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Original Research Article

Identifying Tectonic Components in the Architecture of Rural Houses in the Eastern Region of Gīlān*

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Abstract

Problem statement: Tectonics in architecture contributes to maintaining a stable balance between natural capacities (e.g. topography, soil, hazards) and cultural-climatic requirements (e.g.vernacular materials, structural structures, and artistic expression). However, the accelerated development of urbanization and climate change in the eastern region of Gīlān have upset this long-term balance and caused two fundamental challenges: 1) Substitution of ecosystem-incompatible construction materials; 2) annihilation of architectural identity rooted in culture and climate. These challenges not only threaten structural sustainability but also accelerate the disconnection from traditional knowledge of human-nature symbiosis. Therefore, identifying the tectonic components that affect climatic adaptability and cultural authenticity is an essential step to reestablish this balance and protect the architectural heritage of the region.

Research objective: This research attempts to identify the tectonic components influencing the architecture of rural houses in eastern Gīlān and to examine how their interactions preserve the identity of local architecture. This study seeks to answer these questions: What are the tectonic components affecting the rural architecture of the eastern Gīlān region? What are the spatial relationships of the buildings to each other? And what materials are used in the rural space of this region?

Research method: The research is descriptive-analytical employing field data and literature review to analyze the buildings.

Conclusion: The research results show that physical and semantic components play a synergistic role in the architectural tectonics of houses in the eastern region of Gīlān. In terms of physical components, the extensive use of local materials such as wood, kahgel (a mixture of mud and straw), and stone has created structures that withstand moisture and climate change, which ensures both environmental sustainability and economic benefits. Architectural forms, including sloping roofs, insulated walls, and open spaces of verandas, have been designed to optimize environmental conditions facilitating natural ventilation, creating spatial harmony, and maintaining continuity with nature. Increasing efficiency in terms of semantic components, architectural forms, and details act as cultural and social symbols and strengthen local identity.

Keywords: *Architecture, Eastern Region of Gīlān, Rural Houses, Tectonics.*

Introduction and Statement of the Problem

Architecture in Iran, as one of the most eminent representatives of culture and art, is a symbol of the rich history and civilization of this land. This art has taken on different forms under the influence of climatic and cultural diversity since the distant past (Behnam, 2024). In this regard, vernacular architecture, as an identity indicator, plays a key role in the continuity of regional

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culture and traditions (Cogato et al., 2023). Vernacular architecture is specifically shaped in villages and embraces unique values such as adaptation to the climate, the use of local materials, and an emphasis on harmony with the natural environment. This type of architecture, in addition to aesthetics, is a symbol of the social and economic life of the people of the region (Pratiwi et al., 2023).

However, in recent years, the villages of eastern Gīlān have faced numerous challenges in the terms of construction of vernacular architecture buildings. Urbanization, climate change, and indifference to traditional architectural principles have led to a decline in the identity and values of vernacular architecture in these regions (Azhdari, 2021). For this reason, it seems necessary to identify and analyze the components that affect these challenges.

Tectonics in architecture refers to examining the effects of the earth's structure and geographical features on the design and construction of buildings (Waheed et al., 2025). This concept includes variables such as geology, soil type, topography, and natural hazards that can affect the stability and durability of buildings (Beim, 2023). Tectonics is not only related to the physical structure and the way architectural elements are connected and combined but also includes the artistic expression of materials, where materials speak their language and shape the identity and personality of the building. Tectonics is also a reflection of the culture, beliefs, and technologies of each era, through which architecture can express social and historical values (Frampton, 1998, 75).

The rural vernacular architecture of the eastern Gīlān, as one of the prominent manifestations of human interactions with nature, has been influenced by tectonic components formed in the geographical, climatic, and cultural context of this region. Despite numerous studies in the field of architectural tectonics, previous research has focused on the technical and scientific aspects of these components (e.g. structural resistance, optimization of materials, and implementation techniques). However, the role of tectonics in reflecting cultural identity, addressing social needs, and adapting to the climatic requirements of local communities has received less attention. The scarcity of knowledge has caused the semantic and cultural dimensions of tectonics in vernacular architecture to be forgotten, especially in the rural areas of the eastern region of Gīlān while such dimensions are inseparable parts of the intangible heritage of this area. The present study aims to identify and analyze the tectonic components that affect the architecture of rural houses in the eastern region of Gīlān. This study adopts a descriptive-analytical approach to answer this main question: "What are the influential components of tectonics in the rural architecture of the eastern region of Gīlān?" The significance of this study lies in revealing the dynamic relationship between tectonics and the bio-cultural requirements of local communities to provide a theoretical framework for a deeper analysis of vernacular architecture. The results of this research can be a step towards documenting the vernacular knowledge of local builders. By emphasizing the meaning-making dimensions of tectonics, this study serves as a basis for future studies on protecting this architectural heritage based on the understanding that is compatible with the cultural values of the region.

Research Objectives

To identify the influential tectonic components in the rural architecture of the eastern region of Gīlān.

The secondary objectives of this research are:

To identify the influential values contributing to the construction and architectural structure of the buildings under study.

To examine the spatial relationship of the buildings with each other and to identify the materials and equipment used in the rural space of the eastern region of Gīlān.

Research Questions

1. What are the influential tectonic components in the rural architecture of the eastern region of Gīlān?
2. What are influential values contributing to the construction and architectural structure of the buildings under study?
3. What materials and equipment are used in the rural space of the eastern region of Gīlān and what is the spatial relationship between the buildings in this village?

Literature Review

Table 1 presents the literature review on tectonic

components in the vernacular architecture of the eastern villages of Gīlān in the last 10 years in Iran and international contexts. Recent research on tectonics and vernacular architecture of the eastern region of Gīlān shows that tectonic components significantly influence architectural design and structures. These studies have examined how form and space, technology, and spatial functions interact with traditional construction methods.

Table 1. Literature on tectonic components in the vernacular architecture of eastern Gīlān villages. Source: Authors.

