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Design Characteristics of Mountain City Buildings: Traditional Dwellings' Facades of Old Akre City

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Abstract

Sustainability is important in traditional dwellings. This article explores the architectural traits of the facades in traditional dwellings. These dwellings are in Akre City in the Kurdistan Region of Iraq. This research examines how these dwellings adapt to site characteristics, including environmental and cultural influences. A mixed method was used, combining quantitative and qualitative analysis methods such as field observations, documentation, architectural surveys, and photography. Ten samples were selected based on specific criteria, including traditional elements, preservation of external design, orientation, and unique architectural traits. Consequently, the samples were created using AutoCAD software to determine the opening ratios and features. The results showed that most dwellings faced southwest to optimize natural light. Also, these dwellings have a lot of openings on the upper floors. By putting sustainable practices into the design features, these dwellings preserve the region's cultural heritage. This improves the overall sustainability of the urban environment.

Discipline: Multidisciplinary (Architectural Engineering, Heritage Study, Sustainability).

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1 Introduction

Every culture has different preferences for buildings associated with its traditions, memories, and cultural values [1]. Traditional dwellings are an essential component of cultural heritage. Studies have found that environmental and significant cultural factors influence the design of traditional dwellings [2], reflecting the local people's lifestyle and impacting the construction period [3]. Therefore, the design of traditional dwellings is influenced by several

factors, including geography, available materials, local climate, production methods, social dynamics, family structure, religious beliefs, and sociocultural norms [4].

Traditional architecture consists of types and typologies of unique structures to meet the user's requirements [5, 6]. Also, social interaction significantly contributes to forming spaces in the environment [7], emphasizing privacy in dwelling design [8]. Privacy requirements also differ in a certain way, which is essential when designing indoor and outdoor areas in traditional dwellings [9]. Also, economic issues such as income, resources, and basic needs and demands influence the size, type of material, and shapes [10]. As well as dwellings differ in shape, size, decorations, and construction materials depending on locality to represent Indigenous culture and characteristics [11,12]. These structures reflect the communities' norms, values, and behavioral patterns. For instance, dwellings in regions with steep terrains differ significantly from those on flat land [13]. Therefore, dwellings located in the topography have the advantage of receiving sun and views without obstructing each other [14, 15]. Traditional dwellings are built depending on the slope to provide natural light and air to enter the dwelling and ensure that they harmonize with the surrounding environment for the sustainability and comfort of dwellers. Topography, especially in hilly regions, impacts dwelling placement and design characteristics, with dwellings adapting to natural features and varying levels and appearing single-story from one side and multi-story from the other, ensuring harmony with the environment and enhancing accessibility [2]. Yet, the facades of these dwellings iconographically embody this link. They depend on the environment, cultural traditions, and the inhabitants' economic status. These factors can be observed in the selection of materials, the organization of the openings, and the ornaments applied [16, 17, 18].

Wealthier families also had more elaborate and decorated frontages to describe their economic well-being and social class. The selection of the materials and artistry also reflected the family's cultural beliefs [17]. In addition, the region's climate defines the dwelling's exterior appearance, the life of the people living in it, and the requirements of the house [19]. The size of the openings, like doors and windows, depends on the need for the flow of air and light, the climatic conditions, and the need for privacy [20]. However, building facades and materials are other factors that characterize a building in terms of its architecture and function [21].

Therefore, this study explores how traditional dwellings adapt to mountainous regions and meet cultural and environmental needs. It emphasizes the importance of preserving traditional architectural practices in modern urban development. We aim to document culturally significant heritage sites and traditional architectural features at risk of disappearing.

2 Theoretical Framework

2.1 Design Characteristics of Traditional Dwellings in the Mountain Regions

Forms in nature are shaped by environmental factors, functional needs, and natural selection [22]. The building has different shapes and sizes representing its design characteristics

[23]. However, mountainous regions present a different kind of geography, which defines the landscape and environment and how people live in these regions [24]. Traditional mountain dwellings built in the past were constructed with locally available materials. They are also functional structures emphasizing sustainability and flexibility to improve people's comfort and reduce environmental impact [25, 26]. These dwellings are located according to the natural terrain, exposure to sunlight & winds, and architectural requirements [27]. The location of these dwellings is affected by wind direction, geographical features, and the contours of the landscape in a way that ensures that the structures integrate well into the environment and use the mountains [28].

