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Article

Analysis of Rural Heritage House Facades as the Initial Step Towards Their Adaptive Reuse and Renovation: A Case Study of Sixteen Houses in Mazandaran Province, Iran

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Abstract: The facades of buildings stand as one of the most influential aesthetic elements in urban and rural districts, serving as a boundary between exterior and interior while historically expressing various cultural and climatic functions. In Mazandaran Province, Iran, historical and rural areas have often been overlooked, leading to inappropriate approaches in reusing and renovating these buildings without considering their values. This study aims to analyze the characteristics of the facades of various historical and rural houses to provide a solid foundation for architects dealing with their reuse and renovation or the design of extensions to the existing buildings. In addition to discussing practical applications, this paper offers a methodological approach for scholars active in the field of rural architecture. The research method includes an analysis of several historical houses, drawing from both literature and field studies. The formal approach has been chosen to align with the research goal. The sixteen selected cases are situated in the historical and rural districts of Alasht, Lafour, Qaemshahr, each built in different historical periods of Iran. Given that many historical houses in this area are not officially listed as heritage buildings and no data regarding them are available, the researchers conducted field surveys and interviews with residents to collect the necessary information. The investigation focused on facade elements, including the pattern of openings and the materials used in the selected houses. This research led to the documentation of the facade shapes in the rural areas of Mazandaran Province, highlighting the necessity of documentation to establish a knowledge base before reuse, renovation, or design within these historic regions. This approach could serve as a model for other regions and countries.

Keywords: facade; preservation; adaptive reuse; renovation; historical rural house; formal approach; Mazandaran Province

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1. Introduction

The temperate and humid climate of the northern regions of Iran has increasingly attracted businesspeople and affluent individuals for the construction of new villas. However, using non-vernacular materials and methods has resulted in extensive constructions incompatible with the existing fabric, thus detrimentally impacting the identity of rural districts [1–3]. There are still some less-damaged historical houses in the Savadkouh region of Mazandaran, dating back to the Qajar era (1794 to 1925 AD), the Pahlavi era (1925 to 1979), and the early Islamic Revolution period (1979 to present). However, as they are mostly not listed as heritage buildings, it is imperative to conduct thorough studies, with proper documentation and analyses, of these houses before they become abandoned or demolished [4]. While research on historical houses in Mazandaran Province has primarily focused on houses located in cities (e.g., the research conducted by Delfanian [5]), this studies is one of the first attempts focused on the facades of historic buildings in the villages

within this province of Iran. There are several international studies focused on the villages of this province, and they concentrate on the plan's grammar rather than the details of the facades [6,7]. The aim of this study is to study and analyze the exterior facade details of these historic buildings and document them as a necessary step [8–10], before initiating their reuse to a new function or renovation to continue their lives as houses.

1.1. Analysis as the Initial Step of Transformation Processes

When it comes to reusing or renovating existing built environments and, more specifically, heritage buildings, several studies have proposed different process models for the whole process [11] to not only preserve the values of heritage buildings but also to ensure effective results [12]. In this paper, the process model of Arfa et al. (2022) is used as the backbone of the research, highlighting the necessity of the "analysis" of the existing built environment instead of starting from a blank page [8,9]. Figure 1 shows the model.

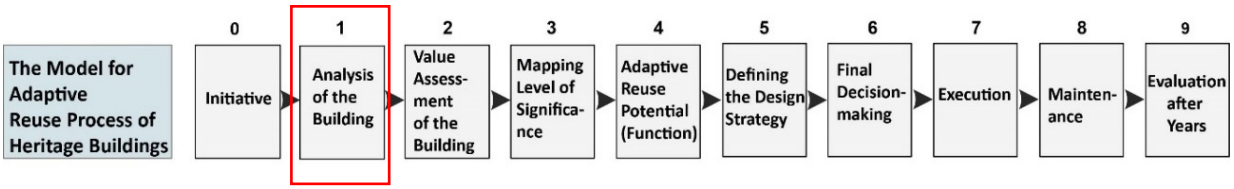


Figure 1. Process model for the adaptive reuse of heritage buildings and the focus of the current research on Step 1 (Analysis), adapted from Arfa et al. [8,9].

While this model seems to be focused on adaptive reuse, it seems to be a comprehensive process model also for the renovation of existing and heritage buildings without changing their functions.

While "Analysis" (Step 1 in Figure 1) includes different aspects (e.g., the analysis of architectural, historical, and technical aspects, among others), this research focuses on facade analysis as a significant and relevant element.

1.2. Brief Review of the Formal Approach

This research adopts a formal approach to analyze heritage buildings as a primary step towards their preservation. The shape and form of a building, comprising a collection of elements that ultimately create a cohesive whole, are fundamental to the essence of the building itself and are reflected in its shape. These shape features serve as the organs of the building, allowing for the distinction between two buildings. Durand, a notable theorist in the formal approach, transformed real-world elements into geometric shapes. He utilized basic shapes to categorize elements, simplifying complex shapes for a better understanding. By integrating architectural components into a formal process, Durand shed light on design for the future, including extensions to existing built environments or buildings yet to be constructed [13].

Rob Krier's objective was to bridge the gap between the past and present, a dimension often overlooked in modern architecture. His work, originating from urbanism and expanding to architecture, incorporates formal procedural steps at the architectural scale. He considered function, structure, building, and shape, amalgamating the structural factor with basic shapes. The result of his work involves classifying historical buildings based on shape types and their evolution [14].

Steadman developed a comprehensive method by formulating architectural plans and translating them into a mathematical language, thereby generating numerous plans. Following the production of formal products, dimensions, proportions, etc., are added, and if an issue arises, the process is repeated [15,16].

This research employs the formal approach with a specific emphasis on exterior elements, including openings, facade proportions, sloping roofs, ornaments, balustrades, and facade and structural materials on the body, platform, and roof. These constitute the

fundamental elements of the exterior facades, which are examined in several case studies of Mazandaran Province.

2. Materials and Methods

This paper focuses on analyzing the facades of historical rural houses in Mazandaran Province. The analysis method employed in this research has been adapted from the method developed by Memarian in 2005 [17], which is based on analyzing existing buildings via the formal approach. Thus, the first step was to conduct a brief literature review of the formal approach, presented as the theoretical background of the research (Section 1.2). Geographical studies of Mazandaran Province were conducted to identify the main elements of historical rural house facades (Section 3.1).

By consulting several experts and studying library sources and documents, five villages have been chosen, mainly due to the high historical value of their rural houses, emphasizing the importance of studying their facades. These villages are Alasht, Bourkhani, Naftechal, Kutena, and Reikandeh, and they can be found in three different climatic zones (mountainous, foothill, and plain zones) in Mazandaran province. A summary of the characteristics of these regions is presented in Section 3.3.

After selecting the villages, the first author conducted field studies to obtain a better understanding of the available historic houses. It should be mentioned that except for the first village (Alasht), no written documents about the historic houses in other villages were available in the municipalities and cultural heritage organizations. Thus, the first author conducted field surveys and interviews with residents to select cases with the potential to be included in this research. The interviewees confirmed their participation in this research by signing a consent form. The main questions asked to the knowledgeable local people and the elders of the village were as follows:

1. Which are the oldest houses in this village?
2. What historical period are they from?
3. Who are/were their owners, and what social class were they from?