Author - Year	Research Title	Objective	Research Method	Result
Yazdani et al. (2023)	Pace tectonics role in building forms: improving the relationship between buildings and sites of cultural buildings 1978 - 2020	Studying the effect of spatial tectonics on the forms of cultural buildings	Field and qualitative analysis	There is no significant linear relationship between space tectonics and physical form in any of the periods.
Siyadati et al. (2023)	A study of tectonics in digital architecture and its impact on design and construction	It is an examination of the relationship between tectonics and digital architecture and an analysis of its impact on design and construction.	Analytical-comparative and different theories in the field of tectonics and actotonic in digital architecture	Digital architecture, with its concepts of tectonics and actotonic, has created a new language of design that highlights the impact of technologies and materials on the understanding of architecture.
Alizadeh et al. (2023)	Features of vernacular architecture in residential buildings in Gīlān province (Case study: Volni village in Rudsar city).	Investigating the characteristics of vernacular architecture and their relationship with the environment and residents	Descriptive and survey analysis (study of 5 vernacular houses)	The vernacular houses of the village of Volni are designed based on climatic characteristics and serve as a suitable model for vernacular architectural design.
Pourmohammadi et al. (2021)	Tectonics in Architecture: Dual nature of tectonic relations in works of contemporary iranian architecture	Studying the compatibility of nuclear and artistic form in contemporary Iranian architectural works and analyzing the impact of tectonics on their unity	Applied research, descriptive-analytical, AHP analytical hierarchy process	The Senate Building is more successful in adapting artistic form and core than other works (Freedom, Museum of Contemporary Arts, City Theater) and demonstrates success in combining technical and conceptual aspects.
Anbari Roozbahani (2016)	Sustainable tectonics: Presenting a conceptual model in analyzing the form structure of environmentally compatible shells	Analyzing environmentally friendly structures and presentation of a conceptual model	Qualitative analysis	Conceptual models are presented to adapt the two macro concepts of sustainability and tectonics in architecture.
Afshari et al.(2020)	Qualitative analysis of contemporary Iranian public architecture buildings in the Second Pahlavi period	Analyzing contemporary Iranian architecture using a tectonic approach	Qualitative and field analysis	A deeper understanding of the tectonic characteristics of buildings has been gained.
Afshari et al. (2022)	Tectonic reading of public buildings of contemporary Iranian architecture in the first Pahlavi period	Tectonic study of public buildings of the first Pahlavi period	Qualitative analysis of historical documents	Exregioning tectonic features in historical samples.
Catherine et al. (2024)	Tectonic effects in vernacular architecture: The expansion of space in Tanean Lanjhang and Osing houses	Identifying and classifying spatial arrangement patterns in Tanian Lenjang and Osing vernacular houses.	Qualitative techniques	Identifying three spatial arrangement patterns in the case study: expansion in the middle, front, and back areas. Development of houses with the needs of residents
Yordanova (2019)	Structural-functional model of tectonics in architecture	Investigating various mechanical and spatial functions of tectonics	Qualitative analysis	Systematization, analysis of buildings, groups of buildings, and even styles in architecture affect the actual performance of the design.
Hematang & Ikaputra (2022)	Four aspects of architectural tectonics through exploration of the meaning of tectonics with a systematic literature review method.	Analysis of tectonic concepts and variables in architectural theory and its role in the art of construction and design.	Comparative analysis and literature review	Identifying tectonic influences on vernacular architecture and analyzing related concepts
Schwartz (2016)	Schwartz, C. (2019). Introducing architectural tectonics: Exploring the intersection of design and construction (2nd ed.). Routledge.	Exploring the relationship between design, construction, and meaning in architecture, providing a comprehensive classification for architectural tectonics	Literature review and analysis of architectural examples	Proposing a comprehensive and multifaceted definition of architectural tectonics creates a classification for analyzing and comparing architectural works from a tectonic perspective Highlighting the importance of tectonics in establishing the connection between form, structure, and meaning in architecture

The methods used in this study include field analyses, interviews with architects and residents, and qualitative data analysis.

A systematic review of architectural tectonics shows that research from the 1990s to the present has covered a variety of topics, such as the balance of form and function, spatial tectonics, and tectonics in digital architecture. However, the absence of a single theoretical framework has led to conceptual fragmentation and caused difficulty in critical interactions from the results. Most studies have adopted qualitative methods. Although enhancing the depth of understanding of local narratives, the generalizability, and reliability of the results remain limited and lack quantitative data or statistical tests. In addition, a small number of studies have conducted cross-sectional comparative studies to examine if tectonic components are independent or overlap. The majority have been carried out in a single context. The thematic evolution of this field indicates a gradual trend from structuralism and Physical ism to anthropocentric and environmental approaches. Fewer studies have paid attention to the direct role of users and local communities in the process of tectonic emergence. Also, many studies are limited to specific case studies, and comparative data between different regions are rarely seen. The main theoretical gap is the lack of sufficient attention to the simultaneous influence of variable and tectonic components on vernacular architecture in four main areas—physical, process, socio-cultural, and technological—in a coherent conceptual framework. These theoretical gaps provide new research opportunities to investigate the complex interactions among tectonic components and their effects on the vernacular culture and architecture of the regions. As a result, this study attempts to fill this gap and provide a comprehensive approach to examining the influence of tectonic components on vernacular architecture in the eastern region of Gīlān to improve the strength and sustainability of structures.

Literature Review

• Conceptualization of tectonics

The concept of "tectonics" in architecture refers to the study of the relationship between form, construction, materials, and spatial experiences. As a design language, this term stands for the harmony of architectural structure and form and examines their interrelationship (Frascari, 1984, 3). Also, tectonics refers to spatial experiences and their impact on human emotions and behavior in architectural spaces (Pallasmaa, 2009, 52). Tectonics in architecture, as a key concept, helps to understand the design and function of spaces better. In his book, "Studies in Tectonic Culture", Frampton defines tectonics as a dimension of architecture that is related to the physical structure and processes of construction. He emphasizes that tectonics is related to how architectural elements are connected and combined, that is, the mechanisms that give form to the structure, and architecture should clearly show its structural aspects. Tectonics in architecture, as a design process, refers to the relationship between structural and spatial elements and emphasizes the importance of analyzing this relationship in contemporary designs (Hartoonian, 2016, 6). Also, with technological advances, tectonics focuses on the use of new technologies and advanced materials to create beautiful and sustainable structures (Kim & Park, 2017, 35). Tectonics also emphasizes the study of cultural and social relationships in the design of buildings and cultural influences in architecture (Ghelichkhani, 2020, 109). Finally, this perspective addresses the impact of tectonic design on spatial and social interactions in urban environments.

• Tectonic components from the perspective of theorists

Theorists in the field of architectural tectonics from the 1980s to the present have highlighted a unique aspect: Frampton (1998) proposed the connection of physical structure with ideas of design and structural transparency. Eisenman (2012) examined geometric patterns in design; Pallasmaa (2017) emphasized the sensory dimension of space and human experience, and Florida (2018) emphasized the impact of design on social interactions. (Andersen, 2019), focused on the integration of new materials and technology, on innovation and sustainability of materials (Abo-Helall et al., 2022) on the re-creation of social spaces, and (Akgun et al., 2022)

on the creative and participatory process. Others, such as Hematang & Ikaputra (2022), have also shown the importance of sustainability and socio-cultural adaptation. Pioneer researchers such as Bötticher (1806–1889), Semper (1803–1879), and Sackler (1905–1988) also proposed discussions of ontology, the role of materials, and the emotional relationship of humans with buildings. In summary, the study of different periods shows that the components of tectonics are diverse and multifaceted with respect to theoretical and temporal developments. Finally, it can be concluded that theorists have considered different components for tectonics in different periods (see Table 2).