Moreover, it is also worth mentioning that the architecture of traditional mountainous dwellings is characterized by a particular type of roof, and additional spaces for social interactions are located in them [29]. It stated that the original mountain residences were designed using easily obtained resources [30]. As a result, stone is the most widely used material for constructing highlands because it is easily accessible in mountainous regions [31].

2.2 Facade

A facade is an essential connection between the interior and exterior. It often becomes a symbol and an iconic structure. Several elements contribute to the uniqueness of a facade, including its shape, structure, history, materials, color, openings, decorations, and roof styles. The design of a facade is influenced by factors like the building's function, privacy, light, climate, historical period, and design concepts [32,33]. The location, weather, landscape, environment, history, culture, local materials, social factors, and financial resources can directly impact the facade and its characteristics [34] (Figure 1).

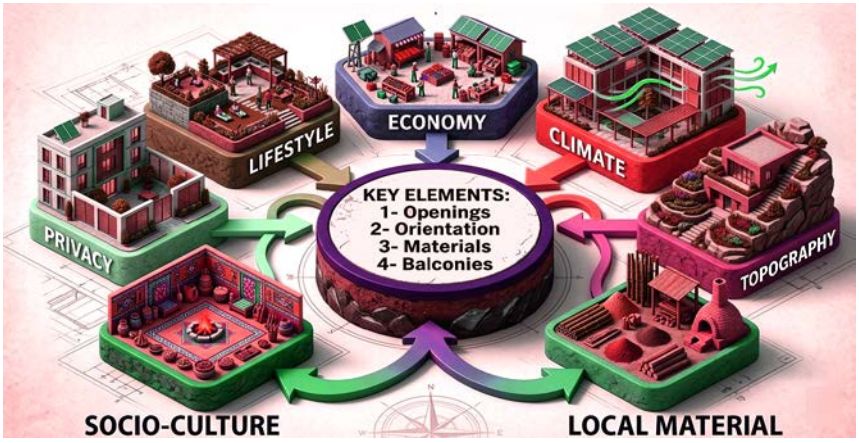


Figure 1: Factors that affect characteristics of facade according to previous studies.

In architecture, the facade refers to the main face of the building entrance, with details varying based on the society and culture that inhabit it [33]. The region's land structure and geographical features significantly impact the number of floors and locations, with dwellings facing the landscape generally built southward as far as the residential area allows [33]. Using traditional elements in facades emphasizes local identity, supports historical environments, and distinguishes regions by reflecting unique regional cultural elements, enhancing the visibility of historical urban identities [35].

3 Case Study

Akre City is in Dohuk, northern Iraq. Before 1991, it was part of the Nineveh province but became formally included in the Kurdistan region after the 1991 revolt. Akre is historically and geographically significant due to its historical ruins, sculptures discovered in its hills, mountains, and caves, and strategic geography [36]. Akre city is considered one of the cities with a long history that goes back to 700 B.C. The town was founded on natural, social, and past living needs. Akre has many rich heritage elements (cultural heritage and natural elements) and many historic dwellings in a particular form distributed on a mountain hillside, making a unique fabric from all other urban elements. Like most of the ancient cities in Kurdistan, Akre's old city (in Kurdish, it is called Akra Kavin) (Figure 2) is embraced among mountains. Hills are situated in the east and southwest of the city [36]. The historic part of Akre City consists of buildings distributed linearly along the hillside south of Akre Castle. The form could be described as terrace dwellings consistent with the site's contour line, where most of the dwellers can use the roof of the neighboring buildings in everyday life activities (Figure 3).

