних наукових методів використано структурно-функціональний підхід. Кожен з цих методів був реалізований через окремі підходи, методи та інструменти. В результаті дослідження було виявлено ключові проблеми та перспективи розвитку концепції безбар'єрної «зеленої» архітектури. При визначенні основних питань було визначено актуальність дослідження в сучасному просторово-предметному середовищі. Завдяки поглибленому аналізу сучасного стану формування безбар'єрної «зеленої» архітектури, встановлено, що безбар'єрна «зелена» архітектура є багатогранною та охоплює інклюзивні енергоефективні, екологічні та економічні аспекти з мінімальним впливом на навколишнє середовище. Виявлено основні тенденції розвитку безбар'єрної «зеленої» архітектури, що дозволило визначити її роль у формуванні сучасного доступного міського середовища не тільки з точки зору сталого розвитку, але й сучасних аспектів доступності та інклюзії. На основі проведеного дослідження визначено ключові принципи безбар'єрної «зеленої» архітектури – принцип енергоефективності, принцип сонячної орієнтації, принцип інклюзивності, принцип екологічної сталості та принцип автономності. Практична цінність дослідження полягає в систематизації процесу розвитку «зеленої» архітектури, де принципи доступності та інклюзивності застосовуються на всіх етапах її формування

Ключові слова: інклюзивність; «зелений» дах; енергоефективність; сонячна енергія; вертикальне озеленення; «зелені» поверхні