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A SOCIO-CULTURAL AND ENVIRONMENTAL STUDY OF VERNACULAR ARCHITECTURE: THE ABHARI HOUSE IN KHANSAR CITY

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Abstract

Vernacular architecture is one of the most important branches of architecture, utilizing local materials and traditional techniques to address the climatic and cultural needs of various communities. The historical Abhari House in Khansar is a valuable example of Qajar-era architecture, designed sustainably and well-adapted to the region's climatic conditions. This article employs field observation, technical plan analysis, interviews with residents, and library research to examine the architectural features of this house. The combination of these methods ensures that field observations provide primary data, technical plan analysis guarantees precision in examining the building's structure, and interviews offer qualitative data related to lifestyle and spatial usage. Library research is also used to compare this data with other examples of traditional architecture. Among the findings are the impacts of factors such as geographical orientation, traditional water systems, the use of local materials, and spatial organization on reducing energy consumption and optimizing thermal comfort in the building. Additionally, the article compares the architectural features of this house with those in other cold and hot regions of Iran to highlight the influence of climate on architectural form and spatial organization. The findings

demonstrate that traditional Iranian architecture offers valuable strategies for sustainable design that can also be applied in contemporary architecture.

I. Introduction

Pietro Bellucci, an Italian architect, defines vernacular architecture as follows (Memarian, 2006): "It is an art not created by a few specialized individuals with a formulated plan, but rather shaped by ordinary people through the collective experience and knowledge passed down through generations." In general, vernacular architecture can be defined as architecture created by and for the people, without the involvement of professional architects, using local materials and techniques tailored to the region's climatic and cultural conditions. It is remarkable that this architecture, despite limited technology, has been able to effectively meet its needs, particularly climatic ones. Vernacular architecture is the result of collective wisdom, a knowledge passed down from one generation to the next (Pirnia, 1992), with each generation adding to it through trial and error. In today's world, where climate change is an urgent concern, learning from the techniques used in these structures to find sustainable solutions for modern construction is of great importance.

Khansar is a historic city with a millennia-old history, located in a mountainous region. The city is known for its geographical location at the foothills of mountains, abundant water resources, and stunning natural beauty. These factors have contributed to the creation of beautiful and responsive urban landscapes and architecture. The city is home to numerous historic houses, which are architecturally significant not only for their aesthetic value but also for the techniques used to combat cold and heat. One such valuable structure is the Abhari House, a distinguished example of Qajar-era architecture. I have had the opportunity to work as a restoration expert in this house for nearly four years, gaining sufficient knowledge about it. I decided to document this knowledge and share it with others to initiate further studies on the vernacular architecture of this city.

In this Qajar-era house, the architect employed simple yet intelligent techniques to largely resolve climatic issues without causing environmental pollution, doing so in a sustainable manner. Existing studies are limited to general information about the city and its history, some archaeological studies on the city's historic bazaar, urban geography and water resources, and a study on urban neighborhoods and pedestrian pathways. Unfortunately, no studies have been conducted on vernacular architecture or the typology of historic houses in this city, as most researchers have focused on the architecture of larger cities or well-known regions. This article aims to explore the history of Khansar, examine the Abhari House and its spatial relationships, and study the techniques and solutions used to create a sustainable and recyclable structure.

To study the Abhari House, methods such as field observation, interviews with residents and owners, and library research were employed. The house is currently under the administration of the Cultural Heritage, Tourism, and Handicrafts Department of Isfahan Province. Much of the information presented here is based on my observations during my work on this building. Although the house is registered as a national historic monument, its technical plans were incomplete. A more comprehensive plan was later

prepared by Kashan University, but it also had some flaws. After reviewing the dimensions and spaces in the plans, I noticed that some spaces were missing and there were errors in the drawings.

Consequently, the Kashan University plans were corrected and used for analysis. In addition to the technical plans, several descendants of the house's owner were interviewed to provide insights into the lifestyle, spatial relationships, and usage of the house. Information about the general form of Qajar-era houses and water systems was also gathered through other articles. It is worth noting that much of the information in this article is based on my interpretation of data analysis and comparisons with other houses in the city.

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II. IDENTIFY, RESEARCH AND COLLECT IDEA

INTRODUCTION TO KHANSAR

Khansar County is located at 33 degrees and 13 minutes north latitude and 50 degrees and 19 minutes east longitude, in the northwest of Isfahan Province. It covers an area of approximately 958 square kilometers in the central region of Iran, situated on the slopes of the Zagros Mountains (Mount Khansar) at an elevation of 2,250 meters above sea level. The abundance of springs and lush gardens has created highly favorable conditions for tourism. Much of Khansar County is characterized by significant slopes, which limit various activities in these areas (Pāsārgād Consulting Engineers, 2009).

In terms of water resources, the main and most important river in Khansar County is the Khansar River. Studies of the county's water resources indicate that springs play the most significant role in supplying water to the region, followed by qanats (underground channels). Even the majority of water obtained from qanats is the result of the recharge from the region's limestone springs. After these two sources, the Khansar River and other methods of utilizing groundwater, such as wells, are of lesser importance (MirMohammadi,1998).