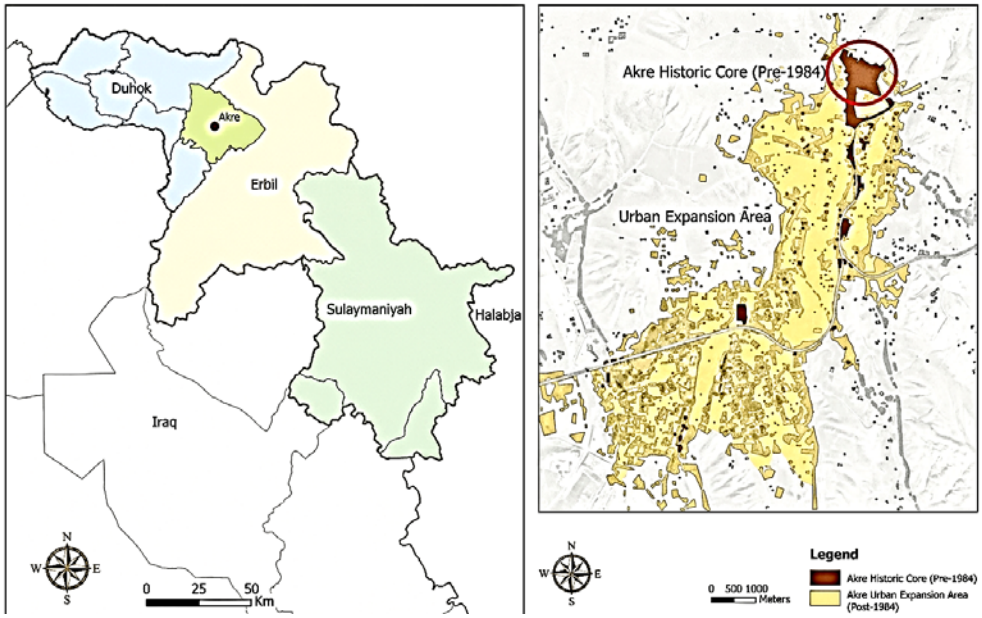


Figure 2: Akre City in the Context of the Kurdistan Region of Iraq. (Right: Akre historic area within Akre City).

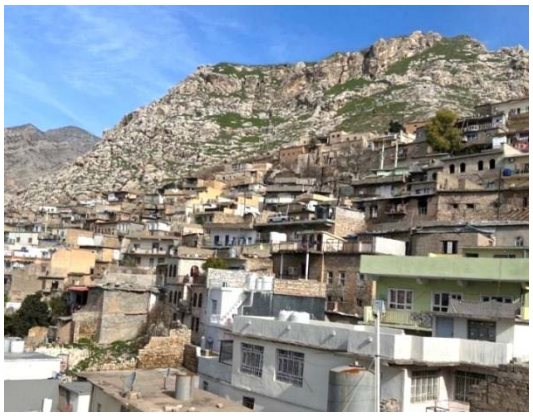


Figure 3: Akre Old City: Terrace-Style Dwellings on Mountainous Terrain

Figure 4: Traditional Dwellings Connection.

Further, these terrace dwellings are connected by narrow, open, and zigzag-staircase roads that follow the rugged and steep topographic nature (Figure 4). These dwellings are mostly one- or two-story buildings, and sometimes different dwellings share the same roof. Yet, the lower dwellings never obstruct the view of dwellings above them. This significant space utilization is characterized by social cohesion, interaction, and the residents' level of trust toward each other [37]. The terraced architecture of these traditional dwellings highlights the importance and value of Akre's cultural heritage. In the old city, there are around 650 buildings spread out and connected by narrow paths and stairs [38].

4 Methodology

A mixed research approach was used, combining quantitative and qualitative research methods. Qualitative research focused on identifying stylistic differences in the facades of dwellings in the old city of Akre. However, over time, the traditional appearance of the old town of Akre gradually disappeared as many historical buildings were replaced with modern architectural engineering or fell into disrepair. Conducting surveys and creating detailed records are essential to preserving cultural heritage and identity. Ten samples were selected based on specific criteria related to traditional features, preservation of exterior design, different orientations, and unique architectural characteristics (See Figure 5). Field observations, architectural surveys, documentation, and photography were conducted to collect qualitative and quantitative data. After meticulously documenting each dwelling, the selected samples are digitally drafted in AutoCAD, and the ratios and characteristics of each facade are identified. This enables a detailed analysis of the ratio of openings, windows, doors, and other elements in each facade. Each dwelling's unique characteristics, such as its position, materials used, and use of decorative elements, are meticulously identified. Furthermore, the positional context of each dwelling within its environment is examined to understand form characteristics and site-specific adaptations. Through a comprehensive analysis of the collected data, we have explored how environmental factors and cultural influences shape the design of these dwellings.