The following are components proposed by theorists (e.g. Frampton, 1998; Hurol, 2022; Pardo, 2023). These components can fall into four main components (i.e. physical, semantic, functional, and cultural). The physical components include the relationship between structure and materials, the selection of local materials, the examination of the physical properties of materials, the sense of place, and construction techniques because they affect the final quality of the structure. Construction

Table 2.Tectonic components and sub-components in architecture from the perspective of theorists. Source: Authors.

Theorist	Year	Component	Definition	Details
Eisenman	2012	Form and design process, the correlation of structure and idea	The form and process used in design, the connection between physical structure and design ideas	Using geometric patterns, designing aligned with human scales, emphasizing the creative design process, selecting materials appropriate to the form
Kuma	2012			
Gawlikowska	2013	Being in harmony with nature	Aligning the design with the natural environment for harmony	Using natural and local materials, designing architectural spaces while preserving the environment, interacting with the natural landscape
Kim & Park	2017	Spatial experience	Emphasis on human experience in architectural spaces	Designing spaces that inspire a sense of peace and comfort, paying attention to visual and sensory balance, and creating a special experience for users
Kassim & Nawawi	2018	Sensory dimension	Users' sensory experience of space	The impact of light, sound, and texture on the user experience, paying attention to the emotional and psychological sense of space, designing spaces that stimulate the senses and emotions
Florida	2018	Social relations	The impact of architecture on human interactions	Designing public spaces for social interactions, creating inviting and attractive spaces, emphasizing the importance of social spaces in modern societies
Andersen	2019	A balance between form and function, the interactions between materials and technology	Creating a balance between beauty and function, combining new materials and technologies	Using advanced technologies, designing based on social needs, paying attention to scale and proportions in design, selecting sustainable and environmentally friendly materials
Rathnayaka	2021	Social responsibility	Designing based on social and cultural needs	Interacting with the local community in the design process, Paying attention to the specific needs of different populations, creating spaces with a social purpose
Trubiano & Beim	2022	The boundary between inside and outside, the interaction of space	Exploring the boundaries of interior and exterior spaces	Designing spaces that create a sense of connection with the environment, using natural light and proper ventilation, creating spaces with a sense of freedom
Theodosso-poulos	2022	Interactions with light	Investigating the effect of light on architectural design	Using large windows and skylights, designing spaces that maximize natural light, paying attention to the play of light and shadow
Hematang & Ikaputra	2022	Sustainability and adaptability	Designing with an emphasis on sustainability and environmental impacts	Paying attention to renewable energies, designing spaces with minimal damage to the environment, using green technologies
Hensel	2023	Contemporary aesthetics	Investigating aesthetics in contemporary architecture	Using new forms and materials, designing artistic and cultural spaces, paying attention to aesthetic aspects in design
Mahmood, & Al-Alwan	2023	Cultural and social impacts	The role of architecture in shaping culture and social interactions	Designing spaces that are responsive to the local community, preserving cultural identity in design, interacting and discussing with the community in the design process

techniques also focus on the way structures are assembled and connected, and the use of modern and traditional methods defines architectural identity. Spatial relationships examine the balance between full and empty spaces, the effect of gravity on design, and the way movement is guided in space. Semantic components include materialism in architecture emphasizing the expressive use of materials, and the selection of sustainable and recyclable materials, diverse processing techniques, and attention to the appearance changes of materials over time are key components in this field. From a functional perspective, functional sustainability maximizes the efficiency of the structure by optimizing energy consumption through careful orientation of the building, the use of natural light and passive ventilation (as seen in Sarmast House), and spatial flexibility that allows the conversion of verandas to various uses. The integration of technology, although not yet common in traditional buildings in the region, allows for improved structural accuracy and durability by introducing digital construction and building information modeling (BIM) to document and improve traditional methods, and the use of climate-friendly techniques such as double-pitched roofs (e.g. Chencho House) and wooden gutters to manage rainfall. Meanwhile, innovation in materials strikes a balance between regulating internal temperature and resisting environmental changes by employing smart materials such as self-healing kahgel and heavy walls with high thermal capacity (e.g.Por Mehr House). Culturally speaking, tectonic elements reflect the connection of architecture with socio-local identity and nature. The cultural and environmental context, through symbolic forms of sloping roofs (e.g. Rafiei House) and vernacular techniques such as nailless wooden joints, narrates the history, agricultural culture, and coexistence with the environment. Social responsibility is reinforced in the participation of residents in construction (e.g. Shirjooposht Building) and the design of communal spaces such as central courtyards and expansive iwans (e.g. Abedini Building). Sustainability and adaptation to preserving the ecosystem are also reflected in the use of sustainable hardwoods (e.g. Sarmast House) and the integration of historical-authentic structures with contemporary needs (e.g.Chencho House). Finally, contemporary aesthetics, by balancing form and function—such as simple plans alongside delicate wood carvings (Por Mehr House)—and emphasizing a sense of place through the natural colors of the materials, create a visual identity that is in harmony with the green landscape of Gīlān. This composite framework ensures the physical function of the structure while reinforcing cultural identity and socio-environmental interaction.

Considering the information and perspectives presented by theorists in recent years, we arrive at a final classification of the components and sub-components of tectonics in architecture (see Table 3 and Fig. 1).

Table 3 and Fig. 1 analyze the impact of various components and subcomponents in architectural design. Based on the analysis, it can be seen that a successful design requires coordination and synergy of these components to create a balanced and meaningful space that responds to social and environmental needs.

Research Method

The research method is descriptive-analytical employing documentary and library studies with field observations. In the first step, the effective components of tectonics in the rural architecture of the eastern region of Gīlān were identified by reviewing

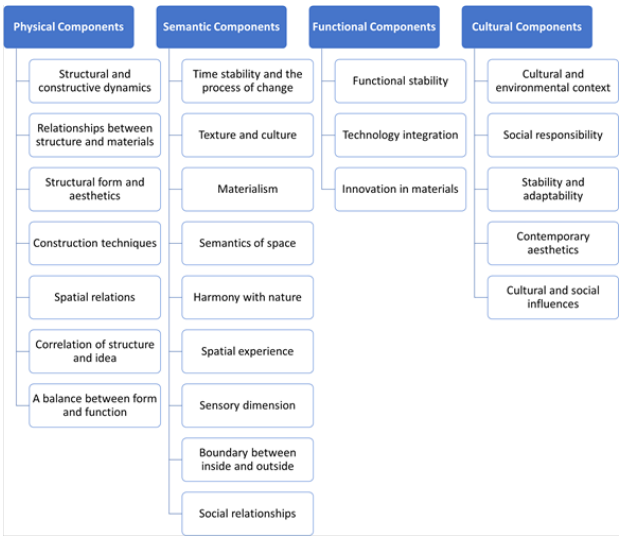


Fig. 1. Tectonic components and sub-components in vernacular architecture. Source: Authors.

Table 3. A Final classification of tectonic components and subcomponents. Source: Authors.