One of the most important surface water resources in Khansar Valley is its flowing springs. The very existence of Khansar as a city is attributed to the presence of numerous springs throughout the valley, which contribute to its greenery. It is estimated that there are over 450 springs in the area, which is also the origin of the city's name. The name "Khansar" has various pronunciations and spellings in different dialects and texts, such as Khunsar, Khansar, and Khusar. However, the original word is composed of two parts: "Khan" and "Sar," with "Khan" meaning "spring" (MirMohammadi,1998).

Khansar in Travelogues

Many travelers have mentioned Khansar in their travelogues. The features described in these accounts generally include the abundance of trees, numerous streams flowing in all directions, and the city's location between two mountains. They also note the city's elongated layout and the humidity in its alleys. Notable travelogues that mention Khansar include those by Count de Sercey, Chérikof, and Lady Sheil.

URBAN DEVELOPEMENT AND GROWTH OVER TIME

Although access to documents and records needed to determine the city's initial core and subsequent development stages is limited, existing studies suggest that the original core of the city aligns with the southern end of the current urban area. This area includes neighborhoods such as the Grand Mosque, Labrud, Raisan, Upper Bazaar, Alavi, Aqa Nazar, and Sarchashmeh (Pāsārgād Consulting Engineers, 2009). Many registered historical buildings and cultural heritage sites, such as the Grand Mosque of Khansar, the Raisan Mosque, and the Abhari House, are located in this core area. In 1982, the city expanded by merging five villages: Rabat, Vadasht, Bidehand, Herestaneh, and Babasultan, located to the north (Pāsārgād Consulting Engineers, 2009). By comparing the architectural patterns of old houses in these areas with those in the city's core, structural differences can be observed, particularly in decorations, house types, size, and elongation.

In general, the architecture of Khansar, like many mountainous cities and rural areas, is extroverted. Houses are typically connected, with windows and verandas facing the streets. Observations show that these houses are usually two-story, built in an L or U shape around a courtyard or garden. The ground floor was often used for keeping livestock, while the residents lived on the upper floors. Key elements in shaping the city's form and architecture include sunlight orientation, land slope, water channels, and

mountain views. The optimal sunlight direction in the city is west and southwest, and houses are usually oriented accordingly. Additionally, the view of the mountains was highly valued by architects of the time, and houses often featured verandas or openings facing the mountains. Every neighborhood in the city has a water channel, each with its own name, the most important of which is Zaraghush. Sometimes these channels pass

Image 3: Khansar aerial map, source: google map

through the courtyards of houses, contributing to the city's pleasant climate and the beauty of its tree-lined alleys. These elements, along with the Khansar River and the surrounding mountains, play a significant role in shaping the city and its elongated development.

As mentioned earlier, one of the neighborhoods in the city's core is Raisan, which means "the elders" or "important people." This suggests that influential and wealthy individuals likely lived in this area. Field studies also indicate the presence of valuable historic houses in this neighborhood. According to locals, some of these houses, belonging to affluent and influential families, have been destroyed in recent years due to neglect and heavy snowfall. One such valuable house is the Abhari House, which differs from other houses in the neighborhood and the city, resembling houses in central Iranian cities in some aspects.

III. FINDINGS

ARCHITECTURE OF THE HISTORIC ABHARI HOUSE

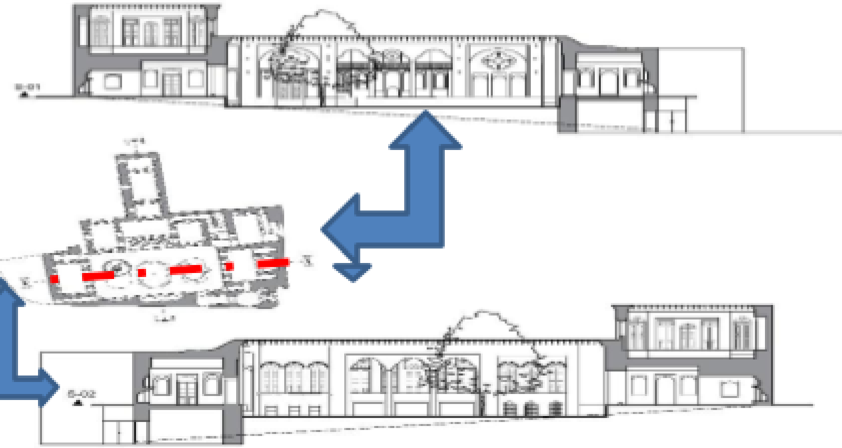
The historic Abhari House belongs to **Haj Seyed Mohammad Bagher Abhari** and is located in the **Raisan neighborhood of Khansar**, covering an area of approximately 800 square meters. The building was registered as a national heritage site in **2003** under number **9052** (Cultural Heritage, Tourism, and Handicrafts Organization of Iran, 2003)

. Ownership of the house was transferred to the Khansar Municipality through an agreement with the owners, and subsequently, **three-sixths of the house** was allocated to the Cultural Heritage Organization under a separate agreement. The house is currently used as the **office of the Cultural Heritage and Historical Building Protection Unit**.

