AJEMA GLOBAL RESEARCH NETWORK

AMERICAN Journal of Engineering, Mechanics and Architecture
Volume 4, Issue 4, 2026 ISSN (E): 2993-2637

Bioclimatic Approach and Factors of Typological Formation in Low-Rise Courtyard Residential Buildings (On the Example of Peripheral Areas of Jizzakh Region)

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Abstract: The article analyzes the factors of bioclimatic approach and typological formation in low-rise courtyard housing, using the peripheral areas of Jizzakh region as a case study. The research highlights the impact of architectural means such as the courtyard, veranda, semi-open spaces, orientation, thick walls, local materials, and landscaping on energy efficiency. It also substantiates the relationship between housing typology and the plot, the courtyard-building ratio, residential and service zones, the family-demographic model, and natural-climatic conditions. As a result, an integrated model of bioclimatic and typological approaches to the formation of energy-efficient housing is proposed.

Keywords: Bioclimatic Architecture, Energy-Efficient Housing, Low-Rise Court–Yard House, Typological Analysis, Veranda, Inner Courtyard, Natural Ventilation, Local Materials, Jizzakh Region

Introduction

At the global level, climate change, rising energy costs, and increasing quality requirements for the living environment necessitate new approaches in residential architecture. In particular, in regions characterized by hot-dry and sharply continental climates, architectural and planning solutions for residential buildings must be developed in harmony with the natural environment [1]. For the peripheral areas of the Jizzakh region of Uzbekistan, this issue is even more significant, as summer overheating, winter cold conditions, variations in wind regimes, and the need for rational use of resources require a reconsideration of residential architecture based on energy-efficient criteria. Low-rise courtyard residential buildings possess considerable scientific and practical potential in this regard, as they allow for the integration of traditional architectural experience, natural microclimate, and modern principles of energy efficiency [2].

Methodology

The research methodology is based on an integrated qualitative and analytical approach aimed at identifying the relationship between bioclimatic principles and the typological formation of low-rise courtyard residential buildings in the peripheral areas of the Jizzakh region. The study employs a case study method, focusing on selected districts characterized by hot-dry and sharply continental climatic conditions, which allows for a context-specific evaluation of architectural solutions [3]. A comparative analysis of traditional and contemporary residential buildings is conducted to determine the effectiveness of architectural elements such as courtyards, verandas, semi-open spaces, building orientation, and the use of local materials in achieving energy efficiency. In addition, typological analysis is applied to classify residential structures based on their spatial organization, courtyard-to-building ratios, functional zoning, and family-demographic patterns

[4]. Climatic data, including solar radiation, wind direction, temperature fluctuations, and seasonal variations, are analyzed to assess their influence on architectural design decisions. The methodology also incorporates observational analysis and secondary data review from scientific literature and regulatory documents to support theoretical and empirical findings. Particular attention is given to the "house–courtyard–plot" system as a unified microclimatic environment, where landscaping, shading, and natural ventilation contribute to thermal comfort [5]. The synthesis of these methods enables the development of a bioclimatic-typological model that integrates environmental adaptation, cultural traditions, and modern energy-efficient design principles, providing a scientifically grounded framework for improving residential architecture in similar climatic regions.

Result and Discussion

The bioclimatic approach is based not on isolating a residential building from the environment, but on adapting it to existing climatic conditions. According to the theory of V. Olgyay, an architectural object should function in harmony with factors such as solar radiation, wind, humidity, thermal radiation, and shading [6]. Within this approach, indoor comfort is formed not through dependence on engineering systems, but through architectural planning, orientation, thermal protection of the building envelope, courtyards, and semi-open spaces. Therefore, the concept of energy-efficient housing implies not reducing energy consumption afterward, but minimizing the initial energy demand through architectural means [7].