Category	Component	Sub-Component
Physical Components	Structural and Constructive Dynamics	Structural performance, flexibility, mobility and dynamics, interaction with the environment
	Relationship between Structure and Materials	Material selection, physical properties of materials, sense of place, construction techniques
	Formation and Structural Aesthetics	Visual language, balance between form and function, user experience, integration of history and modernity
	Construction techniques	Articulation and assembly, structural systems, invisible connections, traditional and modern construction techniques
	Spatial relationships	The role of gravity, light and shadow, negative space, movement in space, connection between interior and exterior space
	Correlation of Structure and Idea	Design based on structural principles, selection of materials appropriate to the form, transparency in structural elements
	Balance between Form and Function	Use of advanced technologies, design based on social needs, attention to scale and proportions
	Physical variables	Type and quality of materials, structural system and method of force transmission, construction process, and construction techniques
Semantic Components	Temporal Stability and the Process of Change	Environmental changes, maintenance management, experience of time, architectural evolution
	Texture and Culture	Cultural influences, integration with the environment, meaning and identity, local diversity
	Materialism	Material expression, sustainable use of materials, material hierarchy, material processing techniques
	Semantics of space	Emphasis on storytelling through space, the design of spaces as an embodiment of history and culture, and the use of forms as symbols.
	Integration with nature	Ontology, appearance and aesthetics, sense of place, expression of cultural identity, artistic aspects, technical and engineering knowledge, use of technology
	Spatial experience and interaction	Use of natural and local materials, design of architectural spaces that help preserve the environment, interaction with the natural landscape
	Sensory dimension	Designing spaces that inspire a sense of peace and comfort, paying attention to visual and sensory balance, creating a special experience for users - paying attention to the movements and traffic of people, creating a sense of continuity and interaction in space
	Borders between inside and outside	The impact of light, sound, and texture on the user experience, paying attention to the emotional and psychological sense of space
	Social relations	Designing spaces that create a sense of continuity with the environment, using natural light and proper ventilation, creating spaces with a sense of freedom
		Designing public spaces for social interactions, creating inviting and attractive spaces, emphasizing the importance of social spaces in modern societies
Functional Components	Functional sustainability	Energy efficiency, optimal use of resources, adapting to changes in use
	Integration of technology	Adaptive technologies, digital construction, Building Information Modeling (BIM), additive manufacturing
	Innovation in materials	Research and development of new materials such as smart concrete, designing flexible spaces with New techniques
Cultural Components	Cultural and environmental context	Cultural narratives, environmental sensitivity, vernacular tectonics, tectonics, and sustainability
	Social responsibility	Interacting with the local community in the design process, paying attention to the specific needs of different populations, creating spaces with a social purpose
	Sustainability and adaptability	Paying attention to renewable energies, designing spaces with minimal damage to the environment, using green technologies
	Cultural and social context	Designing spaces that are responsive to the local community, preserving cultural identity in design, interacting and talking with the community in the design process - creating public spaces that pay attention to culture and history
	Contemporary aesthetics	Using new forms and materials, designing artistic and cultural spaces, paying attention to aesthetic aspects in design

the literature and then the required theoretical framework was developed. Also, to analyze the research data, the effective components of tectonics in the construction and structure of rural houses in the eastern region of Gīlān were first analyzed. For this purpose, rural samples were randomly selected based on their dispersion to be sure that samples represent the entire study area in the rural part of the eastern region of Gīlān. Then, in the practical part, several villages in this area were visited and observed (maps, photography) and then their residents were interviewed. The interviewees were selected from people who had lived in the village for a long time and had sufficient information about this area. The qualitative coding method was used to analyze the data. The interviews continued until theoretical saturation was reached to ensure the adequacy of the data for analysis.

Data Analysis

Based on the analyses conducted in the research, we identified four main components of tectonics, including: (i.e. physical, semantic, cultural, and functional components), but in this part of the research, only two main components (i.e. physical and semantic) and their sub-components in rural houses in the eastern region of Gīlān were analyzed.

In Figs. 2 to 7, some buildings located in the village of Jolgeh Shargh Gīlān were examined based on two main tectonic components (physical-semantic components). The analysis of these buildings shows how the design of Gīlān structures, in addition to providing physical function, incorporates the semantic and cultural values of the region. All buildings attempt to maintain continuity with the environment in some way. From forms and materials to construction techniques, all reflect the lifestyle and local culture of Gīlān. These buildings also represent the deep interactions between architecture and the natural environment of the Gīlān region. Physical

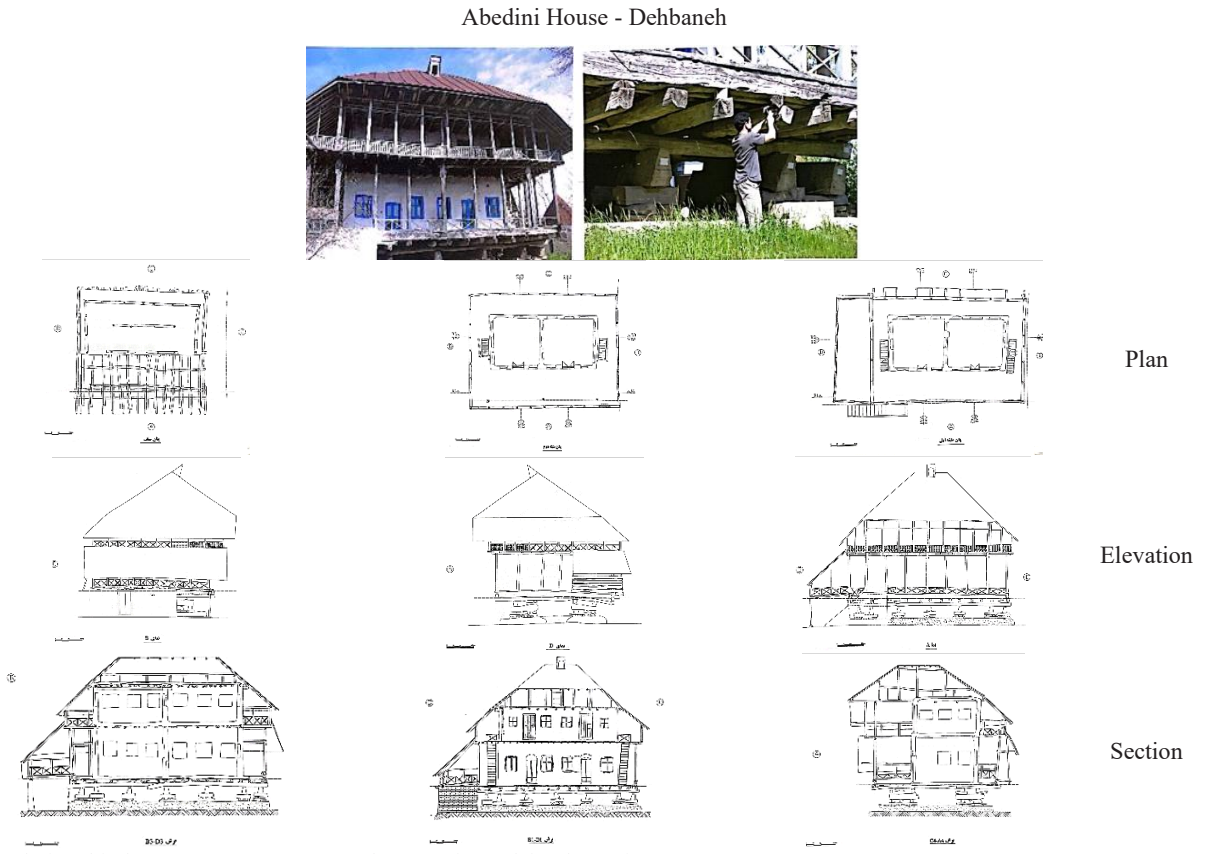
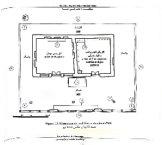
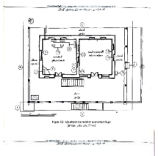
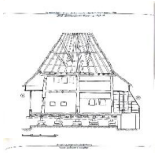
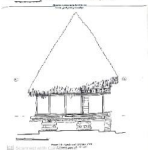
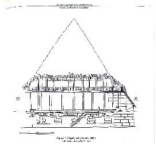