Based on the inscription on the ceiling (Rabīʿ al-Ākhir 1278 AH), the building is over 160 years old, dating back to the mid-Qajar period. Pirnia, in his book *Stylistic Analysis of Architecture*, considers Qajar architecture a subset of the Isfahan style, which began during the Safavid era and ended in the Qajar period (Pirnia, 1992). Pirnia (1992) argues that this style, particularly in the late Qajar period, declined with the emergence of Western architectural styles. Qajar kings, after traveling to Europe and becoming acquainted with Western architecture, developed a preference for neoclassical styles, which they incorporated into the design of their

Image 4: Technical plans of Abhari House, source: Kashan University, Maryam Bagheri

Image 5:



palaces (Nikbakht, Khavandkar, & Sarmadi, 2024). Examples of Western architectural elements used in the Abhari House include semi-circular Roman arches, ceiling paintings, warm-colored plasterwork with naturalistic and non-abstract motifs, and the use of fireplaces and wall heaters (Sa'adati Khamseh, 2017). Features of the Isfahan style from the Qajar period evident in this house include introversion, modular design, the use of uniform elements and proportions (Pirnia, 1992), simplicity in building plans, minimal protrusions and recesses in structures, and the solidity and stability of forms. Vertical connections are relatively hidden and less significant, while central halls play an important organizing role. The spatial circulation follows a room-to-room pattern, and columned verandas are used as strong elements in the plan. Columns and columnar architecture are employed, and the courtyard serves as the organizing element of the building's spaces. The entrances are sunken, and the covered verandas are level with the exterior façade. Symmetry is used in decorative compositions, and arabesque and *khatayi* motifs are employed as architectural decorations (Sa'adati Khamseh, 2017). Although the house cannot be classified as entirely introverted, the presence of a central courtyard surrounded by covered spaces suggests a semi-introverted architecture. The house is connected to the alley and neighboring houses through windows and, in some cases, verandas (which have since been destroyed).

The Abhari House is designed around a central courtyard, with the building elongated along an east-west axis. Rooms are situated on three sides of the courtyard, while a shallow, covered veranda occupies the fourth side. In addition to the central section, a linear structure has been added to the rear of the northern part of the building, creating an irregular form. This space faces the courtyard of the neighboring house (the Mir Mohammad House) and features several windows overlooking it. It appears that this section was purchased and annexed to the building after its initial construction. Further evidence supporting this hypothesis is the difference in floor level between this room and the other rooms on the northern façade. The floor of this space is lower, which is uncommon in traditional Iranian architecture, where connected spaces are typically on the same level or have only minimal height differences. Based on these observations, it can be concluded that the building consists of a quadrangular (fully introverted) structure combined with a linear form, resulting in an irregular layout.

Geographically, the house is situated on a 30% slope, and its architecture fully adapts to the land's topography. The land slopes from east to west, with the eastern side being higher and the western side lower. The house is built in complete harmony with the terrain, so the central courtyard and the shared courtyard with the Mir Mohammad House are not on the same level. On the eastern side, there is an upper room with a small veranda. The eastern section does not have a basement, while the western side, located at the lower end of the slope, features a basement due to the land's depression. In the northern part, where the *shahneshin* (main reception room) is located, there are two basement levels. An additional floor has been constructed on the eastern side, which was used as a guest house and has its own staircase (the same staircase located at the main entrance). This section of the building is taller than the other sides. While the floor level of the northern side is higher than the other sections, the height from floor to ceiling in the interior spaces is roughly the same. To conserve energy and align the ceilings, a false ceiling has been installed. The building has four separate staircases, facilitating easy access to different parts of the house.

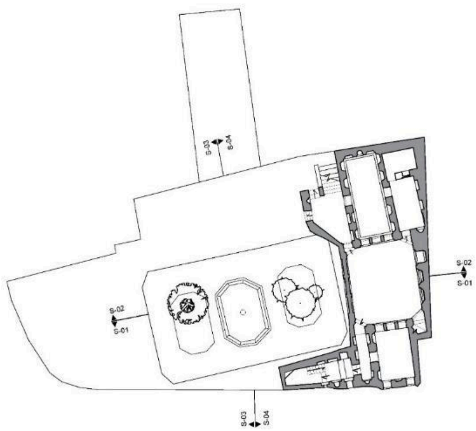
SPATIAL ORGANIZATION OF THE ABHARI HOUSE

The main entrance of the house is located on the eastern side of the building. This entrance features a pointed arch from the exterior, and next to the entrance door, two seating areas have been designed and constructed, reflecting the social aspect of the architecture. The building has two interconnected entrances. The main entrance is a *hashti* (vestibule) with a gem-like design. This *hashti* also includes seating platforms and connects to the courtyard via a corridor. The entrance to the *panjdari* room (a room with five windows), located on the eastern side, is situated in this corridor. Additionally, the staircase leading to the upper floor (guest room) is located within this entrance. It appears that this entrance provided public access to the building, ensuring that strangers did not enter the private areas of the house. For instance, if unfamiliar guests were present, they could ascend the staircase inside the entrance to the upper floor without entering the private spaces of the house. The second entrance is located on the southern side and opens into the courtyard after passing through an intermediate space. This intermediate space is connected to the main *hashti* and is separated by a wooden door, with a step leading down to it.