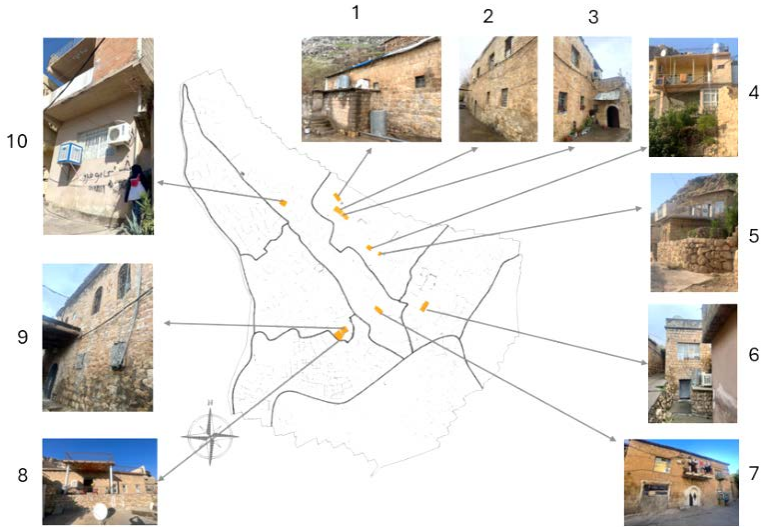


Figure 5: Old Akre City [37]. Featuring selected dwellings, the authors developed it.

5 Results

This section highlights and interprets the findings from analyzing the architectural design of dwelling facades in Old Akre City, particularly in how environmental and cultural factors shape these traditional dwellings.

In Akre, a distinctive feature of the dwellings is their multiple facades; the longer sides of most dwellings are usually oriented towards the southwest. They often result from dwellings with two entrances on different orientations, typically resulting in at least three facades. These dwellings are predominantly two-story buildings, with the ground floor dedicated to services like storage and the living spaces on the upper floor (Figure 6). These facades comprise several elements, including walls, street doors, and notably small windows on the ground floor, alongside more prominent windows and sometimes balconies on the upper floors facing the street.

In addition, stone is the primary wall material because it is abundant, durable, and regularly arranged on the facades. On the other hand, wood is chosen for the roofing and doors, combining local resources and architectural requirements (Figure 7).

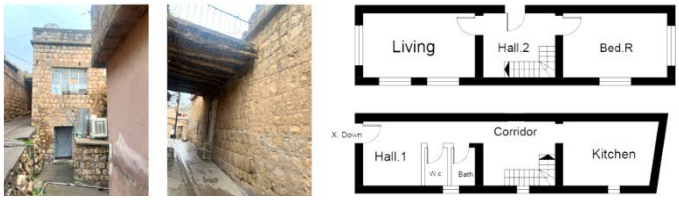


Figure 6: Dwelling No.6 Different Entrances on different levels (x down is the ground floor, while x up is the first floor).

Figure 7: An insulated material that adapts well to the local climate.

The ratio of openings in the facade varies significantly between different sides of the building. The southwest-facing side has an opening ratio ranging from 6.5% to 19.5%, while the northwest-facing sides have a lower proportion, ranging from 0% to 4%. There's also a noticeable difference between the lower and upper floors, with the upper floor's opening proportions ranging from 0% to 12% and the lower floor's ranging from 0% to 8%. Some residences have decorative features above their windows (see Table 1 and Figure 8).