Fig.2. Tectonic analysis of Abedini House in the village of Shargh Gīlān. Source: Authors.

Rafiei House



Plan

Elevation

Section

The building is designed using tall wooden columns that prevent moisture from entering the ground. Its structure is dynamic and resistant to strong winds and rainfall. Traditional construction techniques such as wooden joints without nails or screws and the use of local materials ensure the flexibility and strength of the structure. Structural and structural dynamics: Use of a wooden column system and flexible foundation to deal with moisture. Construction techniques: Implementation of traditional techniques in beam and column connection with local skills. Structural form and aesthetics: Emphasis on a visual balance between roof and body.	Physical	Tectonic Components
This house is a symbol of the agricultural life of the region and reflects the cultural fabric of the region. By using natural materials such as wood, brick, etc. in its construction, this building strengthens the sense of belonging to the place for the local people who have become familiar with nature. Texture and Culture: Symbol of rural identity using local materials. Spatial Semantics: Combining functional spaces inspired by nature. Spatial Experience: Relaxing space with the influence of light and texture.	Semantic	

Fig.3. Tectonic analysis of Rafiei house in the village of Shargh Gīlān. Source: Authors.

Chencho

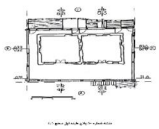
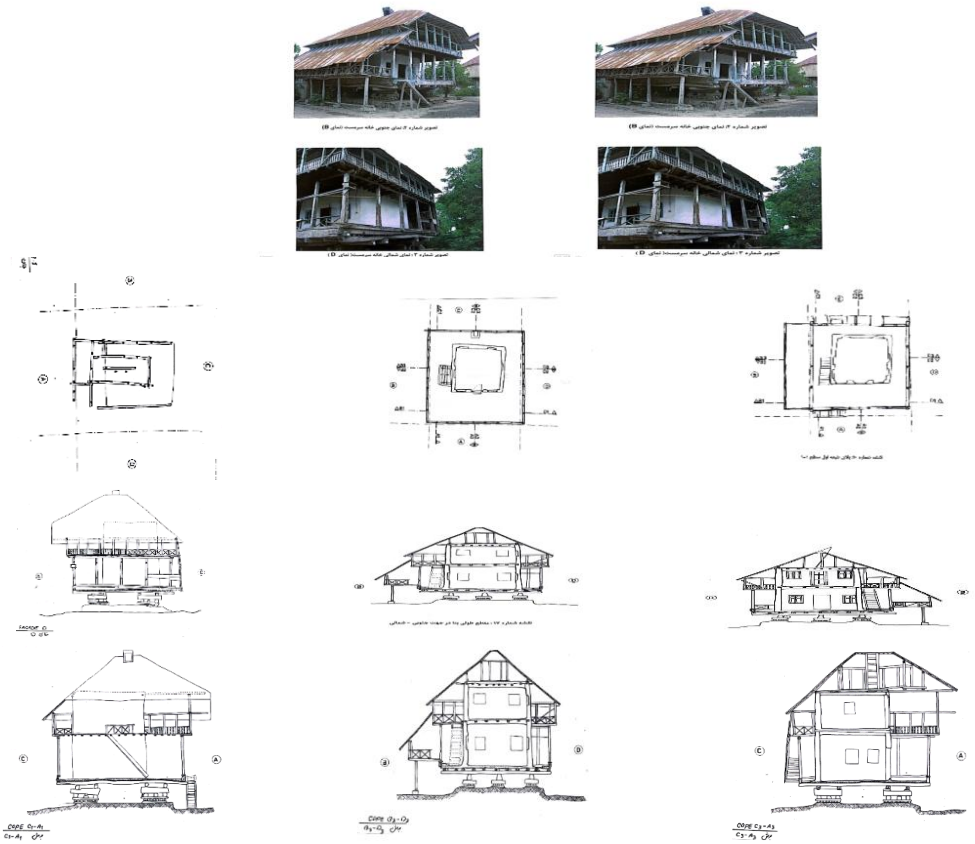
Section	Temperature	Plan	Image	
				
Physical variables: Emphasis on the quality of the wood and the way the force is conducted in the columns. Correlation of structure and idea: Emphasis on the reading of the structure in the design of the building facade.		The multi-layered sloping roof is designed to better drain rainwater. The structural connection between the walls and columns demonstrates the harmony between structure and form. Traditional techniques such as the use of local timber and vernacular skills are evident in this building.	Physical	Tectonic Components
Integration with nature: Complete compatibility with the surrounding natural environment and landscape Sensory dimension: Creating a sense of intimacy by combining texture and natural light.		The unique roof of this building represents regional identity. In addition to its technical function, this design is considered a cultural symbol in Gīlān architecture.	Semantic	

Fig.4. Tectonic analysis of Chencho-Seda Poshte in the village of Shargh Gīlān. Source: Authors.

Sarmast House



The double-sided roofs are designed to withstand rainfall and quickly transfer water to the ground. The form of the structure is such that it inspires a sense of stability while maintaining balance. Spatial relationships: Effective connection of interior and exterior spaces with open terraces. Physical variables: Design based on the transfer of forces through wooden columns.	Physical	Tectonic Components
This building is a symbol of man's ability to adapt to the natural environment. The use of local materials and vernacular techniques also creates a cultural identity in the building's design.		
Social relationships: Design for social interactions in the terrace space and entrances. The boundary between inside and outside: Creating a sense of connection with nature.	Semantic	

Fig.5. Tectonic analysis of the Sarmast house in the village of Shargh Gīlān. Source: Authors.

components such as the use of traditional construction techniques, adaptation to climatic conditions, and specific shaping are intertwined with semantic components such as the reflection of local culture, connection with nature, and the importance of social interactions.