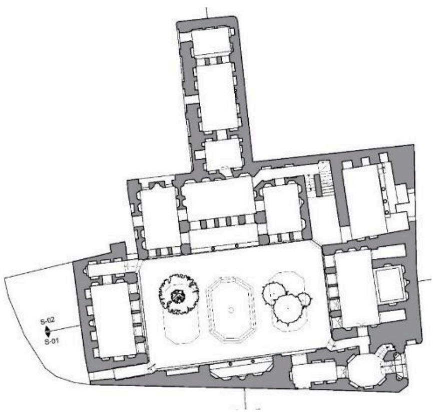
In the southern part of the building, there is a shallow hall adorned with exquisite plasterwork and a fireplace. In the northern part of the house, which receives southeast light (very close to southern light), the main reception area, known as the *shahneshin*, is located. In Iranian architecture, the *shahneshin* refers to a space positioned in the optimal climatic orientation, usually built at a higher elevation than other spaces and featuring more elaborate decorations (Pirnia, 1992). The *shahneshin* in the Abhari House is taller than the other sections and has two basement levels beneath it. The lower basement level is aligned with the courtyard of the Mir Mohammad House, another notable Qajar-era building in Khansar. In addition to the basement, a stable is located in this section (below the bridal room), with an entrance for livestock such as horses and mules from the Mir Mohammad courtyard. Two staircases are located here: one leads to the *shahneshin* level, and the other descends to the upper basement.

The *shahneshin* consists of three separate rooms overlooking the courtyard. Behind the central room, another space opens into the Mir Mohammad House. This space has three rooms, with the central room being larger (approximately 2.5 times the size of the others). The central room is renowned for its ceiling paintings and beautiful plasterwork and is known as the bridal room. Given the low light in this room and the absence of windows (except for one small window), it is likely that this room served as the *hajlegah* (bridal chamber for the wedding night). The bridal room is connected to the third room through three beautifully crafted doors, and this room also has a window overlooking the Mir Mohammad courtyard. The first room, which connects this space to the *shahneshin*, has no windows. Additionally, the staircase to the basement is located in this room. The rooms on the western and eastern sides each have five windows. All ceilings are fully covered with wooden beams and regular planks, and the niches inside the rooms and the arches in the courtyard are semi-circular and perfectly symmetrical. The *shahneshin* has five windows, while the adjacent rooms each have three. The division of the façades is entirely symmetrical.

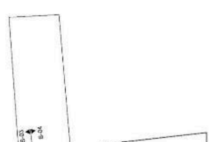
The kitchen is located next to the eastern rooms. Unlike the other spaces, which are elevated above ground level, the kitchen is at the same level as the courtyard and has a very high ceiling. A small water basin is built into the kitchen, fed by a stream running through the eastern alley. Several stoves are visible in the kitchen, all of which were wood-burning. This indicates that either a large number of people lived in the house or numerous ceremonies were held here. Next to the kitchen is the staircase leading to the *shahneshin*. In the corridor adjacent to the *shahneshin*, there is



First Floor Plan



Ground Floor Plan



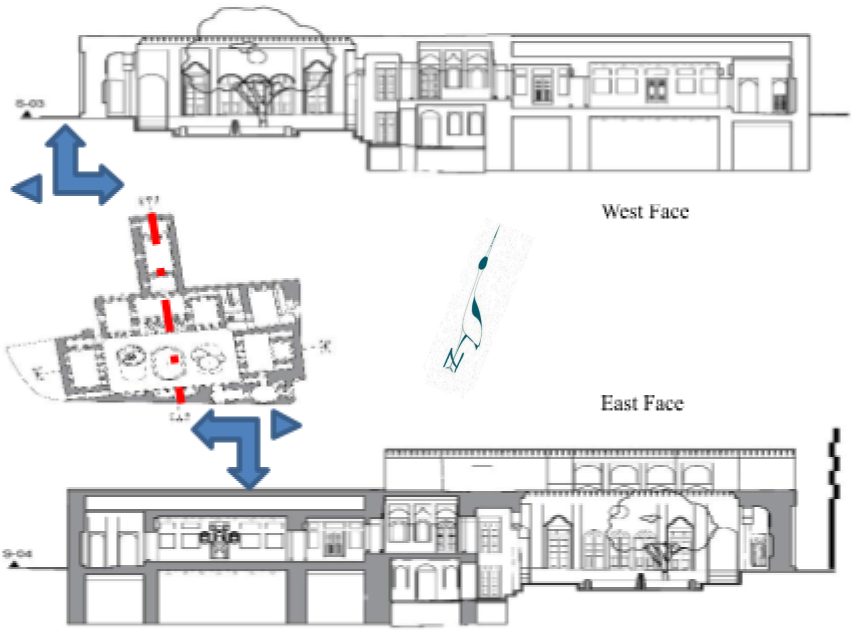


Image 8: Technical plans of Abhari House, source: Kashan University, Maryam Bagheri