In some cases, the selected persons for case selection consultation were also owners of historic houses. Thus, two more questions were posed to them:

4. Why was your house or your ancestors' house built this way (in terms of shape, materials, or structure)?
5. What kind of peripheral work has been carried out in or around the house?

If, during the interviews, native and local terms were used, the interviewer also asked about their meanings.

In the few cases where these houses had a written history, the necessary information was obtained by studying the relevant documents. For example, in the Alasht region, visiting the Alasht Anthropology Museum (which used to be the house of King Reza Pahlavi) made most of the house's documented information accessible.

It should be noted that it was impossible to visit some houses, as some were damaged or unsafe. These were excluded from the preliminary case list and replaced with similar ones. The selected cases are the ones that have received the least intervention to ensure they are representative of their periods. Finally, the houses were categorized, and the types with more repetitions were visited again, measured, and analyzed. The points mentioned by the interviewees were also codified, and they are used throughout the Section 3.

3. Results

3.1. Mazandaran Province

The focus of this research is specifically on Mazandaran Province due to the special characteristics of the facades of the houses in this province. Situated near the Caspian Sea in the north, the Alborz mountains in the south, and abundant surface water resources, the province experiences an almost Mediterranean climate [18,19]. The average annual temperature in the province is 14 °C, with relative humidity reaching 85% in winter, 79% in

spring, 76% in summer, and 85% in autumn, accompanied by an average annual rainfall of 815 mm, increasing up to 1200–1300 mm in plain areas [20]. Geomorphologically, Mazandaran is divided into three main zones: the mountainous zone, foothill zone, and coastal plain [21]. A summary of the characteristics of these geomorphologies is presented in Table 1.

Table 1. Characteristics of the geomorphologies in Mazandaran Province.

Zone Name	Explanations
Plain zone	The plain zone of the province has a slope of 0–1% [20] and is located below an altitude of 100 m above sea level [22].
Foothill zone	The foothill zone is situated between an altitude of 100 and 500 m above sea level, and in some cases, it extends up to 800 m [22]. This zone includes the Caspian Hyrcanian mixed forests and boasts the most convenient climatic conditions among the zones.
Mountainous zone	This zone is located at 500 m above sea level and has a relatively high slope from south to north and west to east [22]. The Alborz mountains in the mountainous zone separate Mazandaran from the south of Alborz, and like a long wall, they extend from west to east near Gorgan Valley [21].

The Main Elements of the Exterior Facades of Historical Rural Houses in Mazandaran

The predominant climatic characteristic of the research area is the high humidity, resulting in significant rainfall and a temperate climate. Typically, houses are elevated on platforms to mitigate the infiltration of moisture, rain, and snow into the living spaces, thereby creating a distinction between residential, service, and living areas. In the plain zone, stairs in two-story houses are positioned externally on the porch, whereas in the foothill and mountain zones, they are located inside the building due to colder weather conditions. Geographical variations, spanning from the plain to mountainous zones, are correlated with changes in climate, elevation, slope, and humidity, which, in turn, influence the physical architectural configurations [23].

- Porch

The porch is a semi-open or semi-enclosed space that acts as a transitional zone between enclosed and open areas. Most indoor activities can be shifted to the porch during spring and summer. Porches are found on the ground floor, first floor, or both [24]. In the plain and foothill regions, favorable climatic conditions allow for the year-round use of semi-open spaces like porches. They promote airflow while offering protection from rain and excessive sunlight. As illustrated in Figure 2, semi-open spaces in mountainous areas are typically situated on one side, whereas in plains and foothill regions, they may surround the building on one, two, three, or even all four sides [22]. In colder areas, porches may sometimes be omitted altogether [23].

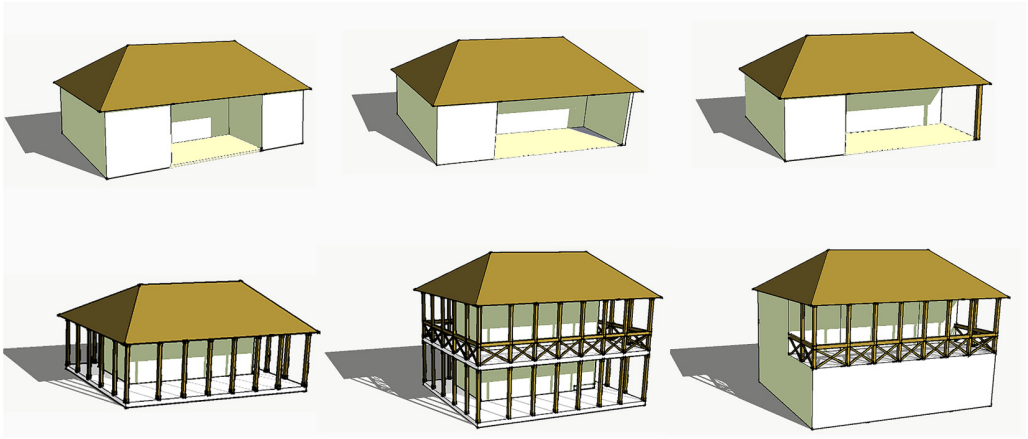


Figure 2. The diversity of the shapes of houses in the vicinity of the Caspian Sea, adapted from Raheb (2014) [23].

In local parlance, a porch on the second or third floor is commonly called 'Telar'. Telar is located a few steps above the porch, often with a barn or corral underneath. In some instances, the space below may remain empty. The room situated behind Telar is known as 'Bala-khaneh' or 'Upper house' (Figure 3) [25].



(**a**) (**b**)

Figure 3. (**a**) Typical shape of Telar. (**b**) Different types of Telar in a building plan [14].

- Roof

Due to the consistent rainfall in northern areas, houses typically feature sloping roofs. The space between the sloping roof and the building's ceiling serves as a suitable area for storage, designed to facilitate airflow and ventilation [25]. These sloping roofs play a crucial role in providing thermal insulation, as well as in preventing damage from heavy rainfall [26]. The prevalent types of sloping roofs in these houses include gable roofs (roofs with two slopes) and hip roofs (roofs with four slopes) (Figure 4). The angle of the slopes varies based on the regional climate and the amount of rainfall. Notably, the roof slope increases from Mazandaran Province to Gilan Province due to the heavier rainfall in the latter.

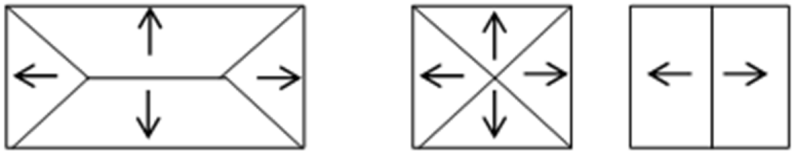


Figure 4. Types of common sloping roofs in the southern margin of the Caspian Sea.

- Facade proportion

The long side of the building typically faces north and south, ensuring uniform light distribution and providing ample opportunities for openings, which enhance ventilation. In response to the high humidity in the plains and foothill regions, these spaces typically feature higher roofs. Conversely, in the mountainous zone, winter living spaces are characterized by shorter roofs designed to retain heat and protect against wind exposure [22]. In Mazandaran Province, the architectural styles of houses vary considerably. In the high-humidity plain zones, houses often feature rectangular patterns with wide porches. In the foothill regions, houses may have rectangular patterns with semi-enclosed porches. Meanwhile, in the mountain regions, houses tend to adopt fully enclosed and compact forms [23]. In the plain and foothill regions, windows are typically large and equipped with wide canopies [22].

