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## ENVIRONMENTAL APPROACHES IN THE DESIGN OF THE EXTERIOR OF RESIDENTIAL COMPLEXES

**Vorobchuk Maria Serhiivna**

*PhD in Design, Senior Lecturer at the Department of Architecture and Design,  
Lutsk National Technical University, Lutsk, Ukraine,*

*e-mail: mariakalytiuk888@gmail.com, orcid: 0000-0002-4792-525X*

***Abstract.** The importance of using ecological approaches in designing the exterior design of residential complexes is analyzed. The main stages of the evolution of the exterior of residential buildings are structured. Approaches to designing the exterior of buildings are studied and the role of the ecological approach is determined, on the basis of which methods of applying the ecological approach in the design of the exterior of buildings are proposed.*

***Purpose.** Study and analysis of ecological approaches to designing the exterior of residential complexes; to investigate methods of applying the ecological approach in exterior design in order to better understand practical use..*

***Methodology.** Analytical and structural approaches and a comparative-historical method were used, which allowed us to trace the stages of the evolution of designing houses in the natural environment. To determine the methods of designing ecological exteriors of residential complexes, a visual-analytical method of artistic-compositional analysis was used.*

***Results.** The evolution of the development of house design in the natural environment is structured. It was studied that in the exterior design of residential complexes, such ecological design methods as facade landscaping, green roofs and green pockets are used. The main principles of designing residential complexes are highlighted: utilitarian, where the main function is utility, utilitarian-aesthetic, based on stylistic creative composition, where the design is based on the human life cycle, and aesthetic, which is reflected through social self-expression, forming a work of art. The role of the ecological approach in the design of the exterior of buildings is determined, on the basis of which a design scheme for the design and development of the exterior of residential complexes is developed.*

***Scientific novelty.** The possibilities of using ecological approaches in the design and development of the exterior of residential complexes are clarified, the features of their application in practice are revealed. Methods of applying the ecological approach in exterior design are determined and principles for the design of residential complexes are developed.*

***Practical relevance.** The results of the study can be useful both for the development of new methods and structures of design and planning, as well as in other areas of research design for students, teachers and architects.*

***Keywords:** ecological approaches, residential complexes, design, construction, ecology, image analysis, visual appearance, exterior.*

## INTRODUCTION

Humans have altered nature through intervention and threatened the extinction of living things, leading to severe consequences of technological development that began with increased industrialization in the 20th century and continues today [21]. This situation has led to an ecological crisis, so it has become important to use ecological technologies to produce products that are compatible with the ecosystem and do not pollute the environment [20]

Since the demand for housing is constantly increasing with the increase in population, this need must be met with all available resources. However, these energy sources are limited and quickly depleted. Various options are available to resolve this situation. An ecological approach in construction is one of the effective ways to solve this problem. In general, the cost of ecological residential complexes is higher compared to ordinary houses, however, maintenance is much less.

Designing the ecological exterior of residential complexes and districts has significant advantages for the environment, allows people to get closer to nature and integrate with it. However, there are still some limitations in the development process of the housing industry, such as: insufficient government support, relatively backward technology of industrialization of housing construction, lack of support and contribution from enterprises [22].

Today, humanity is questioning technology and trying to reduce the damage it causes to the environment. The ecological approach in exterior design is that nature is taken as a model in the design of the territory, because the goal is to become part of the urban ecosystem [6]. This is reflected in the emergence of new ecological projects of residential complexes in the construction sector. Environmental construction is responsible for protecting, preserving and reducing the use of natural resources, maintaining proper air quality.

## REVIEW OF PREVIOUS STUDIES

Urbanization is one of the main global environmental problems of the 21st century. Rapid construction causes significant changes in land cover and the creation of new ecosystems, which have serious consequences for nature and human well-being. Author T. Elmqvist believe that urbanization has harmful effects on living organisms, ecosystems and the natural environment, and has a direct impact on human health and well-being [5]. Scientists G. Garrard in their research indicate that today architects and designers design sustainable, sustainable

and livable cities, pay special attention to the development of ecology, contribute to the creation and restoration of ecosystems [7]. In the coming decades, the urban environment will be affected by climate change and the technological revolution, which may have both positive and negative effects on urban biodiversity and the relationship between humans and nature [19].