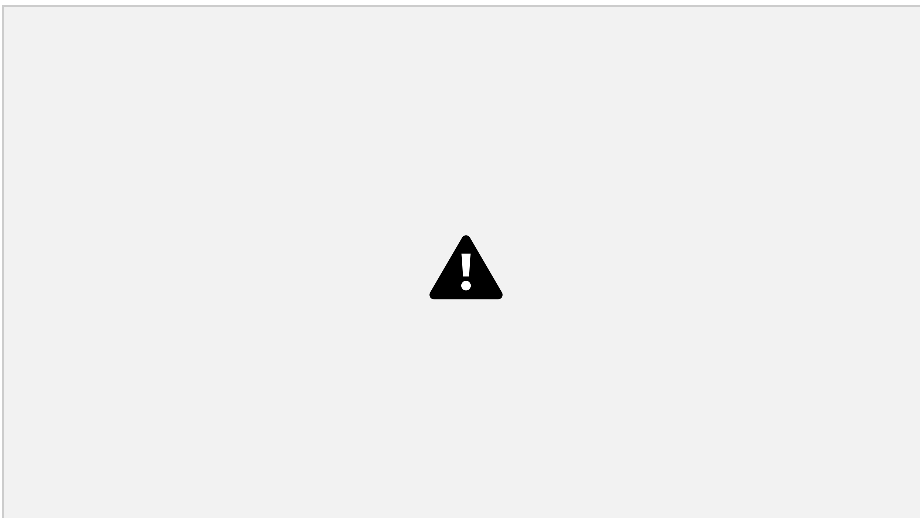


Image 9: Western Side of Abhari House, source: Writer

Image 10: Eastern Side of Abhari House, source: Writer

another staircase providing access to the upper floor of the eastern wing. In the corridor next to the western room, a door opens into the Mir Mohammad House, which, according to the owners, once led to a veranda. However, this veranda has since been destroyed. A corridor on the southern side of this room leads to a bathroom.

Image 11: Decoration of veranda, source: Writer

Image 12: Decoration of Ceil of Bride Room, source: Writer

The western wing of the building is two stories high, with the upper floor primarily used for hosting guests. This section features a small courtyard enclosed by rooms on two sides and walls on the other two. Openings in the walls facing the courtyard offer views of the nearby mountains, though the mountains are not visible from within the courtyard itself. Two staircases are located here: one leads to the corridor next to the *shahneshin*, and the other connects to the veranda opposite the *shahneshin*. The staircases are designed to facilitate smooth and fluid movement throughout the space, ensuring easy access to all areas.

As can be seen in the images, a circular feature is visible on both the eastern and western façades. On the eastern side, this circle is a vent that opens to the floor of the upper courtyard. During winter, snow accumulated on this courtyard (which is essentially the roof of the eastern room) was shoveled through this circular vent into the courtyard below. To maintain balance and symmetry, a similar circular vent was created on the western side, which was likely used for ventilating the double-layered roof in that section as well.

ARCHITECTURAL DECORATIONS

On the southern side of the house, there is a veranda with two wooden columns and exquisite plasterwork featuring floral and bird motifs, which enhance the beauty of the structure. This section is positioned opposite the *shahneshin* (main reception room) and is slightly recessed from the courtyard. It features a canopy with two wooden columns, symmetrically aligned with the opposite veranda. What is strikingly evident in the historic Abhari House and its architecture is the harmony and proportionality of its components and structural elements. The doors, windows, wooden columns, garden, and even the design of the entrance portals are perfectly symmetrical, adding to the aesthetic appeal of the building. The windows of this house once had beautiful latticework (*girih-chini*), though only two examples of this remain today. If one looks around the courtyard from within, the upper edges of the roof are adorned with crenellations, a characteristic feature of historic buildings from the Qajar era. In the center of the courtyard is a beautiful stone pool with a fountain, fed by water from a stream in the northern part of the building through earthenware pipes. This historic house boasts plasterwork, intricately designed lattice doors and windows, stained glass, painted ceilings, and delicate mirror work. Together, these elements create a level of elegance and beauty that is truly unique.

CLIMAT ADAPTION & SUSTAINABLLE FEATURES

CLIMATIC DATA OF KHANSAR COUNTY

Based on climatic data collected over ten years (1995-2004) from the Khansar weather station, the average annual temperature in the city is 11.9°C. On a monthly scale, the lowest temperature recorded was -0.3°C in Azar (November-December) during autumn, while the highest temperature reached 25.5°C in Mordad (July-August) during summer. The average annual maximum temperature at the station is 18.8°C, and the average annual minimum is 2.4°C. The absolute maximum and minimum temperatures recorded at the station are 40°C and -17°C, respectively, resulting in a temperature range of 57°C. The absolute maximum temperature occurred in Tir (June-July), while the absolute minimum temperatures were recorded in Bahman (January-February) and Azar (November-December). According to the available data, the number of frost days at the station is 120, a significant figure that highlights the importance of cold and frost as key climatic challenges in this region (Pāsārgād Consulting Engineers, 2009).

The presence of high mountains in the southwest of Khansar, overlooking the Zagros range, contributes to the cold temperatures in these elevated areas and the formation of precipitation as snow. These snow deposits remain on the mountain peaks until late spring. In general, precipitation in Khansar falls as snow during winter and as rain in early autumn and spring. The station reports approximately 3-4 months of the year without precipitation, while rainfall or snowfall is likely during the remaining 8-9 months. The highest relative humidity levels at the Khansar station are recorded in autumn, and the lowest in summer. In conclusion, factors such as topography, the region's cold climate, and the abundance of trees in Khansar County contribute to higher humidity levels compared to the central areas of the province. The relative humidity lines of 45% to 51% encircle the county, reflecting this. Considering these factors and the relevant climate classifications, Khansar falls into the category of cities with harsh winters and mild summers (Pāsārgād Consulting Engineers, 2009).

GEOGRAPHICAL ORIENTATION: USE OF SUNLIGHT

Based on the available data, it can be concluded that the most critical climatic factor in the construction of houses and historic buildings in this region was overcoming the harsh winter cold. Providing warmth and retaining thermal energy within the spaces were key challenges that required effective solutions.