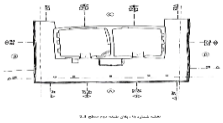
The construction techniques used in six buildings in the eastern region of Gīlān are mentioned below.

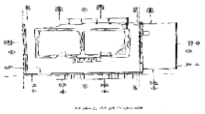
In all of these buildings, local materials such as kahgel, reed, stone, and pottery were used, walnut-oak and hardwood were used for the railings, and Kurmanj poplar-oak and cedar wood was used for the roof, which is specifically in harmony with the climatic conditions of the region.

Wood: It is used for the structure's skeleton and columns to increase strength and resistance to weather conditions (especially humidity and rainfall).

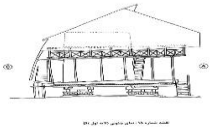
Kahgel: It is used for insulating walls to prevent moisture and extreme cold from penetrating. Kahgel

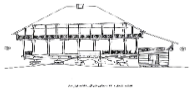
Montazeri-Shirjopasht



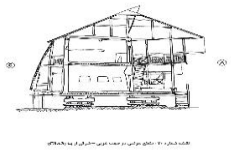


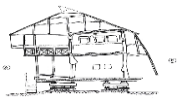
Plan



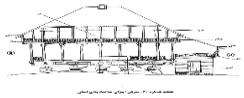


Elevation





Section



Building Components

The use of a conical roof form is important to prevent rainwater from accumulating in areas with high rainfall. The simple but solid structure of the building demonstrates a harmony between functionality and aesthetics.

Physical

Balance between form and function: Combining functional and aesthetic space in the roof facade. Construction techniques: Using traditional vernacular techniques in the construction of conical roofs

Tectonic Components

This building evokes harmony with nature and the rural traditions of the region. The design of this building reflects vernacular art and culture in the simplest possible form.

Semantic

Materialism: Using natural materials with an emphasis on sustainability. Spatial experience: Instilling a sense of calm with open space around the building.

Fig.6. Tectonic analysis of Montazeri-Shirjopasht House in the village of Shargh Gīlān. Source: Authors.

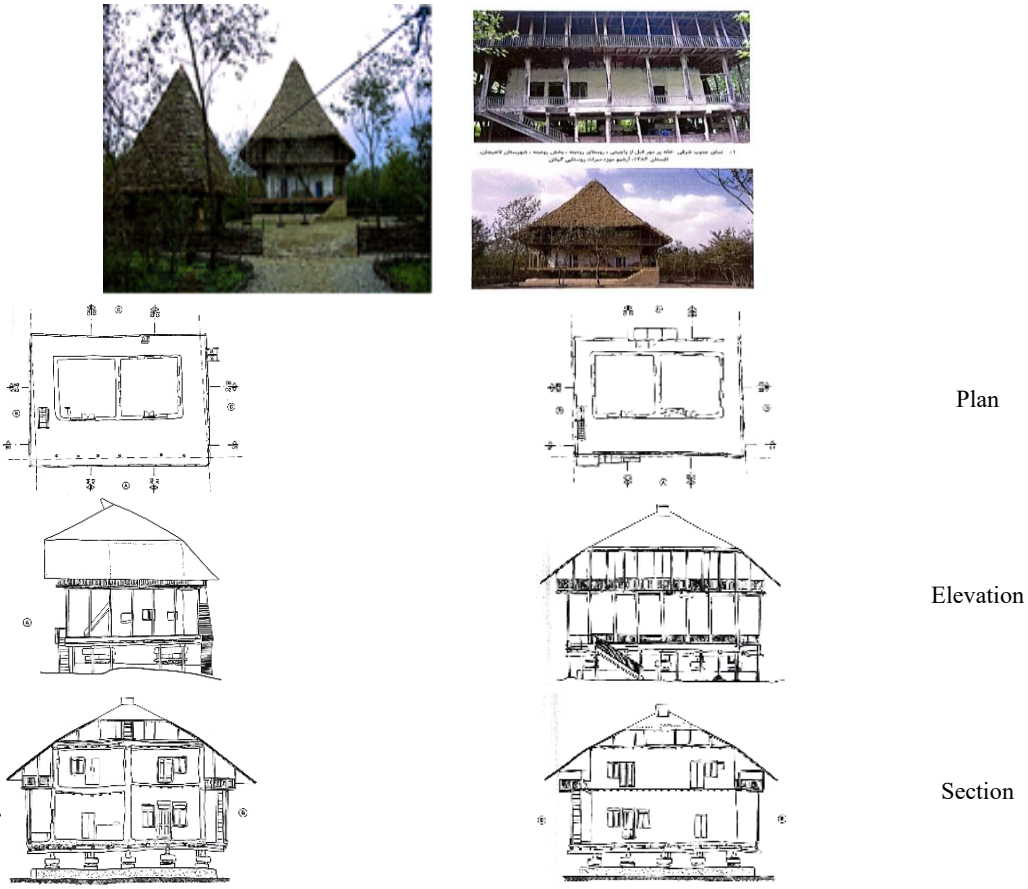
acts as an excellent thermal and moisture-proof material.

Stone: It is used in foundations and some other places to strengthen the structure and prevent damage caused by high humidity.

Pottery: It is used to cover the roof and some wall components. In addition to providing strength, pottery gives the space a beautiful visual effect.

Rice stalk: It is used for the final roof covering on sloping roofs.

Por Mehr House



The building's open terraces and wooden columns provide ideal conditions for natural ventilation. The design also allows for social interaction in the open air.	Physical	Tectonic Component
Structural and structural dynamics: sloping roof to cope with heavy rain.		
Structural form and aesthetics: symbolic design and specific form of the roof according to local architecture.		
In addition to reflecting the Gīlāni culture of hospitality, this building also demonstrates the deep connection between architecture and nature.	Semantic	
Texture and Culture: Reflecting the regional identity and culture of Gīlān.		
Semantics of Space: Design as a cultural symbol to preserve history.		

Fig.7. Tectonic analysis of Por Mehr house in the village of Shargh Gīlān. Source: Authors.

Connecting the wood: In the skeleton structure, manual wood connections are used in the form of bolts and nuts or by simple methods such as knotting.

Using beams and columns vertically and horizontally: Structures that use long wooden columns and horizontal wooden beams to create balance at different levels.

Frame structural system: Wooden frames are a widely used technique in these structures. The frames are arranged vertically and horizontally for greater strength.

Multi-layered roofs: In some buildings, multi-layered roofs have been used to provide effective rain protection and good thermal insulation.

Use of conical roofs: In some of these buildings, conical roofs are designed to direct rainwater quickly and prevent its accumulation.

Porches: Semi-open spaces are usually located on the front facade of buildings. The porches serve as a place for social interactions and passage between different spaces.

Multi-purpose space: Porches are designed for various purposes such as relaxation, parties, or workspaces, which in turn increases the efficiency of the spaces.