Modern design is human-oriented, so urban space is not always understood as a part of nature. Instead, modern urban planning and architecture are aimed at projecting a «civilized» space of human domination over nature [14]. For the convenience of living in the city, architecture must be designed with an ecological approach in mind. An ecological approach in design is based on long-term planning and an understanding of the limitations of natural resources. Author G. Perez and J. Coma compares the advantages and disadvantages of each method of calculating various variable costs when designing ecological residential complexes [17]. The conclusion of his research is the presentation of a literature review on cost-benefit forecasting methods combined with a SWOT analysis. Instead, Y. Zhai and W. Li summarizes such aspects as a comparison of the stages of design, construction and commissioning of conventional and ecological residential complexes [22]. This study identifies common challenges that arise when managing such projects and suggests methods for overcoming identified obstacles.

Ecological construction provides a number of advantages for owners, both material and spiritual. Ecologically designed residential complexes throughout the life cycle become economically beneficial for human life in them [16]. Features of building materials, their social and economic impact on the development of industry and human health were studied [18]. Ecologically manufactured building material minimizes side effects on the environment, reduces pollution both inside and outside the residential complex. Researchers A. Ghaffarianhoseini determined that the entire process of design, construction, marketing and operation includes a complete industrial system that implements integrated models of housing production and operation [8].

The use of an ecological approach in exterior design is possible as a result of combining information obtained through the study of traditional housing with modern living standards. A. Babu described the criteria that are taken into account in ecological design: the choice of a system that is fed naturally, but at the same time does not consume nature, placing the building on the street, sunlight in the design

of the space, the use of local materials [3]. When analyzing literary sources, it was found that environmental approaches to the design of residential complexes were studied by various groups of scientists, however, most considered the technical aspects of design without taking into account the design component.

**THE PURPOSE OF THIS RESEARCH**

The purpose of this work is to study ecological approaches to the design of the exterior of residential complexes. The main tasks were: to study the evolution of the design of residential complexes in the natural environment, to reveal the principles of designing residential complexes that are designed based on an ecological approach and to determine the role of an ecological approach in the design of the exterior of residential complexes.

**RESULTS AND DISCUSSION**

The ecological approach in exterior design examines historical and traditional residential structures and considers the issue of creating ecological building structures taking into account modern conditions. Accordingly, in modern projects it is important to present ecological approaches taking into account the data of the past (Table 1).

Throughout history, the exterior of the house has changed its style, mainly due to the development of construction and building materials. Early decoration of the facade and the outdoor space around the house were used as sources of production, so the designers sought to accommodate trees and grasses that would provide food for their owners and local

communities. The exterior design of buildings has evolved over the centuries, in the Middle Ages it became an area that had a certain religious connotation and was mostly located in castles or monasteries. During the Renaissance, with the increase in the quality of life, the appearance of the upper classes took place.

With the development of technologies, designers and architects have more opportunities to design the exterior of residential complexes. At the beginning of the 2000s, the lawn, which was conceived as a closed and well-kept landscape with space for walking around the residential complex, became a modern classic for decorating the outdoor space around houses. Since 2018, local green spaces have been integrated into the appearance of residential complexes, but preference is given to the individual design of the building, where greenery is projected into the exterior. The main function of residential complexes today is a place for recreation, as well as recognition of one or more owners. Today, the exterior of residential complexes is considered directly as an artistic decoration of the house, which allows a person to form an aesthetic perception. Facades of houses are increasingly considered as a subject for design, which can be «stylized» in the same way as any interior room.

An ecological approach allows you to develop a house exterior in which nature plays a key role and is combined with more refined forms and materials. In this way, art, science and nature become interconnected, which is expressed in the design of the exterior of residential complexes. The exterior design of residential complexes is directly related to nature.