The architect of this building aimed to maximize energy efficiency by utilizing available tools and harnessing natural energy sources. The most important and primary tool was the use of sunlight. In this regard, the architect optimized the building's orientation toward sunlight, which in Iran typically comes from the south. In Iranian architecture, efforts are made to utilize sunlight from the east to the southwest, and occasionally from the west. Spaces facing north, which receive little to no sunlight, are usually designed as open or semi-open areas. This pattern is also evident in the Abhari House. The space facing north features a shallow veranda. The building is elongated along an east-west axis, oriented toward the southeast light. This section includes the *shahneshin* (main reception room) and two adjacent rooms, which served as the primary living quarters for the residents. The eastern room, located next to the entrance corridor, receives southwest light. The other room, situated on the western side, receives eastern light, which is minimal during winter. However, in summer, the sunlight from morning until nearly noon can be somewhat bothersome in this room. Perhaps for this reason, a tree was planted in the garden adjacent to this room to control the sunlight during the summer months. Based on the experience of residing in this building and comparing it with the other three residential façades, the eastern light proved less efficient. In summer, the intense sunlight generated excessive heat, while in winter, the limited sunlight provided little assistance in heating the space.

WALL THICKNESS AND MATERIALS

The foundation of the building is constructed from local stones known as *arduāl*, which extend approximately 80 cm above ground level, while the exterior façade is built with bricks. These stones prevent moisture from penetrating the building's floor and walls. Lime mortar, which is water-friendly and strengthens when exposed to water, was primarily used in the foundation. According to the technical plans, the internal walls are between 80 to 90 cm thick. Walls facing the courtyards are thicker, ranging from 100 to 110 cm. The external walls, which face the alley or adjacent spaces, are even thicker, with widths of approximately 140 cm or more. These wide walls, constructed from brick and clay, are internally coated with a mixture of straw and clay (*kahgel*) and plaster, which helps prevent heat transfer between the interior and exterior.

Dimensions of Internal Spaces

Based on the technical plans, the dimensions of the internal spaces are as follows:

Space Name	Length (m)	Width (m)	Sunlight Orientation
Shahneshin	6.80	3.75	Southeast
Room above Shahneshin	5.95	3.50	Southeast-Northwest
Room below Shahneshin	4.75	3.45	Southeast
Bridal Room	6.50	3.60	Southwest
Room above Bridal Room	3.65	2.90	Southwest
Corridor between Bridal Room and Shahneshin	3.50	2.90	-
Eastern Room	7.50	3.70	Southwest
Alcove of Eastern Room	3.64	2.90	Southwest
Western Room	7.20	3.70	East

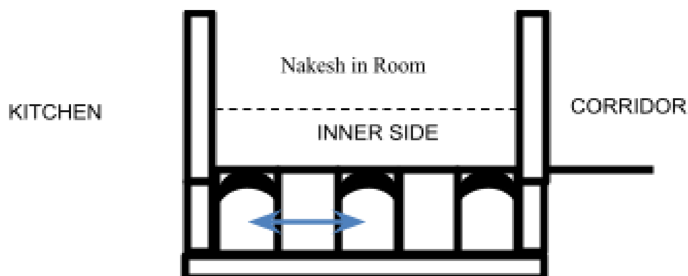
In this table, the side that receives sunlight is highlighted in yellow.

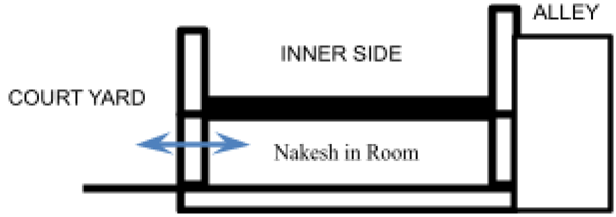
In the main rooms, the elongation of the space (i.e., the length) is oriented toward the sunlight. The names of these main rooms are bolded. The rooms adjacent to these main spaces are oriented widthwise toward the sunlight. The depth of the spaces for receiving sunlight ranges between 3.50 and 3.70 meters. There is one room with a depth of 4.75 meters and another with a depth of 5.95 meters, where the latter receives sunlight from two sides.

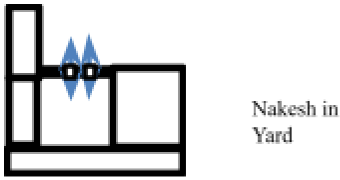
WIND FLOW & VENTILATION ATRATEGIES:
PRESENCE OF NAKASH (AIR CHANNELS) IN THE COURTYARD and ROOMS

Due to the building's placement on a slope and the movement of groundwater and moisture from the water channel, the adjacent room (eastern room) features *nakash* (air channels). These channels serve a dual purpose: they facilitate the transfer of moisture and act as insulation, helping to warm the interior space. *Nakash* refers to air passageways that remove humidity from the structure.

Additionally, given the heavy snowfall and frost during winter, and the fact that snow would remain in the courtyard for several months, channels were dug around the courtyard to prevent moisture from penetrating the courtyard walls. These covered channels have ventilation holes in certain sections to allow air exchange. The airflow through these channels helps dry out the moisture in the foundation and walls, maintaining the structural integrity of the building.







MICROCLIMATE

The presence of windows on the building's façade during summer allows direct access to the central courtyard, facilitating the expulsion of hot air and ventilation of indoor spaces. The enclosed nature of the courtyard, combined with the water pool and the movement of wind across the courtyard, creates a suction effect, making the central courtyard highly effective in establishing a microclimate during summer. The water pool also contributes to cooling and humidifying the air.