In the theory of low-rise courtyard houses, the courtyard is not merely a compositional center, but an active space that generates a microclimate. During the day, it ensures a balanced distribution of sunlight and shade, while at night it retains cooled air. International studies substantiate the role of the courtyard as a "passive climate buffer," demonstrating its ability to moderate extreme external temperatures and reduce cooling energy consumption [8]. In traditional courtyard houses studied in Damascus, it has been observed that natural ventilation combined with courtyard composition provides a cooling effect of up to 3°C during the day and up to 6°C at night [9]. These findings confirm the scientific significance of courtyards in modern energy-efficient residential architecture.

In local traditional practice, the courtyard, veranda, and raised platform (supa) have also developed as key means of climatic adaptation. V. L. Voronina provides important insights into the division of plots into external and internal zones in Uzbek traditional houses, the specific role of semi-open spaces such as verandas and supa in everyday life, and the contribution of thick walls and adobe-based structures to balancing the microclimate [10]. The veranda functions as a buffer space between the interior and the courtyard during the summer period, providing solar protection and moderating ventilation. Therefore, in modern energy-efficient housing, the veranda should be interpreted not only as a traditional element but also as a functional tool of passive cooling.

Typological analysis serves as an important scientific tool for classifying low-rise courtyard residential buildings and understanding their energy efficiency potential. Within typology, residential units differ according to their relationship with the plot, courtyard-to-building proportions, functional zoning of living and хозяйственные areas, number of storeys, entrance systems, family-demographic models, and seasonal usage characteristics. D. U. Isamukhamedova highlights the importance of courtyard-based residential types in rural settlements, neighborhood-based layouts, and the formation of household plots according to family needs [11]. These perspectives provide a methodological basis for analyzing residential architecture in the Jizzakh region.

The typological characteristics of low-rise courtyard housing are shaped by natural and climatic

conditions. In desert-adjacent areas, internal courtyards and shaded semi-open spaces play a dominant role, whereas in foothill regions, building orientation and envelope systems become more important due to wind regimes, diurnal temperature differences, and winter cold conditions [12]. Therefore, instead of a single typological model, it is necessary to develop multiple housing models that consider climatic and demographic differences for the districts of Do‘stlik, Arnasoy, G‘allaorol, and Baxmal in the Jizzakh region. Such an approach ensures adaptation to local conditions, reduces energy consumption, and improves living comfort.

In forming an energy-efficient housing model, not only the thermal protection of the building envelope, orientation, compactness, and natural ventilation are important, but also the overall composition of the plot [13]. Trees, vines, and other vegetation within the courtyard reduce overheating, moderate air temperature through evaporation, and provide additional shading in living areas. Thus, the household plot, green elements, entrance zones, хозяйственные structures, and the main residential building together form an integrated microclimate system. This demonstrates that energy efficiency should be considered not only at the building level, but within the “house–courtyard–plot” system [14].

For the peripheral areas of the Jizzakh region, the proposed bioclimatic-typological model should be developed based on the following principles: orienting the building according to solar and wind regimes; enhancing summer comfort through internal courtyards and verandas; increasing thermal inertia through thick walls and local materials; rational zoning of residential and хозяйственные areas; using landscaping as a tool for microclimate regulation; and, where necessary, integrating standards of passive house design into architectural solutions [15]. These principles make it possible to embed energy efficiency directly into architectural design rather than relying solely on technical systems.

Conclusion

In low-rise courtyard residential buildings, the bioclimatic approach and the factors of typological formation are closely interconnected. While the bioclimatic approach transforms housing into a system that responds to the natural and climatic loads of the region, typological analysis helps to identify appropriate models for various demographic, бытовые, and climatic conditions. Using the peripheral areas of the Jizzakh region as an example, the roles of the courtyard, veranda, semi-open spaces, thick walls, orientation, local materials, and landscaping in ensuring energy efficiency are scientifically substantiated. As a result, the necessity of a bioclimatic-typological model is proven for the formation of low-rise courtyard residential architecture that is adapted to the region, preserves identity, ensures comfort, and reduces energy consumption.

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