Table 1  
**Evolution of the development of the exterior of residential complexes**

<b>Ancient</b>	
1400 BC	<i>Ancient Egypt, Persia.</i> Decorating the exterior of the home with local plants in closed courtyards.
550 BC.	<i>Ancient Greece and Rome.</i> Greco-Roman courtyards - decorative gardening.
400 year	<i>Japan, China.</i> Emphasis on the unity of the house with nature, harmony and order. Absence of artificial water bodies.
800 year	<i>India, Persia.</i> Chahar Bagh (Four Gardens) is a special place for people to rest, designed according to the rules of the Koran.
1300 year	<i>Middle Ages.</i> Ecological exteriors are designed within the castles for the nobility.
<b>Classical</b>	
1600 year	<i>Renaissance (Italy, France, Great Britain).</i> Estates of the Tudor era (luxurious hanging ecological interiors in the Baroque style); Formal houses (included parterres and long avenues of trees along with exotic plants).
1800 year	<i>Renaissance (Victorian era).</i> Emphasis on the exterior decoration of the house and the environment around.
<b>Modern</b>	
1900 year	<i>Modern era.</i> The cottages are surrounded by suburban lawns. Emphasis on architecture with natural plantings (long borders with flowers and pergolas that are covered with climbing plants).
2018 – now	Residential complexes in the exterior of which local greenery is integrated (preference is given to the individual design of the building; greenery is projected into the exterior).

Greening systems are one of the approaches among other innovative technologies to improve the environmental performance of a building. Thus, three classifications of green planting systems were distinguished: green roof, green facade and green pockets (Table 2). Green pockets are three-dimensional green areas in buildings that can appear in a rich variety of spatial forms and layouts [23]. They can be integrated into the building exterior surfaces and at different levels. Green pockets function as a transitional space between the natural and artificial environment. For example, the Efsun Mountain Residence (Tab. 2, Fig. 1) Green pockets are represented by single massive trees (Tab. 2, Fig. 2). Architect Stefano Boeri designed the residential building «Bosco Verticale» where the facades have become a living organism Tab.2, Fig. 3). Another example is the Nautilus Eco-Resort (Tab. 2, Fig. 4). With the restrictions imposed by the COVID-19 pandemic, the integration of biophilic principles has taken place directly into the architecture (Tab. 2, Fig. 5, 6).

With the correct application of compositional requirements and technical conditions, which lay the foundation for architectural projects, harmony is created. However, the exterior design of residential complexes should solve not only aesthetic, but also technical and functional tasks.

Irreversible climate change has forced people to pay attention to environmental problems. Today, more people strive to create an ecological space around their home that brings minimal harm to the environment. Accordingly, there are certain principles of designing residential complexes based on the use of an ecological approach. Conventionally, they can be divided into three groups: utilitarian, utilitarian-aesthetic, and aesthetic (Table 3).

The utilitarian principle of exterior design of residential complexes is based on mathematical laws, which are expressed in architectural proportions. Therefore, the emphasis is

on utility, not beauty. The utilitarian-aesthetic principle of the exterior design of residential complexes is considered as an ideal option for a decorated and finished area around the house. The aesthetic principle of the exterior design of residential complexes is based on the idea that the exterior of the house is an imitation work of art.

The interaction between man and nature means that the living environment can bring mental and physical benefits to people. A clearly defined external design of the house can ensure a favorable stay in it.

Thanks to the constant development of new technologies, the ecological approach in the design of the exterior of residential complexes is constantly updated, creating the current practice of environmentally friendly buildings. Therefore, the role of the ecological approach in designing the exterior of residential complexes includes ecological design, social requirements and economic development.

Accordingly, the following approaches to designing the exterior of residential complexes were singled out: accessibility, aesthetics, economic efficiency, functionality, productivity and health, authenticity, safety, protection and sustainability.

Therefore, in accordance with the role of the ecological approach in the design of the exterior of buildings, it is possible to develop a design scheme for the design and development of the exterior of residential complexes using an ecological approach (Table 4).

Thus, designers create industrialized and flexible residential complexes. Therefore, the ecological approach in exterior design is aimed at leaving a livable world for future generations through the conscious use of resources, without abandoning innovations aimed at preserving the environment and energy resources for future generations.