- Materials

The utilization of vernacular materials in rural architecture reflects an adaptation to the geographical conditions of the area [27]. Residents in these regions, possessing extensive knowledge of vernacular materials, incorporate thin wooden boards into building structures using various methods [28]. In these zones, stone is commonly used at the foundation of the walls, with its application varying in the plain and foothill areas [26]. Wood is one of the most prevalent materials for constructing sloping roof trusses, often of the lath type [29]. Common covering materials for roofs include tin sheets, clay tiles, and straw [26].

3.2. Selected Villages

The selected villages are situated in the eastern part of Mazandaran Province (see Figure 5), encompassing the cities of Qaemshahr, North Savadkouh, and Central Savadkouh. This region is bordered to the south by the Alborz mountains and to the north by coastal towns. Savadkouh is positioned in the central part of Mazandaran, on the northern slope of the central Alborz mountains, within a latitude of 35°49″ to 36°23″ northern hemisphere and longitude of 52°39″ to 53°14″ eastern hemisphere.

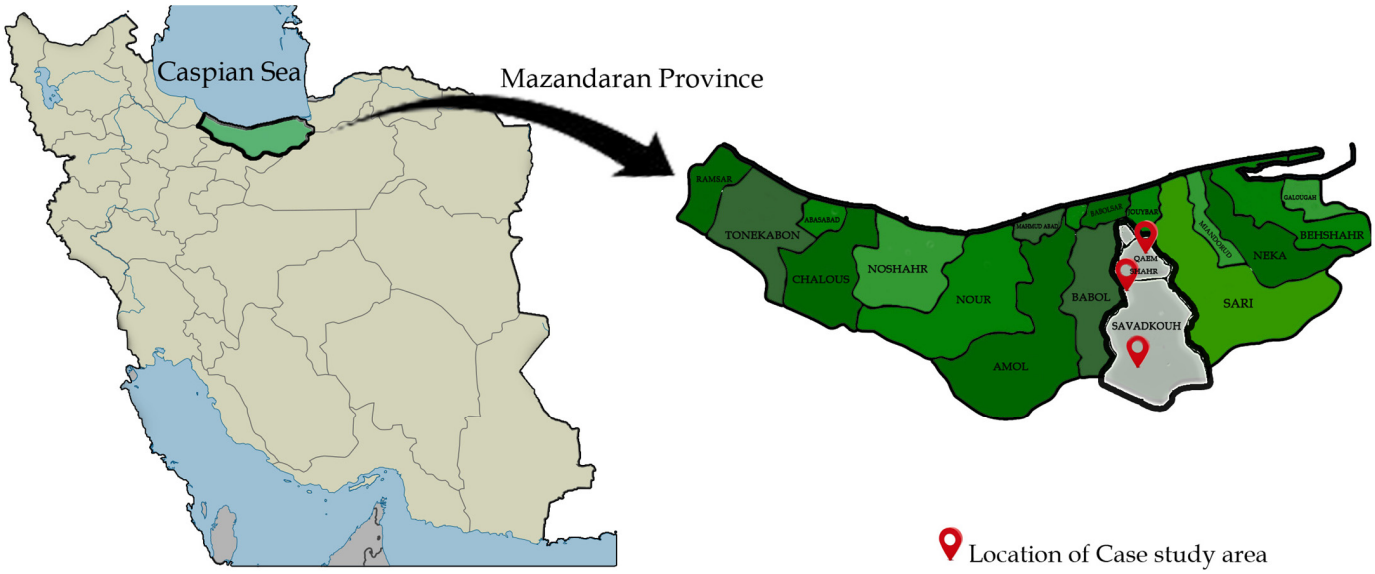


Figure 5. Map of Iran (left) and the location of the study area (mountainous, foothill, and coastal-plain zones) on a map of Mazandaran Province.

The selected villages include Kutena and Reikandeh, representing the plain zones of Qaemshahr; Naftechal and Bourkhani in Lafour, a rural district representing the foothill zones; and Alasht village in Central Savadkouh, representing the mountainous zones. A summary of some information about these villages is presented in Figure 6.

Mountainous Zone

Central Savadkouh

Village (city): Alasht





Alasht is a historical rural area which has been transformed into a city. It was the birthplace of King Reza during the Pahlavi era, and his house is now the museum of Anthropology. This region is 1908 meters above sea level at a latitude of 50°50″ and longitude of 36°4″. The temperature range is between 7.5 and 10 degrees Celsius. Alasht has protected wildlife that can grow black root trees. The old part of Alasht has already been nationally registered (registration number 867) due to its valuable native architectural features.

Foothill Zone

North Savadkouh

Village 1: Bourkhani





Bourkhani is one of Lafour's villages located east of it. It is connected to the village of Naftechal from the west and to the forest from the north, south, and east. This village is 651 meters above sea level at a latitude of 52°50″ and longitude of 36°15″. The vegetation of this village is mainly forest. Burkhani has a moderate Caspian climate and in some conditions it has cold mountain microclimates. According to the stories, the settlement in this village goes back to 1000 years ago.

Village 2: Naftechal





Naftechal is the greatest village of Lafour (about 60 hectares). It is located at 500 meters above sea level at a latitude of 52°49″ and longitude of 36°15″. It is connected to Burkhani village from the east side and to the forest from the south and east. The climate vegetation of Naftechal is almost of similar to Burkhani. The main occupations of the people of this village are agriculture and animal husbandry work due to its location in the temperate climate region. Besides those professions, silkworm breeding is one of the seasonal side jobs common among the region's villagers.