Figure 8: Window Diversity in Traditional Akre Architecture: Functional and Aesthetic Considerations

Moreover, the orientation of dwelling entrances, which can vary to the right or left, lends the structures a semi-symmetrical appearance in dwellings (Figure 9). In addition, the materials used in constructing traditional dwelling doors with some doors crafted from wood and others from metal, and a notable number featuring stone frames (Figure 10). On the other hand, most dwellings feature balconies above the main entrance door and are used as living spaces (Figure 11).

Figure 9: Location of the Doors in Traditional Dwellings.

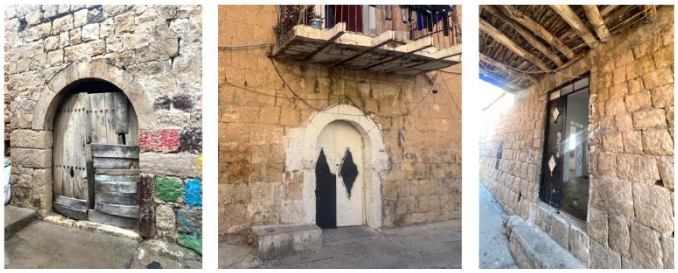
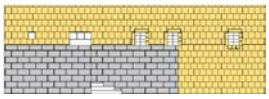
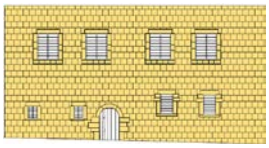
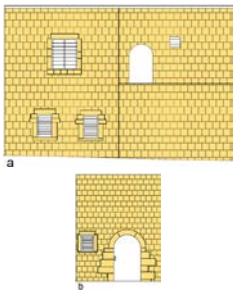
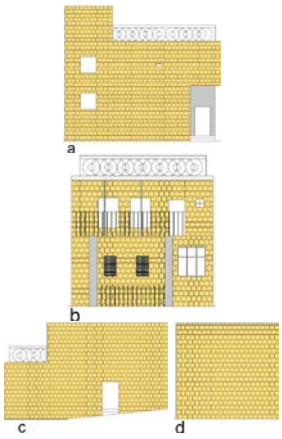
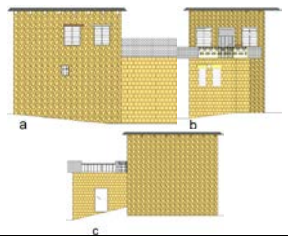
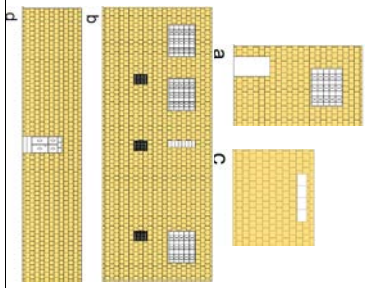
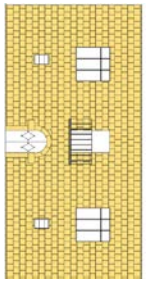
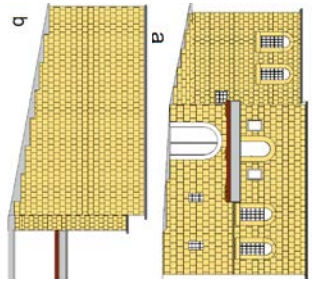
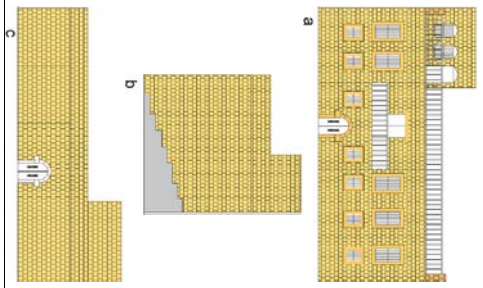
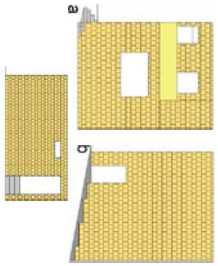


Figure 10: Types of Doors in Old Akre City.

Figure 11: Traditional dwellings, Balconies (Barbank).