Strengthening the building with wooden columns: Long wooden columns are used to maintain the main structure and distribute weight throughout all parts of the building.

Use of stone foundation: Stone foundation with manual connections and assembly system using traditional techniques helps to strengthen the building and prevents ground moisture. These construction techniques are not only designed in line with functional needs but are also coordinated with local identity culture and natural conditions, which gives these buildings special durability, sustainability, and aesthetics.

A study of six traditional architectural buildings in Gīlān using two main tectonic dimensions (i.e. physical and semantic) shows that this architecture has harmoniously interacted with structural and cultural requirements.

Key findings include: In the physical dimension: Adaptation to climate and environment: The architecture of these buildings is well adapted to the geographical and climatic conditions of the region. Sloping roofs and the use of tall columns to cope with humidity and heavy rainfall are examples of this intelligent adaptation. Vernacular materials: The choice of wood and other natural materials indicates an emphasis on the sustainable use of local resources. These materials not only ensure the sustainability of the structure but also strengthen the sense of place and local identity.

Traditional construction technology: Construction techniques such as traditional wooden joints and vernacular assembly methods highlight the use of technical skills specific to the region. The balance between aesthetics and function: The design of these buildings has always attempted to maintain structural function and aesthetics together. In addition to functionality, forms and structures also have visual beauty. In the semantic dimension: Reflection of local culture: Buildings reflect the cultural values, lifestyle, and social identity of the people of Gīlān. Interactive spaces such as verandas and terraces symbolize the hospitality and social connections of this society. Integration with nature: Buildings interact closely with nature symbolically and practically. The use of natural materials and designs that optimize the flow of light and air indicate harmony between humans and the environment. Simplicity and artistic expression: Simple but effective forms indicate the integration of local art with functionalism. In addition to preserving identity, the architecture of this region respects simplicity and natural beauty. Symbolism of space: The ceilings and interior spaces of many of these buildings are considered symbols of the agricultural and environmental culture of the region. As a result, the traditional architecture of Gīlān shows that physical and semantic components function in an integrated manner. The use of local materials, the design of interactive spaces, and attention to climatic and social needs have all led to the creation of a special and identity-giving experience for users. Table 4 analyzes the materials used in 6 rural buildings (i.e. Abedini-Rafiei-Chencho-Sarmast-Shirjopasht-Por Mehr) in the eastern region of Gīlān. Then, the spatial relationships that exist in these buildings are examined.

Analysis of the selected buildings shows that these structures are well-adapted to the climatic conditions and cultural environment of the region by using local and natural materials such as wood, pottery, kahgel. Their design is such that it creates a dynamic connection between indoor and outdoor spaces and emphasizes interaction with nature and the environment. Large Iwans, numerous openings, and semi-open spaces are the main features of these buildings, which, in addition to optimizing natural ventilation, strengthen the sense of continuity between the indoor and outdoor environments.

The materials used not only have appropriate structural performance but also display the local

Table 4. Findings of materials used in rural buildings in eastern Gīlān and the spatial relationships of the buildings. Source: Authors.

No	Used Materials	Spatial Communication
1	Stone for foundation, wood for frames, kahgel	Open and interactive space between the interior and exterior, creating smooth movement passages, wooden skeleton to create a resistant and flexible structure, kahgel to insulate the walls and prevent moisture penetration.
2	Wood for the skeleton, mud, and soil for walls, clay for the roof - iwans and semi-open spaces	Internal and external communication using a large veranda and multiple openings, wide verandas to create interaction between the interior and exterior spaces, using multipurpose spaces for different applications.
3	Wood for columns and beams, clay for roof, straw for decorations	Using a wooden frame for greater strength, tall columns to reinforce the building and prevent ground moisture, combining closed and open spaces, interacting with the surrounding natural environment
4	Use of straw for conical roof, wood for walls	Sloping roof to channel rainwater, conical roof to repel precipitation and increase ventilation, creating a sense of oneness with nature, designing spaces for gathering and social interactions
5	Local materials such as wood, mud, and soil, use of glass-stone	Spatial design to maintain privacy and a strong sensory connection with nature, using stone for the foundation to prevent moisture, wood for durable and lightweight structures
6	Wooden beams, clay roof, kahgel for wall covering	Focusing on semi-open spaces and creating interaction between interior and exterior spaces, using hand-jointed wood to connect components, using assembly systems for faster and more durable construction

and cultural identity of the buildings. The use of traditional construction techniques and the selection of durable materials have made these structures resistant to environmental changes and time. As a result, these buildings are an example of a successful combination of function, aesthetics, and adaptation to environmental conditions that reflect the historical, cultural, and social values in the architecture of the Gīlān region.

According to Fig. 8, the characteristics of the vernacular architecture of eastern Gīlān are shown based on two physical and semantic dimensions, where the physical dimension includes compatibility with the climate and environment, vernacular materials, traditional construction technology, and balance between aesthetics and function, and the semantic dimension includes reflection of local culture, coherence with nature, simplicity and artistic expression, and symbolism of space. This pattern is derived from the study of tectonic components and can be introduced as a sustainable model for the vernacular architecture of eastern Gīlān.

Conclusion

A study of the architecture of rural houses in the eastern regions of Gīlān shows that the tectonics in this type of architecture is based on four main components (physical, semantic, functional, and cultural). These components have synergistically led to the creation of sustainable, meaningful architecture that is in line with the climatic and social context. Vernacular materials, traditional construction methods, and interaction with nature are prominent features of these buildings that not only strengthen local identity but also provide an effective response to climatic conditions and the needs of the residents. The architecture of these houses reflects the history, culture, and lifestyle of the people of the region and indicates the close interaction of humans with the environment and the surrounding society.

Based on the analyses conducted from the perspective of theorists in different years, it was concluded that the 4 main components mentioned in the research are the influential tectonic components in the rural architecture of the eastern Gīlān region, and in this research, we have examined 2 main components (physical and semantic components) in 6 existing buildings in eastern Gīlān (the Abedini-Rafiei-Chencho-Sarmast-Shirjupasht and Parmehr buildings). The analysis of the physical components in these 6 buildings shows that sloping roofs, insulated walls with kahgel, and open spaces of verandas are common features that help control temperature and humidity, prevent water infiltration, and provide better ventilation. Special designs such as open courtyards and verandas help with social interactions. In the semantic component: The architecture of