Figure 6. *Cont.*

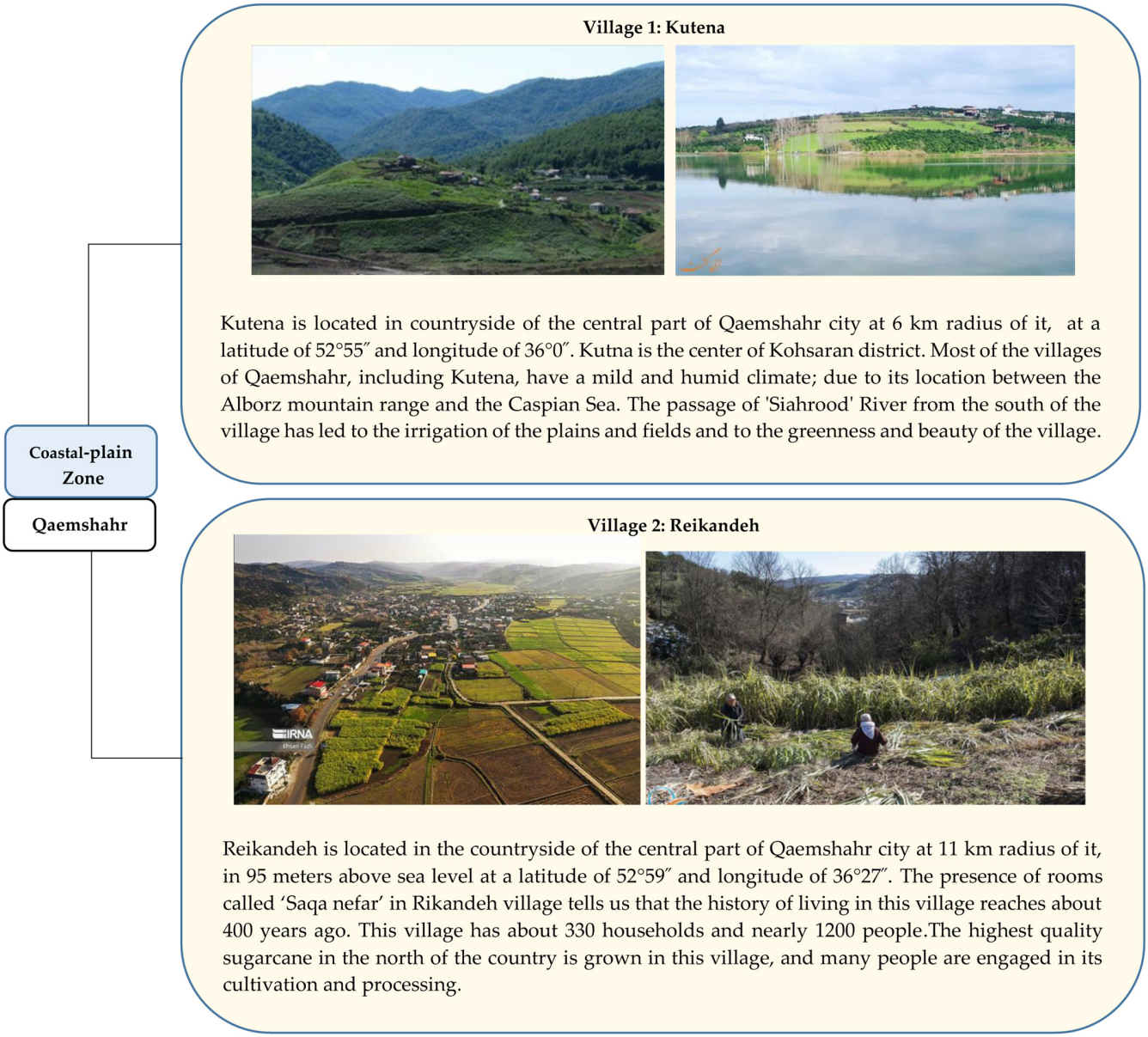


Figure 6. Case study villages.

3.3. Analysis of the Houses

In this section, the main elements of the exterior facades of houses in the selected villages are investigated. They are then examined and compared based on their characteristics. As mentioned previously, this study focuses on the dominant typologies found in valuable historical homes that have not undergone significant changes over time. Thus, this study encompasses almost all available typologies in the selected areas, providing a comprehensive understanding of the region's architectural diversity.

3.3.1. Mountainous Zone: Alasht

In the rural area of Alasht, five houses with various typologies were investigated (Figure 7). Due to the sloped terrain in this region, the houses are either one-story structures with a high platform or two-story buildings. The investigation showed that depending on the height and function of the lower spaces, they serve additional purposes, as they can be used for storage, as a henhouse, or as a barn. The porch typology is predominantly one-sided in most houses, but aristocratic residences, such as the house of Reza Pahlavi

(the king of Iran in the Pahlavi era) and that of Mr. Mustafa Khan, feature two- or three-sided porches. The ratio of openings to the entire wall is approximately 15%; however, in aristocratic houses, this ratio can reach up to 30%. The doors are typically wooden, with both single and double casements, while the windows are mostly wooden, with double or triple casements. Due to the cold weather, some houses' doors are entirely wooden, with no glass. Regarding facade proportions, the diversity in the number of floors and the size of these houses results in various length-to-width ratios, ranging from approximately 1 to 5.

Houses in Alasht typically feature hip roofs with four and three slopes, each with a more than 30% slope. Facade ornaments are limited to carved pillars, wooden grids, inscriptions on windows or doors, and X-shaped balustrades. However, aristocratic houses exhibit more intricate details and ornaments, sometimes showcasing carved pillar heads and traditional eaves. Except for some one-story houses, the majority have wooden balustrades, with X-shaped designs being more common. These houses often have cob walls with stone foundations, and in a few cases, they follow the 'Lardei' structure. The older ones typically have wooden lath roofs, while the more recent ones feature tinned roofs.

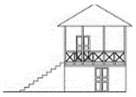
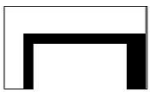
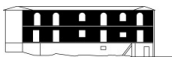
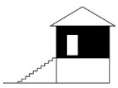
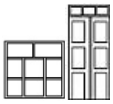
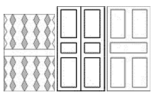
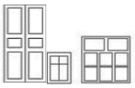
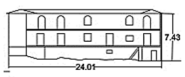
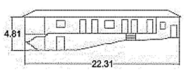
Owner	**King Reza Pahlavi**	**Mr. Mustafa Khan**	**Mr. Rafati**	**Unknown**	**Mr. Jamshidi**
Time period	Ghajar	Ghajar	Pahlavi I	Early Islamic Revolution	Pahlavi II
House image					
Main facade	 two-story on high platform	 one-story on high Platform	 one-story on Platform	 two-story	 two-story
Porch pattern	 three-sided (U type)	 two-sided (L type)	 one-sided	 one-sided	 one-sided
Openings	 OFR [1] = 20%	 OFR = 28%	 OFR = 15%	 OFR = 15%	 OFR = 15%
	 wooden double casement	 wooden double and triple casement	 wooden single and double casement	 wooden single, double, and triple casement	 wooden double casement
Facade proportion	 $\frac{\text{Length}}{\text{width}} = 3.2$	 $\frac{\text{Length}}{\text{width}} = 4.6$	 $\frac{\text{Length}}{\text{width}} = 3.9$	 $\frac{\text{Length}}{\text{width}} = 2.2$	 $\frac{\text{Length}}{\text{width}} = 0.95$