Ecological construction today is characterized by an effort to minimize harm to the

Table 3

### Principles of designing residential complexes

Principle	Utilitarian	Utilitarian-aesthetic	Aesthetic
Style	Organic direction	Creative composition	Identification
Function	Utility, not beauty	Design based on the life cycle	Human interaction with nature
Value	Spiritual and emotional state	Spiritual and emotional state + social self-expression	Social expression = work of art







Table 4

### Design scheme for the exterior design of residential complexes

Preliminary design	Concept development	3D model design
Study of the legislative framework, local features.	Definition of problems, formulation of environmental goals.	Modeling the exterior of the house using an ecological approach.

Table 2

**Ways to apply an ecological approach to exterior design**

Green pockets		
	<p><i>Fig. 1. Efsun Mountain Residence, Delora Studio, Cappadocia, Turkey, 2022. (<a href="https://amazingarchitecture.com/tags/efsun-mountain-residences">https://amazingarchitecture.com/tags/efsun-mountain-residences</a>)</i></p>	<p><i>Fig. 2. Iron Manor, Rabani Design, New York, USA, 2023. (<a href="https://amazingarchitecture.com/futuristic/iron-manor-by-mohammad-hosseini-rabbani-zade">https://amazingarchitecture.com/futuristic/iron-manor-by-mohammad-hosseini-rabbani-zade</a>)</i></p>
Green facade		
	<p><i>Fig. 3. Boeri Tower, vertical forest, Stefano Boeri, Milan, Italy, 2014. (<a href="https://www.stefano-boeri-architetti.net/en/project/vertical-forest/">https://www.stefano-boeri-architetti.net/en/project/vertical-forest/</a>)</i></p>	<p><i>Fig. 4. Nautilus Eco-Resort, Vincent Callebaut, Palawan, Philippines, 2019. (<a href="https://vincent.callebaut.org/object/170831-nautilus-eco-resort/nautilus-eco-resort/projects">https://vincent.callebaut.org/object/170831-nautilus-eco-resort/nautilus-eco-resort/projects</a>)</i></p>
Green roof		
	<p><i>Fig. 5. Tehran residential complexes, biophilic architecture during the epidemic, Rezvan Yarhaghi studio, Tehran, Iran, 2020. (<a href="https://amazingarchitecture.com/futuristic/residential-complexes-of-tehran-biophilic-architecture-during-the-epidemic-by-rezvan-yarhaghi">https://amazingarchitecture.com/futuristic/residential-complexes-of-tehran-biophilic-architecture-during-the-epidemic-by-rezvan-yarhaghi</a>)</i></p>	<p><i>Fig. 6. Peruri 88 Tower, designed by MVRDV, Jerde, Arup, Jakarta, Indonesia, 2015. (<a href="https://www.mvrdv.com/projects/18/peruri-88">https://www.mvrdv.com/projects/18/peruri-88</a>)</i></p>

environment while satisfying human needs. Thus, the architectural design of the future must become more biocentric, considering the coexistence of humans with non-human stakeholders as a primary design goal.

**CONCLUSIONS**

The work examines the history of the development of residential complexes from the point of view of ecology and examines the state of scientific research on the topic. The analyzed

studies make it possible to establish the evolution of the development of the design of houses in the natural environment.

Green spaces within the building are useful for human physical health. They increase the satisfaction of residents and encourage them to pay a higher rent to meet their needs and create personal comfort. That is why the integration of plants into residential complexes is becoming an increasingly popular phenomenon today. Greening systems are innovative technologies for improving the environmental performance of a building. Among them, green roofs, green facades, and green pockets were distinguished.

The following principles for the design of residential complexes are distinguished: utilitarian, utilitarian-aesthetic, aesthetic. Each of them is designed in a certain style, has its own functions and meanings. Thus, the utilitarian principle has an organic direction, where the main function is usefulness, not beauty, and the emphasis is on the spiritual and emotional state of the residents of the house. The utilitarian-aesthetic principle is based on a stylistic creative composition, where the design is based on the life cycle of a person, plant or material, and the spiritual and emotional state that is transmitted through social self-expression is important. The last, aesthetic principle is the stylistic identification of human interaction with nature, which is reflected through social self-expression forming a work of art.