Table 1: Design characteristics of traditional dwellings in Old Akre City

Dwellings	Design characteristics									
	Position	Plan Type	Ratio of Opening	The ratio of Openings on the Ground Floor	The ratio of openings on the first floor	Symmetry	No. of Floors	No. of Doors	Door Position	Type of Door	Type of window
1. 	South-West	Tree Plan Diagram	6.5%	6.5%	-	-	1	1	Left	Rectangular	Rectangular
2. 	South-West	Tree Plan Diagram	11%	4%	7%	Semi symmetry	2	1	Left	Semicircular	Rectangular
3. 	a- South-West b- West	Shallow Plan Diagram	a- 7% b- 17%	a- 2%	a- 5%	-	2	1	Right	Semicircular	Rectangular
4. 	a- West b- South-West c- South-east d-Northeast	Ring Plan Diagram	a- 5% b- 16% c- 4% d- 0%	a- 3.5% b- 6% c- 4% d- 0%	a- 1.5% b- 10.5% c- 0% d- 0%	-	2	2	a- Right b- Right	Rectangular	Rectangular
5. 	a- West b- South c- East	Tree Plan Diagram	a- 4% b- 16% c- 3%	a- 0.5% b- 3% c- 2.5%	a- 3% b- 11.5% c- 0%	-	2	1	Left	Rectangular	Rectangular

Dwellings	6.	7.	8.	9.	10.
Design characteristics					
Position	a- South-West b- South-East c- North-East d-Northwest	North- East	a- South-West b- North-West	a- South-West b- South-East c- North-East	a- South-West b- North-West c- North-East
Plan Type	Ring Plan Diagram	Shallow Plan Diagram	Shallow Plan diagram	Ring Plan Diagram	Ring Plan Diagram
Ratio of Opening	a- 19.5% b- 11% c-5% d-3.5%	11%	a- 11.5% b- 0%	a- 16% b- 0% c- 3%	a- 17% b- 4.5% c- 12.5%
The ratio of Openings on the Ground Floor	a- 5.5% b- 1.5%	3%	a- 4% b- 0%	a- 4% b- 0%	a- 8.5% b- 4 %
The ratio of openings on the first floor	a- 12% b- 10%	8.5%	a- 7% b- 0%	a- 8.5% b- 0%	a- 7.5% b- 0%
Symmetry	d c		Semi symmetry	Semi symmetry	-
No. of Floors	2	2	2	2	2
No. of Doors	2	1	1	2	2
Door Position	a- Left. d- Center	Center	Center	a- Left. c- Right	b- Right c- Left
Type of Door	Rectangular	Semicircular	Semicircular	Semicircular	Rectangular
Type of window	Rectangular	Rectangular	Semicircular Rectangular	Semicircular Rectangular	Rectangular

6 Discussion

Akre includes rich formal characteristics, functional design, and artistic stonework combination that reflects Akre's rich cultural heritage and architectural ingenuity. In this section, we will explore which factors affect these characteristics.

6.1 Dwellings Pattern

Various elements shape the spatial layout of these traditional dwellings. Notably, the topography and location of the land play a crucial role in influencing the design features of these dwellings. Due to the sloping nature, most of the dwellings are designed with an additional entrance accessible from a higher-level street. Typically, old Akre city dwellings are either one or two stories.

6.2 Materials and Construction Techniques

Due to environmental factors, such as local materials in the architectural heritage and traditional dwellings of Old Akre City, the facades are generally covered with natural stones, underlining the excellent availability of the construction materials in the region, which undoubtedly influenced the building traditions of its inhabitants. Yellowstone is a primary material used in the construction of walls, selected for its durability, while wood is preferred for roofs. Walls are characteristically thick; they range from 40 centimeters up to a meter. This is not taken only for structural purposes, but it goes a long way in making the dwelling energy-efficient using the natural temperature.