Figure 7. *Cont.*

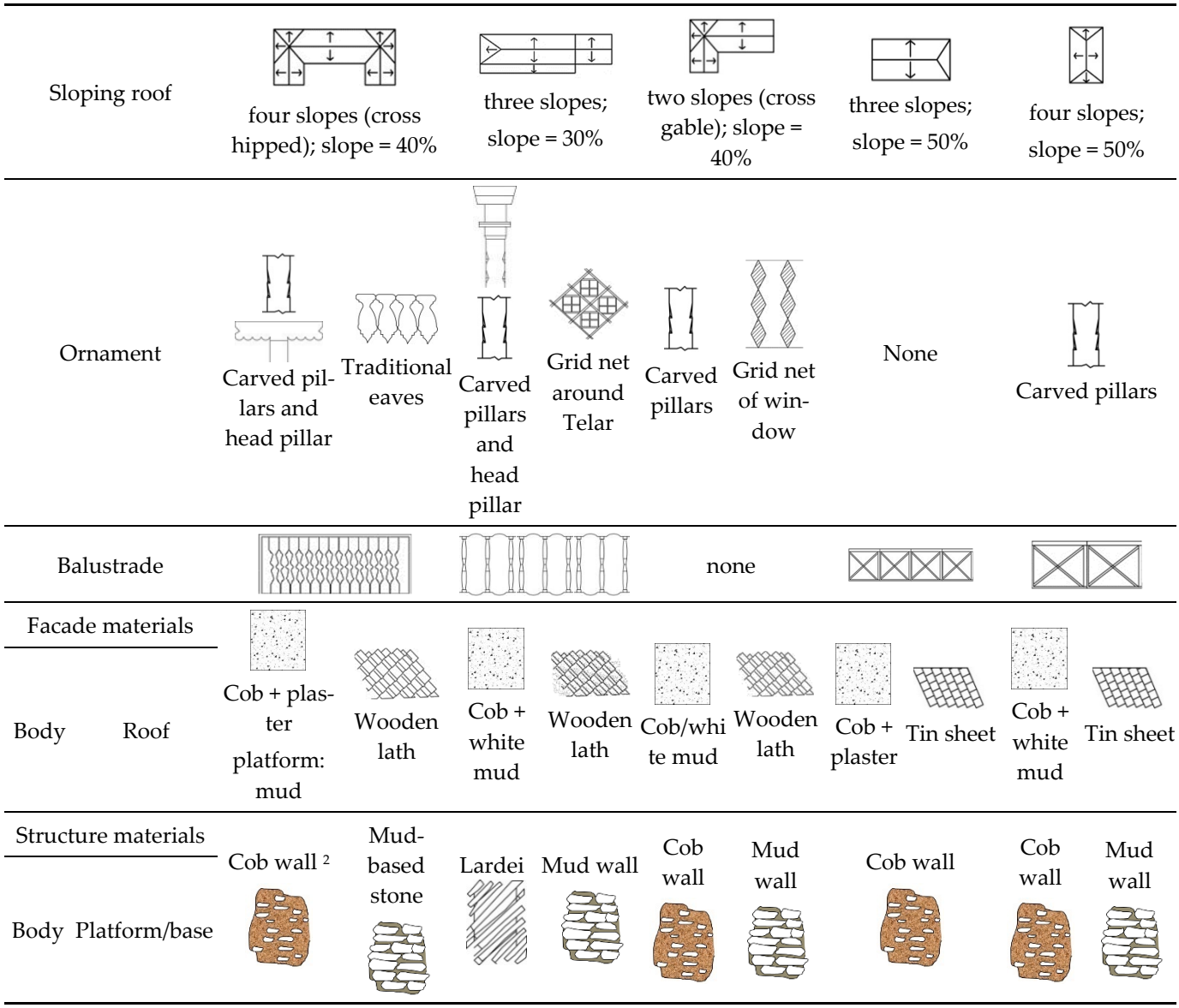


Figure 7. Formal investigation of the main elements of rural houses' facades in Alasht, a mountainous city of Central Savadkouh. [1] Opening-to-facade ratio; [2] the main substances are stone, clay (mud), and straw.

3.3.2. Foothill Zone: Bourkhani and Naftechal of Lafour

In the villages of Bourkhani and Naftechal in Lafour, six houses with diverse typologies have been investigated (Figure 8). Due to the moderate slope of the land, one-story houses on a high platform is common in this area. Porch typologies are predominantly two-sided (L type) and three-sided (U type), with side porches often serving as Telar. The ratio of openings to the entire wall is approximately 20%. The doors are mostly wooden with double casements, and the windows are wooden with double and triple casements. Regarding facade proportions, the length-to-width ratios vary from approximately 2.5 to 4. The sloping roofs of the houses predominantly have four slopes (hip roofs), with a slope ranging from 30% to 40%. The facades generally lack special ornaments. Most houses feature wooden balustrades, with Bourkhani employing simple thin board balustrades, while Naftechal favors the more common X-shaped ones. The materials used for the houses are often cob with mud coating, mostly following the 'Kal-be-kal' structure. In Naftechal, a combination of 'Lardei' and 'Kal-be-kal' structures is

more prevalent. Thatched roofs were used in the past, but nowadays, during the renovation process, most roofs are replaced with tin.

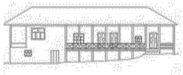
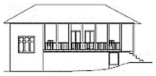
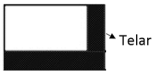
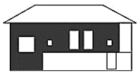
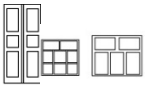
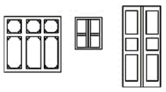
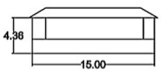
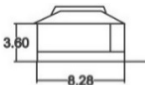
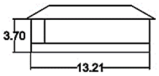
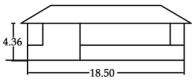
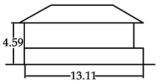
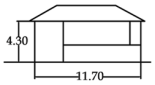
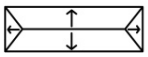
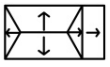
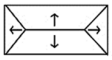
	Bourkhani Village			**Naftechal Village**		
	1	**2**	**3**	**4**	**5**	**6**
Owner	Mr. Amiri	Mr. Darvish Ali Amiri	Mr. Ahmadi	Mr. Gholami	Mr. Masoudi	Mr. Shabani
Time period	Pahlavi II	Pahlavi II (house with renovation)	Early Islamic Revolution	Pahlavi II	Pahlavi II	Pahlavi II (house with renovation)
House image						
Main facade	 one-story on high platform	 one-story on platform	 one-story on platform	 one-story on high platform	 two-story	 one-story on high platform
Porch pattern	 three-sided (U type)	 two-sided (L type)	 two-sided (L type)	 three-sided (U type)	 two-sided (L type)	 two-sided (L type)
Openings	 OFR = 18%	 OFR = 22%	 OFR = 20%	 OFR = 18%	 OFR = 16%	 OFR = 18%
	 wooden double and triple casement	 wooden casement	 wooden double casement	 wooden double and triple casement	 wooden double casement	 wooden double and triple casement
Facade proportion	 $\frac{\text{Length}}{\text{width}} = 4.2$	 $\frac{\text{Length}}{\text{width}} = 2.7$	 $\frac{\text{Length}}{\text{width}} = 2.8$	 $\frac{\text{Length}}{\text{width}} = 4$	 $\frac{\text{Length}}{\text{width}} = 2.8$	 $\frac{\text{Length}}{\text{width}} = 2.7$
Sloping roof	 four slopes; slope = 40%	 four slopes; slope = 40%	 four slopes; slope = 30%	 four slopes; slope = 30%	four slopes; slope = 30%	four slopes; slope = 40%
Ornament	none	none	none	none	none	none
Balustrade		none				
Facade materials						

Figure 8. *Cont.*

body	roof	Thatch	Thatch	Tin sheet	Tin sheet	Thatch	Tin sheet
		Cob + white mud	Cob + white mud	Cob + plaster	Cob + white mud	Cob + white mud	Cob + plaster
Structure		Kal-be-Kal	Kal-be-Kal	Kal-be-Kal	1: Kal-be-Kal 2: Lardei	Kal-be-Kal	1: Kal-be-Kal 2: Lardei

Figure 8. Formal investigation of the main elements of rural house facades in Bourkhani and Naftechal.

3.3.3. Plain Zone: Reikandeh and Kutena of Qaemshahr

In the villages of Reikandeh and Kutena, five historical houses with diverse typologies were investigated (Figure 9). This area features two types of one-story and two-story houses on platforms. Porch typologies vary, ranging from two- to four-sided, with occasional instances of one-sided porches, where the side or back porches are utilized as Telar. The ratio of openings to the entire wall is approximately 20–40%. Doors are predominantly wooden with double casements, and windows are wooden with double and triple casements.