The design of the exterior of residential buildings is based on the integrated use of ecological design, compliance with social requirements and economic development. They, in turn, form the following approaches to the design of residential complexes: accessibility, aesthetics, economic efficiency, functionality, productivity and health, authenticity, safety, protection and sustainability.

All of the indicators listed above form a design scheme for the design and development of the exterior of residential complexes using an ecological approach, which is presented in three stages: preliminary design, concept development, 3D model design. Designing for the relationship between man and nature is the main principle of ecological design of buildings, because residential areas are where people live. To meet the needs of people and the environment in the design process, designers must consider the overall planning of the environment, visual and tactile requirements, thereby improving the quality of people's lives.

The results of the study can be used for further study of ecological approaches in the design of the exterior of residential complexes, as

well as serve as theoretical and practical material in the training of design specialists.

*In further work, it is planned to analyze the ergonomic parameters of the design of ecological residential complexes for low-mobility population groups, while specifying the requirements for their functionality and ease of use to maximally adapt the design to the specific needs of users.*

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## АНОТАЦІЯ

### **Воробчук М. Екологічні підходи в дизайн-проектванні екстер'єру житлових комплексів**

Проаналізовано важливість використання екологічних підходів у проектуванні дизайну екстер'єру житлових комплексів. Структуровано основні етапи еволюції екстер'єру житлових будинків. Досліджено підходи до проектування екстер'єру будівель та визначено роль екологічного підходу, на основі якого запропоновано способи застосування екологічного підходу в дизайні екстер'єру будинків.

**Мета.** Вивчення та аналіз екологічних підходів до проектування екстер'єру житлових комплексів; дослідити способи застосування екологічного підходу в дизайні екстер'єру з метою кращого розуміння практичного використання.

**Методологія.** Було використано аналітичний та структурний підходи та порівняльно-історичний метод, що дозволило простежити етапи еволюції проектування будинків у природному середовищі. Для визначення способів проектування екологічних екстер'єрів житлових комплексів було використано візуально-аналітичний метод художньо-композиційного аналізу.

**Результати.** Структуровано еволюцію розвитку дизайну будинків у природному середовищі. Досліджено, що у зовнішньому дизайні житлових комплексів використовують такі екологічні способи проектування, як озеленення фасаду, зелені дахи та зелені кишені. Виділено основні принципи проектування житлових комплексів: утилітарний, де основною функцією є корисність, утилітарно-естетичний, заснований на стилістичній творчій композиції, де дизайн базується на життєвому циклі людини, та естетичний, який відображається через соціальне самовираження, формуючи витвір мистецтва. Визначено роль екологічного підходу в проектуванні екстер'єру будинків на основі чого розроблено схему проектування дизайн-розробки екстер'єру житлових комплексів.

**Наукова новизна.** З'ясовано можливість використання екологічних підходів в дизайн-проектванні екстер'єру житлових комплексів, розкрито особливості їх застосування на практиці. Визначено способи застосування екологічного підходу в дизайні екстер'єру та розроблено принципи щодо проектування житлових комплексів.

**Практична значущість.** Результати дослідження можуть бути корисними як для розробки нових методів та конструкцій дизайн-проектвання, а також в інших галузях дослідницького дизайну для студентів, викладачів та архітекторів.

**Ключові слова:** екологічні підходи, житлові комплекси, дизайн, будівництво, екологія, зображальний аналіз, візуальний вигляд, екстер'єр.

## ДОВІДКА ПРО АВТОРА:

**Воробчук Марія**, доктор філософії з дизайну, старший викладач кафедри архітектури та дизайну, Луцький національний технічний університет, Луцьк, Україна, e-mail: [mariakalytiuk888@gmail.com](mailto:mariakalytiuk888@gmail.com), orcid: 0000-0002-4792-525X.

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