6.3 Openings

6.3.1 Windows

Environmental and cultural factors in Old Akre city dwellings affect the window design and diversity. For example, environmental factors like orientation and topography are crucial in determining the ratio of openings. For example, the ratio of openings on the southwest facade is more than on other facades since the orientation in that direction corresponds with the mountain position and the sun path, thus ensuring maximum natural light and views. Another factor affecting window design is privacy. For example, on upper floors, windows are more oversized and have a larger opening ratio since they are not aligned with the street level, allowing extra natural light into living spaces and providing a good view. On the other hand, windows on lower floors are smaller and have a lower opening ratio. This design option is influenced by both the functional need and a desire for more privacy. Nonetheless, there are a variety of window shapes noted in old Akre City: semicircular, rectangular, and square. Amongst the various types of windows are semicircular arch windows, primarily located on the upper floors; as such, they are chosen from an aesthetic point of view. In addition, some of the dwellings are equipped with ornamental bars above the windows to increase their attractiveness, security, and privacy.

6.3.2 Doors

In Old Akre, architectural heritage styles are presently and visibly dominant in the various doors designed throughout the area. These doors, which are both functional and decorative, mainly come in two shapes: arched doors and rectangular doors. However, the door's materials are affected by local materials; because Akre is a mountainous region, the wood is easily accessible. Therefore, the dwellings are made from a variety of materials such as wood and metal, and some even include stone frames, which represent the material clout displayed in the city's architecture. In addition, other factors, such as topography, affect the position of doors. It features the semi-central position of the main entrance door, which represents the symmetry and balance of the images due to the region's topography.

6.3.3 Balconies (Barbank)

In old Akre city, many dwellings, balconies, or wooden rails, also known as "Barbank," are observed. Besides, these are easily noticeable as they distinguish the dwellings and extend the living area to the outdoors. However, environmental factors such as orientation toward the sun's path and view affect the porches' position in the southwest facade for a good view. Their architectural importance is highlighted through the strategic placement above the main entrance of the dwellings, which accentuates their significance in both design and the social arrangements in the community, creating a powerful bond among residents. Additionally, these balconies have a unique characteristic: some have been customized to span over the entryways, light up the narrow roads, and even connect perfectly to the roofs of the dwellings next door, thereby making them better at creating beautiful functional scenes or a perfect architectural landscape in Akre.

7 Conclusions

Studying traditional dwellings in the mountainous regions creates a rich tapestry of cultural heritage, architectural ingenuity, and environmental adaptation. The findings are multi-aspect, from environmental to cultural dimensions of the traditional architecture in Old Akre City. However, the study identifies two sets of factors that influence the formal characteristics of traditional dwellings related to the site characteristics of a region: environmental and cultural.

Environmental factors, including topography, local materials, and orientation. Topography is an important factor affecting the structure of the dwellings. These steep slopes created multi-level designs to optimize the little available land, hence developing unique forms of architecture in which the roofs of the lower dwellings mainly served as courtyards for the dwellings above. Due to topography, the position of doors is semi-central in some dwellings. Multiple facades are quite common in dwellings, usually resulting in a dwelling with two entrances, each oriented differently. Moreover, orientation also plays a crucial role in shaping formal characteristics; dwellings in Akre are characterized by a bigger ratio of openings in the southwest facade due to the orientation toward the sun and good view. This orientation is affected by the mountain's position. The formal

characteristics of the dwellings are also determined by local materials that use natural stone and wood for roofs and doors, which is the hallmark feature that defines Akre's traditional architecture.

Cultural factors, such as privacy, primarily affect the formal characteristics of traditional dwellings in Akre and influence the design, size, and placement of windows. Traditional dwellings have small windows and a less open ratio on the ground floor, maintaining privacy. The architectural structure also reflects social dynamics, where most of the dwellings are built on a stepped slope so that the roofing of the lower dwelling acts as a yard for the dwelling above, and allows socialization among them easily. Also, the decorative elements above the windows have two main functions: aesthetic and privacy.

The formal characteristics of the traditional dwellings in Old Akre City show the unity of ecological sustainability, cultural identity, and social cohesion. This research underscores the urgent need to integrate these traditional architectural methods within contemporary urban development. This is to preserve the region's rich architectural heritage.

8 Availability of Data and Materials

All information is included in this article.

9 Acknowledgments

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10 Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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