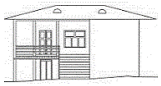
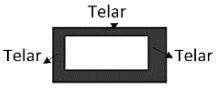
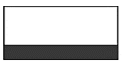
	Reikande Village			**Kutena Village**	
	1	**2**	**3**	**4**	**5**
Owner	Mr. Barari	Mr. Samadi	Mr. Gholami	Mr. Akbari	Mr. Azizi
Time period	Pahlavi II	Pahlavi II	Early Islamic Revolution (house with renovation)	Ghajar (house with renovation)	Ghajar (house with renovation)
House image					
Main facade	 two-story	 half two-story	 one-story on platform	 one-story on platform	 one-story on platform
Porch pattern	 four-sided	 two-sided (L type)	 two-sided (L type)	 one-sided	 four-sided

Figure 9. *Cont.*

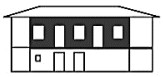
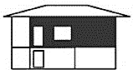
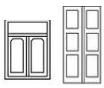
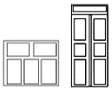
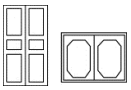
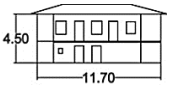
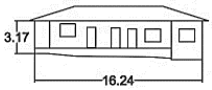
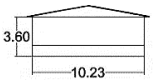
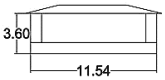
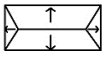
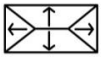
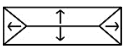
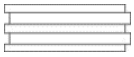
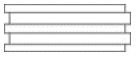
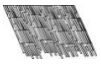
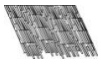
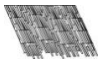
	 OFR = 34%	 OFR = 20%	 OFR = 24%	 OFR = 21%	 OFR = 37%
Openings	 wooden double casement	 wooden double and triple casement	 wooden double and triple casement	 wooden double casement	wooden double and triple casement
Facade proportion	 $\frac{\text{Length}}{\text{width}} = 2.6$	 $\frac{\text{Length}}{\text{width}} = 2.2$	 $\frac{\text{Length}}{\text{width}} = 5$	 $\frac{\text{Length}}{\text{width}} = 2.8$	 $\mathbf{\frac{Length}{width} = 3}$
Sloping roof	 four slopes; slope = 20%	 four slopes; slope = 15%	 four slopes; slope = 15%	 two slopes; slope = 10%	 four slopes; slope = 15%
Facade Ornament	none	none	none	none	 curved head pillar
Balustrade			none	none	none
Facade materials	 	 	 	 	 
body roof	cob coat	thatch	cob coat	tin sheet	cob coat	tin sheet	Cob coat	thatch	cob coat	thatch

Figure 9. Formal investigation of the main elements of rural houses facades in Reikandeh and Kutena, two villages of the foothill zone in Qaemshahr.

Regarding facade proportions, the length-to-width ratios range from approximately 2.5 to 3; in some cases, they reach up to 5. The sloping roofs of the houses are mostly hip roofs (four slopes), with a few cases featuring gable roofs (two slopes) at slopes between 10% and 20%. Generally, the facades lack special ornamentation. Only two-story houses exhibit a wooden balustrade shaped as simple and thin boards. Houses typically have cob walls with wooden ceilings. Thatched roofs were used in the past, but most roofs have undergone renovation with tin sheets.

4. Discussion

4.1. General Pattern

In the mountainous rural area, the steep slopes dictate the architectural patterns, with most houses featuring either two stories or one story on a high platform. Many of these houses have a barn or corral in their lower floors. In the foothill villages, only a few houses have two floors, and the majority are one-story structures based on a high platform or colonnade. Some homes in this region designate the lower part for birds, while in areas with steeper slopes, it is used for keeping livestock.

In the plain villages, both one-story houses on a short platform and two-story houses are observed. In the one-story houses, the low slope and the short height of the platform limit the possibility of keeping animals. However, in two-story or one-and-a-half-story houses with an L-shaped residential facade, the lower spaces remain empty and are often used as a corral and/or barn.

4.2. Porch Pattern

In the mountainous zone, the porch pattern, excluding aristocratic houses, typically features a one-sided design on the southern front. In the foothill and plain areas, however, porches are often two-sided (L-shape) or three-sided (U-shape), as shown in Figure 10. In plains, four-sided (rectangular) porches are also observed. Our investigations reveal that in the foothill and plain regions, the entrance porches serve a distinct purpose compared to the east and west ones, known as 'Kal Telar' or 'Telar.' In some cases, these porches are enclosed by wooden grids, positioned in the shaded section of the house, and they are used for resting and housework, with wooden flooring being common.

Plain Zone			**Foothill Zone**		**Mountainous Zone**
					
two-sided (L shape)	three-sided (U shape)	four-sided	two-sided (L shape)	three-sided (U shape)	one-sided

Figure 10. Porch patterns in three different zones.

4.3. Openings

In the mountainous zone, with the exception of the aristocratic houses, the average opening-to-facade ratio is about 15%. In these zones, reducing the number of openings and their dimensions is a climate solution to reduce heat transfer with the surrounding environment in cold winters. This ratio increases in the foothill zone and reaches an average of 20%. In the plain zone, increasing the level of openings up to 40% is a climatic strategy for natural ventilation and preventing moisture accumulation indoors (Figure 11). In all three zones, the doors are mostly wooden, with single and double casements with rectangular inscriptions. The windows are often wooden, with double and triple casements. In mountainous zones, the doors are sometimes completely wooden and without glass.

Plain Zone	**Foothill Zone**	**Mountainous Zone**
		
Ave OFR = 30%	Ave OFR = 18%	Ave OFR = 15%

Figure 11. Opening patterns in three different zones.

4.4. Facade Proportion

Regarding the facade proportions in these three zones, it is noteworthy that the proportions exhibit significant differences, making specific comparisons challenging (Figure 12). Generally, the length-to-width ratio of facades varies from 1 to 4 in the mountainous zones, from 2.5 to 4 in the foothill zone, and from 2.5 to 3 in the plain zones, with some cases reaching up to 5. In the mountainous zone, characterized by steep slopes, most houses have two floors, resulting in these facades having the lowest length-to-width ratios.

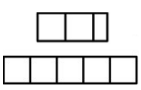
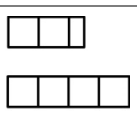
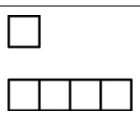
Plain Zone	**Foothill Zone**	**Mountainous Zone**
		
$\frac{\text{Length}}{\text{width}} = 2.5 - 3$ to 5	$\frac{\text{Length}}{\text{width}} = 2.5 - 4$	$\mathbf{\frac{Length}{width} = 1 - 4}$

Figure 12. Facade proportions in three different zones.

4.5. Sloping Roof

The roofs of the studied historical rural houses in all three zones typically feature four slopes. However, three-sloped roofs are also observed in mountainous villages, and two-sloped roofs are common in plain villages. The slope of the roofs varies across all three zones, with an increase from plain to mountainous areas, primarily due to higher wind intensity and precipitation. Survey data from village houses indicate that in plain zones, roof slopes range from 10% to 20%; in foothill zones, they range from 30% to 40%, and in mountainous zones, they exceed 40% (Figure 13).