MATERIAL & CONSTRUCTION TECHNIQUES:

BUILDING MATERIALS

The primary materials used in the Abhari House are brick, adobe, and wood. Plaster was used for interior wall finishing and decorative plasterwork. Natural pigments were employed for the ceiling paintings in the bridal room. Additionally, lime and clay were used as mortar for binding materials, and the ends of wooden beams on the roof were coated with tar or oil to protect against insects. All materials used were locally sourced and environmentally friendly, capable of returning to nature after the building's demolition. In Khansar, there are gardens for planting cypress trees, locally

known as *qalamestoon*. Once these trees reached sufficient growth, they were sold for construction purposes. Adobe and bricks were made from soil, water, straw, and, in some cases, small stones. All materials used in construction were eco-friendly and would naturally decompose after the building's destruction. In this city, farmers often take the soil from demolished adobe houses for their agricultural fields, considering it high-quality soil for farming. In essence, these materials are part of a natural cycle, continuously reusable in various forms without harming the environment.

USE OF INTERMEDIATE SPACES

Another architectural strategy for controlling cold temperatures was the creation of intermediate spaces between open and closed areas. No enclosed space directly opens to the outdoors; instead, all rooms are connected to the courtyard through corridors. This design minimizes energy loss when doors are opened or closed. Additionally, residents used relatively thick curtains at the entrances of rooms, which significantly reduced energy loss.

DOUBLE-LAYERED ROOFS

To combat cold, double-layered roofs were constructed in the western room and the bridal room. The gap between the main roof and the false ceiling acted as an insulating layer, preventing heat transfer. Moreover, the double-layered roof provided protection in case the primary roof was damaged by snow or rain (a common occurrence), allowing time for

Image 13: Technical Section of Nakesh in Yard and Room Side of Abhari House, source: Writer

repairs without affecting the interior spaces.

CREATION OF SHADING ELEMENTS

Another strategy was the recessed design of windows, which created shading for the openings. These shading elements controlled sunlight during summer. For instance, a large veranda in front of the *shahneshin* blocked direct sunlight in summer, while the lower angle of sunlight in winter allowed it to penetrate. These recesses also protected the windows from rain and snow.

EARTH-SHELTERED ARCHITECTURE

Due to the topography, part of the building is embedded in the ground, such as the eastern wall of the kitchen, the eastern wall of the basement beneath the western room, and the southern wall of the basements under the *shahneshin*. This integration with the earth helps conserve energy, and the low ceilings of the basements keep them warm in winter and cool in summer. The connection between the upper spaces and these basements prevents energy loss through the floors of the upper rooms.

FIREPLACES

Fireplaces are present in every room and corridor, including the veranda on the southern side. Fireplaces, along with the *korsi* (a traditional heating system), were used for heating and maintaining warmth. The *korsi* was a wooden platform, about 2x2 meters and 60-70 cm high, under which a charcoal brazier was placed. A thick, large blanket covered the platform, allowing people to sit or sleep underneath to stay warm. The charcoal brazier would remain warm for several days, and after it turned to ash, wood was burned to produce more charcoal.

WATER MANAGEMENT

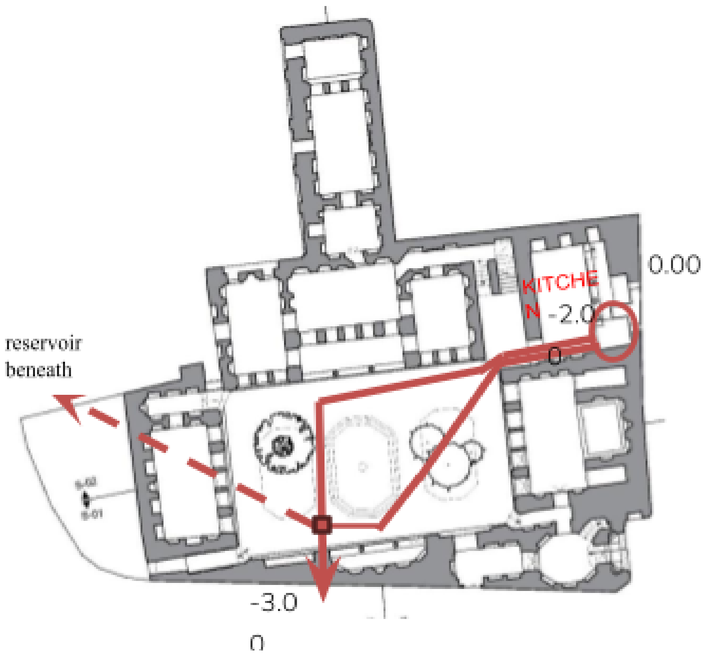


Image 14: The Path of Movement of Clay Pipes, source: Writer

Due to the abundance of water resources, particularly surface water, Khansar has a highly intelligent water distribution system. Along the course of a large river that flows through the valley-like city, there were numerous watermills, some of which still exist. Although many have been destroyed or are in disrepair, one has been recently restored and is operational. Water flowed through the city, was used, and then returned to streams and rivers. This system applied not only to watermills but also to houses. Water would enter houses from upstream channels, be used, and then flow into downstream channels. This transfer was facilitated by earthenware pipes called *tanbushes*, which had narrower ends that fit into one another. These pipes came in various shapes and sizes.