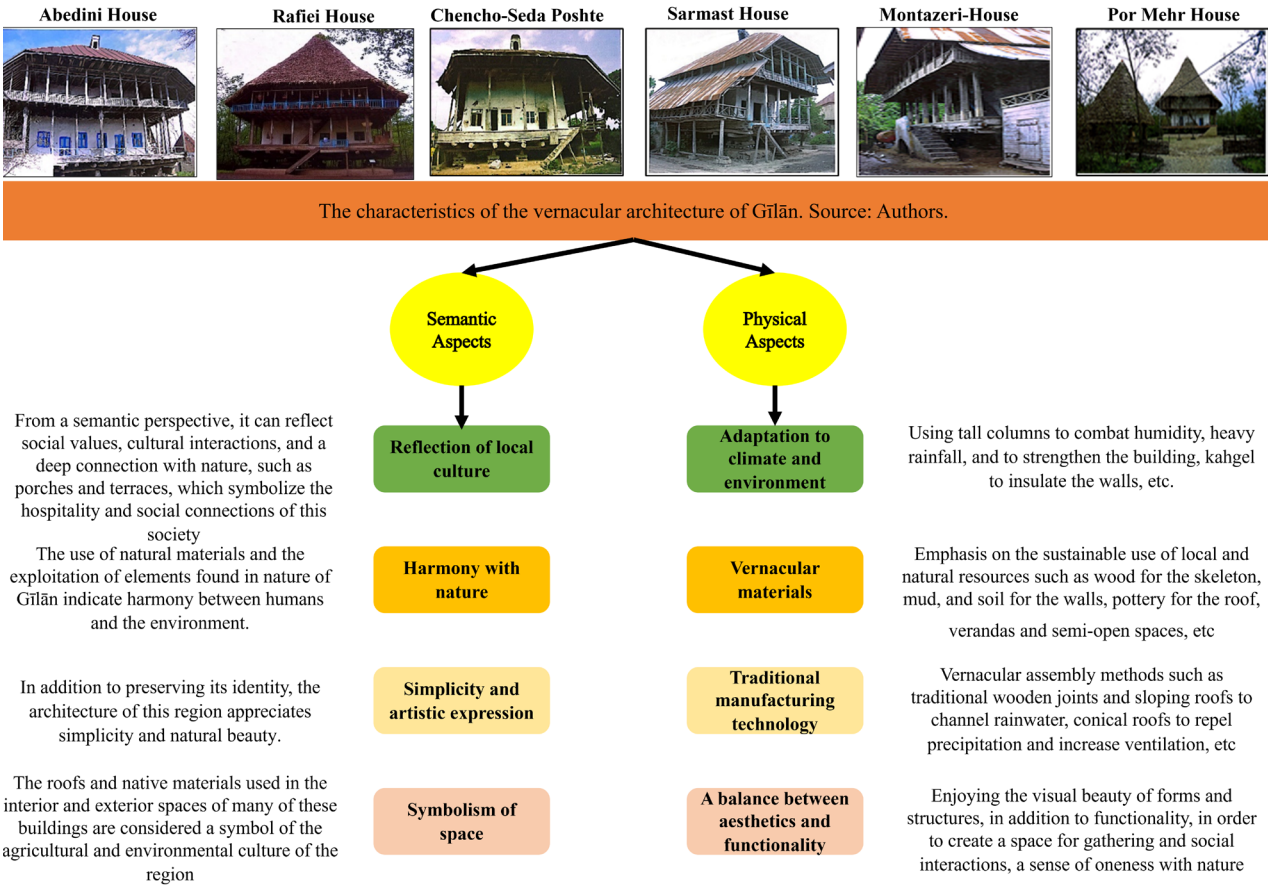


Fig. 8. The characteristics of the vernacular architecture of Gīlān. Source: Authors.

these houses implicitly emphasizes cultural values and social meaning. The use of specific forms such as sloping roofs and open plans, in addition to optimizing climatic conditions, preserves the cultural and historical identity of the region. These forms act more as symbols of regional culture and traditions and have a special meaning in the local culture.

In response to the question raised in the research, the values influencing the construction and architectural structure of the buildings under study can be influenced by environmental, cultural, social, aesthetic, and economic values. From an environmental perspective, the use of local and natural materials such as wood, kahgel, and stone in this region helps to reduce environmental damage and save on non-renewable energy. These materials are resistant to moisture and climate change and protect natural ecosystems. In the cultural dimension, the architecture of these houses is closely related to local history and identity; architectural forms and details such as sloping roofs and verandas, in addition to responding to climatic needs, are a symbol of local culture and traditions and play a role in strengthening local identity. Also, in the social dimension, the design of spaces such as open courtyards and verandas helps social interactions and strengthens family and social ties. Aesthetically, the balance between form and function and the fusion of history and modernity has resulted in attractive and efficient spaces. Economically, the use of local materials and the simplification of the construction process reduce construction and maintenance costs, which is especially valuable and important in rural communities that need sustainable economic resources.

Also, in response to the last question of the research, which is the materials and construction materials used in the construction of these buildings and the spatial relationship between them in this village, it can be said that in the rural space of eastern Gīlān, the materials and construction materials used are mainly from local and

natural resources that are compatible with the climatic and environmental conditions of the region. The main materials include wood, kahgel, stone, and mud, which are resistant to moisture and climate change and reduce the need for non-renewable energy. These materials are especially used in the construction of walls, ceilings, and floors and ensure the stability and durability of buildings. The use of these local materials not only helps to preserve the environment but also creates buildings that are resistant and compatible with the climatic conditions of the region at the lowest cost.

The spatial connection in these villages is such that the interior and exterior spaces of the buildings are designed in harmony. Open courtyards, verandas, and open spaces next to the buildings provide opportunities for social and family interactions. The design of these spaces is such that there is a direct connection between the interior spaces and the exterior environment so that natural light and proper ventilation easily enter the buildings. This spatial connection helps create a sense of continuity with the natural environment and facilitates social and family interactions. Therefore, the synergy of local materials with efficient spatial design creates sustainable, meaningful, and communicative spaces in these villages.

As a result, the traditional architecture of Gīlān is a clever combination of local construction techniques using natural materials such as wood and mud, designed according to climatic conditions and having structures resistant to moisture and precipitation. With simple and functional forms, this architecture maintains a balance between aesthetics and efficiency and strengthens the cultural identity of the region with handmade and local construction techniques. In terms of meaning, it reflects social values, cultural interactions, and a deep connection with nature and can be inspiring in contemporary designs as a sustainable model for local and climatic architecture.

Research limitations

The present study focused on rural houses located in the eastern region of Gīlān and its results may not be directly generalizable to other regions with different climatic and cultural conditions. Also, due to limited access, financial resources, and research time, the analysis was conducted on only six study samples.

Suggestions for Future Studies

1. Quantitative modeling of structural efficiency and durability in rural architecture using GIS and multi-criteria modeling.
2. Application of building information modeling, artificial intelligence, 3D printing, and environmental sensors in documenting and monitoring vernacular materials in rural architecture.
3. Comparative study of tectonic patterns of rural architecture in Iran and similar climatic countries.
4. Evaluation of the impact of conservation interventions based on tectonic principles on the performance and cultural identity of vernacular buildings.
5. Analysis of the impact of migration dynamics and climate change on the continuity of tectonic components in rural architecture in eastern Gīlān.

Declaration of No Conflict of Interest

The authors declare that they have had no conflict of interest in conducting this research.

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