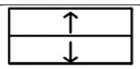
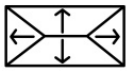
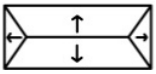
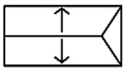
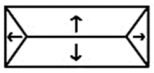
Plain Zone		**Foothill Zone**	**Mountainous Zone**	
				
Gable roof (two slopes)	Hip roof (four slopes)	Hip roof (four slopes)	Three slopes	Hip roof (four slopes)
Slope = 10–20%		Slope = 30–40%	Slope > 40%	

Figure 13. Sloping roofs in three different zones.

4.6. Facade Ornaments

Rural houses in the plain and foothill villages generally do not have any special ornaments in their exterior facades. In some cases, there are some X-shaped balustrades and simple inscriptions on the doors and windows, which slightly adorn the exterior of the house. In the mountainous zone, the facade ornaments are in the form of carved pillars or wooden grids. However, in the aristocratic houses of the Qajar period, especially in the mountainous zone of Alasht, more detailed ornaments are seen in the shape of woodcarving inscriptions, carved pillar heads, and various balustrades (Figure 14).

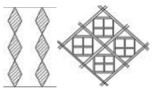
Plain Zone	**Foothill Zone**	**Mountainous Zone**	
Nothing special: X-shaped balustrade/simple inscriptions on doors and windows	Nothing special: X-shaped balustrade/simple inscriptions on doors and windows	 Wooden grids	 Carved pillars
		Different balustrades/inscriptions on doors and windows	

Figure 14. Facade ornaments in three different zones.

4.7. Balustrade Pattern

In the foothill and mountainous villages, excluding a few one-story houses with short platforms, most houses feature wooden balustrades. In the mountainous houses of Alasht, X-shaped balustrades are common, while in the foothill villages of Lafour (Bourkhani and Naftechal), both simple thin boards and X-shaped balustrades can be observed (with wooden lath types being common in the village of Bourkhani). Aristocratic houses often showcase balustrades with special designs. In the surveyed plain villages, due to the low height of the platform, balustrades are primarily observed in two-story houses, often taking the form of simple thin boards (Figure 15).

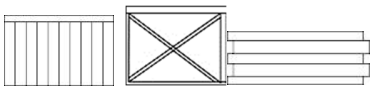
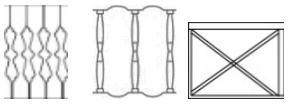
Coastal—Plain Zone	Foothill Zone	Mountainous Zone
 Simple thin board	 X-shaped and simple thin board	 Wooden X-shaped/wooden special design in aristocratic houses

Figure 15. Balustrade patterns in three different zones.

4.8. Materials and Structure

In the mountainous village (Alasht), the prevalent structure is cob walls with stone foundations and, in a few cases, Lardei. As already mentioned, because of the abundance of stone in this zone, using stone in combination with clay is common. In the foothill villages of Lafour, the predominant structure is mostly wooden Kal-be-kal or Lardei, which is filled with cob mortars. The Lardei part is usually extended to the ground level and includes the guest room. In the plain villages, the surveyed houses have cob structures. In all villages, most of the facades of historical houses are covered with cob and white mud; however, following renovation, they have been covered with plaster. In mountainous villages with strong winds, roofs are covered with wooden lath, and in the mountainous areas with milder winds, such as Alasht, they are covered with wooden lath. In the foothill and plain zones, where prevention against penetration is important, sloping roofs are covered with thatch. It should be mentioned that the roofs of these historical houses have been replaced with tin sheets, except for the ones that were constructed in the late Pahlavi period (1960s) (Figure 16).

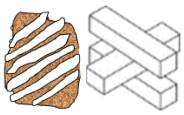
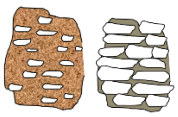
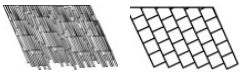
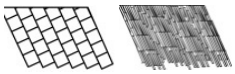
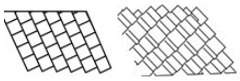
Coastal—Plain Zone	Foothill Zone	Mountainous Zone
 Cob wall	 Lardei Kal-be-Kal	 Cob wall Mud-based stone
 Thatch Tin sheet	 Thatch Tin sheet	 Tin sheet Wooden lath

Figure 16. Materials and structures used in three different zones.

5. Conclusions

The construction of incompatible houses in rural areas, inappropriate additions to historic houses, and the inappropriate reuse of them, without considering their inherent value, pose a problem that this research aimed to address. The primary objective of this paper was to emphasize the significance of conducting an analysis of built environments as the primary step toward their reuse and renovation or even in the design of new constructions next to them. In this study, a formal approach was used to critically analyze the main architectural elements of the facades of sixteen historical rural houses representing common typologies in three climatic zones—mountainous, foothill, and plain zones—in the eastern part of Mazandaran Province. The results serve as a tangible foundation for architects engaged in either constructing new buildings or planning interventions for existing historical rural buildings in this region. Additionally, this study outlines the necessary methodology for the analysis step preceding interventions in rural areas.

The results of the analysis of the main facade elements from the studied cases indicated a direct relationship between the number of floors, the height of the platform, and the land

slope, considering the climatic conditions of the zones. Generally, all houses in these zones maintained a specific distance from the ground to prevent moisture penetration. In the mountainous zone, porches typically adopted a one-sided pattern, whereas in the foothill and plain zones, they were often two-sided (L-shape) or three-sided (U-shape). In the plain zones, four-sided (rectangular) porches were also observed, indicating a demand for ventilation.

No specific principle was observed regarding facade proportions, but the lowest ratio belongs to houses in the mountainous zone, while the highest belongs to houses in the plain zone villages. In the higher zones, the opening-to-facade ratio (OFR) decreased from an average of 30% to 15%. In all three zones, doors and windows were mostly wooden with double and triple casements, along with rectangular inscriptions. Houses in the plain zones often had larger windows to facilitate ventilation.

Most houses had four-sloped roofs, and in a few cases, they had two or three slopes. The slope of the roofs increased from the lower plain zones to the mountainous zone, ranging from 10% to 50% and more. Facade ornaments were more commonly observed in mountainous houses than in the foothill and plain zones. In mountainous houses (Alasht), X-shaped balustrades are prevalent, while in Lafour foothill villages, both simple thin boards and X-shaped balustrades are common. In plain villages, simple, thin boards are typical.

Regarding materials, the mountainous zone structures consisted mostly of cob walls with stone foundations. In the foothill zone, the structure is primarily wooden, either 'Kal-be-kal' (timber frame) or a combination of 'Kal-be-kal' and 'Lardei' (adobe) filled with cob mortar. In the plain zone, cob walls were also common in the historical rural houses. Thatched roofs were common in the plain and foothill historical rural houses, while lath roofs were more prevalent in the mountainous ones, mainly due to the differences in climatic conditions across these three zones.

The analysis of the exterior facades of houses in these zones is crucial for planning interventions in these rural areas. Emphasizing the importance of analyzing the existing built environment and heritage as the primary step, further research is needed to validate this methodology in other villages to document heritage buildings before they become abandoned and/or ruined. While the current research is comprehensive in that it covers four climatic zones in Mazandaran Province of Iran, acting as a solid foundation of information, it is necessary to consider the plans of houses and how they are connected with the facades, as well as how they are influenced by other climatic conditions in the regions.

This study has several limitations that need to be acknowledged. Firstly, the methodology relied on case studies, which, while providing detailed insights, may not be representative of all rural areas in the selected regions, leading to potential risks of overgeneralization. The selection of sources was limited to specific types of historical rural houses within Mazandaran Province, which might not capture the full diversity of rural architecture in other regions. Additionally, the analysis focused predominantly on the architectural elements of facades, potentially overlooking other significant aspects, such as interior layouts and cultural significance, which could also influence the overall understanding of these buildings.