In the Abhari House, a similar system was used for water supply. Two water channels are located on the eastern and southern sides of the building. Water entered the kitchen through earthenware pipes (*tanbushes*) from the eastern channel, which was about two meters lower than the

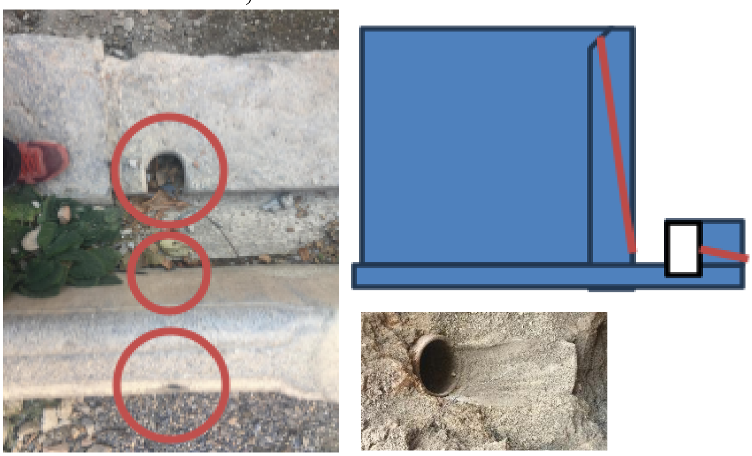


Image 15: The Path of Movement of Water in Pool, source: Writer

street and the water channel. The water filled a small basin in the kitchen and then flowed into the courtyard. This water was used for

cooking and washing. From the courtyard, some water entered the pool, some was used for irrigating the garden, and the rest flowed into the southern channel. Water was always in motion, flowing from one house to another or into other channels. Unlike houses in desert cities, which had water reservoirs and stagnant pools, the constant flow and sound of water in Khansar, especially in summer, were prominent features. Ventilation shafts were placed every 40 to 50 meters along the *tanbushes* to prevent pipe damage during water flow. Unlike other regions, Khansar's system did not require drainage wells because the water channels in every neighborhood allowed water to flow naturally into adjacent houses or channels, eventually reaching agricultural fields for irrigation (Valibeig, Ziaei, & Nazariyeh, 2017).

Water from the *tanbushes* reached the reservoir beneath the pool's fountain and entered the pool through the fountain. The stone edges of the pool had holes that allowed water to flow into the *pashuyeh* (a small drainage channel), preventing overflow. The *pashuyeh* also had several holes connected to earthenware pipes, which helped drain water from the pool.

Image 16: reservoir beneath, source: Writer

IV. DISCUSSION

One of the main features of traditional houses in cold regions is the use of thick walls and materials with high thermal capacity, which reduce heat loss in winter and retain coolness in summer (McHenry, 1989). This strategy is also observed in historic houses in Tabriz and Hamadan, highlighting the direct influence of climatic conditions on the development of vernacular architecture in these regions (Givoni, 1998). Given the high efficiency of thick walls in energy conservation, this technique can be applied to the external walls of modern buildings. Thickening walls and using various insulators can significantly reduce energy consumption.

Additionally, the use of central courtyards and semi-subterranean spatial organization plays a crucial role in mitigating the impact of external temperatures on indoor environments (Pirnia, 1992). In Khansar, the Abhari House exemplifies this architectural style, optimizing energy consumption by creating shade in summer (through recesses, verandas, or greenery) and absorbing solar heat in winter. In contrast, in hot regions like Yazd, vernacular architecture focuses on natural ventilation through windcatchers (*badgirs*), deep verandas, and shading (Qobadian, 2003).

From a sustainability perspective, many strategies employed in Khansar's traditional architecture can be adapted to modern building design. For example, some contemporary projects use thick walls and natural insulators similar to those found in traditional architecture to reduce reliance on artificial heating and cooling systems (Yeang, 1995). The concept of central courtyards has also been reintroduced in the design of low-energy residential complexes aimed at optimizing energy use (McHenry, 1989). This idea is particularly effective for creating airflow in buildings during hot seasons and maintaining humidity levels.

V. CONCLUSION

The architecture of the Abhari House in Khansar is a successful example of vernacular design in Iran's cold regions (Qobadian, 2003). By employing climatic principles, it offers sustainable solutions for regulating indoor temperatures and optimizing energy consumption. Key features include the use of central courtyards, thick walls, semi-subterranean spatial organization (Yeang, 1995), traditional water systems, and solar energy utilization. Comparisons with other houses in cold regions reveal similar strategies for combating severe cold, such as thick walls for heat retention, central courtyards for temperature control, and basements as thermal insulators. These strategies are also observed in historic houses in Tabriz and Hamadan (McHenry, 1989), underscoring the influence of climatic conditions on the development of vernacular architecture. In contrast, in hot regions like Isfahan and Yazd, architecture focuses on cooling spaces through windcatchers, shading, and natural ventilation. Examining these differences can enhance our understanding of the relationship between climate and architecture, inspiring sustainable designs in contemporary architecture. For instance, the use of central courtyards and thick walls in traditional Khansar houses is now being incorporated into modern sustainable building designs, such as low-energy residential complexes and high-energy-efficiency buildings.

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