Moreover, the analysis process could be subject to biases, including the personal interpretations of the researchers and the inherent subjectivity in assessing architectural elements. The selection of architectural elements for analysis was based on the researchers' discretion, which means it may have introduced selection bias. Furthermore, external factors such as environmental changes and renovations over time could affect the current state of these buildings, making it challenging to ascertain original design intentions accurately.

Despite these limitations, this research provides valuable insights and a foundational methodology for future studies and interventions in rural architecture. However, it is essential for future research to address these limitations by incorporating a broader range of case studies, including different regions and building types, and considering a more comprehensive range of architectural and cultural elements.

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References

1. Demolition of Historical Rural Houses of Alasht. 2013. Available online: https://www.isna.ir/news/92060100092/%D8%AA%D8%AE%D8%B1%DB%8C%D8%A8-%D8%AE%D8%A7%D9%86%D9%87-%D9%87%D8%A7%DB%8C-%D8%AA%D8%A7%D8%B1%DB%8C%D8%AE%DB%8C-%D8%A2%D9%84%D8%A7%D8%B4%D8%AA (accessed on 25 June 2024).
2. Gharakhlou, M.; Khalilabad, H.K.; Eskandari node, M. Study on Transformation in Structural and Architectural Construction of Village and Formation of Rural-Towns. *Hum. Geogr. Res.* **2008**, *41*, 53–70.
3. Alalhesabi, M. Necessity of a new approach in rural development and construction. *J. Hous. Rural Environ. (Hous. Revolut.)* **2002**, 14–23.
4. Arfa, F.H.; Pottgiesser, U. *Roundtable VII: Time and Unlisted Heritage*; TU Delft Open: Delft, The Netherlands, 2021.
5. Delfanian, H.; Khakzand, M.; Kamyabi, S. Identifying the Relationship between Vernacular Architecture & Climate through Studying Thermal Comfort Indicators in Nowshahr City. *Arman. Archit. Urban Dev.* **2019**, *11*, 69–79.
6. Posht, A.R.; Daneshjoo, K.; Mofidi-Shemirani, S.-M. Balcony Effect on Thermal Performance of the Building and Its Climate Assessment in Local Houses in Mazandaran Province. *J. Comput. Theor. Nanosci.* **2019**, *16*, 5265–5276. [CrossRef]
7. Yousefniapasha, M.; Teeling, C.; Rollo, J.; Bunt, D. Shape grammar, culture, and generation of vernacular houses (a practice on the villages adjacent to rice fields of Mazandaran, in the north of Iran). *Environ. Plan. B Urban Anal. City Sci.* **2019**, *48*, 94–114. [CrossRef]
8. Arfa, F.H. Adaptive Reuse of Heritage Buildings: From a Literature Review to a Model of Practice. *Hist. Environ. Policy Pract.* **2022**, *3*, 148–170. [CrossRef]
9. Arfa, F.H.; Quist, W.; Lubelli, B.; Zijlstra, H. Architects' Methodology in Adaptive Reuse of Heritage Buildings. In *As Found International Colloquium on Adaptive Reuse*; Augustiniok, N., Ed.; Hasselt University: Hasselt, Belgium, 2023; pp. 134–135.
10. Arfa, F.H.; Lubelli, B.; Quist, W.; Zijlstra, H. A model of the adaptive reuse process of heritage buildings: Validation on four cases in the Netherlands. *Des. Stud.* **2024**, *91–92*, 101252. [CrossRef]
11. Misirlisoy, D.; Günçe, K. Adaptive reuse strategies for heritage buildings: A holistic approach. *Sustain. Cities Soc.* **2016**, *26*, 91–98. [CrossRef]
12. Arfa, F.H.; Lubelli, B.; Zijlstra, H.; Quist, W. Criteria of 'Effectiveness' and Related Aspects in Adaptive Reuse Projects of Heritage Buildings. *Sustainability* **2022**, *14*, 1251. [CrossRef]
13. Aita, D.; Barsotti, R.; Bennati, S. Studying the dome of pisa cathedral via a modern reinterpretation of durand-claye's method. *J. Mech. Mater. Struct.* **2019**, *14*, 603–619. [CrossRef]
14. Memarian, G. *Introduction to Iranian Residential Architecture: Extroverted Typology*; Soroush Danesh Cultural Institute: Tehran, Iran, 2008.
15. Chebaiki, L.; Chemrouk, N.C. *Moorish Architectural Syntax and the Reference to Nature: A Case Study of Algiers*; WIT Transactions on the Built Environment: Cambridge, MA, USA, 2014.
16. Steadman, P. *The Evolution of Designs: Biological Analogy in Architecture and the Applied Arts*; Routledge: London, UK, 2008.
17. Memarian, G. *A Look at the Theoretical Foundations of Architecture*; Soroush Danesh Publications: Tehran, Iran, 2005.
18. General Department of Information Statistics of the Agriculture Ministry. *Atlas of Land Use and Coverage of Mazandaran Province Using Satellite Information Scale 1: 200,000*; Ministry of Agriculture Publications: Tehran, Iran, 1997.
19. Statistical Center of Iran. *Country Statistical Yearbook of 1385*; Information Office and Statistical Database: Tehran, Iran, 2007.
20. Mazandaran Province's Management and Planning Organization. *The Study Program of Mazandaran Province: A Study of Situation and Structure Analysis*; Mazandaran Province's Management and Planning Organization: Danesh, Iran, 2005; pp. 1–135.
21. Bahrani, M.H. *In the Realm of Mazandaran: Article Series of Climate, Human and Activities in Mazandaran Province (the Language of Statistics)*; Babel Publication: Naghsh-e-Jahan, Iran, 1966; Volume 1.
22. Tahbaz, M.; Djalilian, S. Compatibility indicators with climate in rural housing of gilan province. *Hous. Rural Environ.* **2011**, *30*, 23–42.
23. Raheb, G. Typology of housing formation zones in rural settlements of Iran in interaction with environmental factors. *J. Fine Arts Archit. Urban Plan.* **2014**, *19*, 87–100.
24. Sartipipour, M. Architecture of native folk houses in the villages of Markazi province. *Phys. Dev. Plan. Q.* **2013**, *1*, 25–36.

25. Mahlabani, Y.G.; Daneshvar, K. Impact of climate on the principles of Gilan traditional architecture. *J. Arman.* **2010**, *3*, 135–145.
26. Zargar, A.H.E. *An Introduction to Understanding Rural Architecture in Iran*; Shahid Beheshti University Publishing Center: Tehran, Iran, 2011.
27. Sartipipour, M. *Pathology of Rural Architecture to the Desired Settlement*; Islamic Revolution Housing Foundation and Shahid Beheshti University: Tehran, Iran, 2009.
28. Sartipipour, M. Housing architecture in Iranian villages. *J. Hous. Rural Environ. (Hous. Revolut.)* **2007**, *119*, 2–15.
29. Pirzad, A.; Riyahimoghadam, S. Investigating the relationship between localism in rural architecture and rural economy in the central areas of Mazandaran and central areas of Yazd. *Two Res. Q. J. Nativ Art Stud.* **2014**, *2*, 43–62.

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