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Evaluating the Effects of Physical Parameters of *Shanashir* on Thermal Comfort based on UTCI Index, a Case Study

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Abstract

The relationship between sustainable architectural design and human thermal comfort is significant. Proper design and construction methods are crucial in reducing energy consumption and enhancing people's comfort. Traditional Iranian cities, constructed 150 years ago with limited knowledge of air circulation and ventilation, employed passive systems to achieve satisfactory thermal comfort using natural resources. This study investigates the environmental aspects of *Shanashir*, a unique architectural element in Bushehr, a hot and humid city in Iran, and its impact on human thermal comfort. *Shanashir*, a narrow balcony with a wooden shading façade, offers various environmental benefits. This research explores different *Shanashir* types and characteristics, using DesignBuilder and Ladybug software to analyze their impact on thermal comfort based on the Universal Thermal Climate Index (UTCI). The results of this research outline the optimum physical characteristics of *Shanashir* to maximize thermal comfort in semi-outdoor spaces and indicate that a *Shanashir* with moderate height and depth (1.2 meters) and with a 45-degree angle roof provides fewer days with intense heat stress and a higher comfort zone.

Introduction

Vernacular architecture was historically created to meet the limitations of the climate and region and, due to its strong connection with human experience, has shown satisfactory performance over the years (Octay 2002). It includes information about how to enhance the performance of the buildings while simultaneously reducing energy consumption, using local materials and available construction technologies (Jafari et al. 2014, Engin et al. 2007). Due to its compatibility with the environment and users' comfort, vernacular architecture has always been a subject of interest for researchers to understand their mechanism better and take advantage of the local techniques used in modern building design (Ahmadi 2003, Engin et al. 2007). Humans have long been interested in using renewable energy and, through trial and error over time, have created methods that not only can compete with today's designs but, in some cases, can even be used as a guide to climatic design (Coch 1996). Nowadays, recognizing, evaluating, and implementing the effects of climate on architectural design is essential. It is also equally important to reduce energy consumption using renewable sources instead of mechanical systems while enhancing residents' comfort (Ozay 2004). Bushehr city, located in the south of Iran and the north of the Persian Gulf, has special native features in different scales such as urban texture, single buildings, and architectural details and elements such as *Shanashirs*, which are formed following the particular climate of this region (Fani et al. 2022, Shahin et al. 2014). *Shanashir* is a semi-open space (a balcony) with a small width and a specific wooden shading facade. It is installed on the upper levels of the building facade, creating a cool and shady space while connecting the interior building spaces to urban life (Hamidi 2010). This paper aims to investigate various environmental aspects of *Shanashir* and quantify its impact on human thermal comfort. First, we provide a comprehensive description of "*Shanashir*'s "main functions and their environmental aspects. Second, different types and physical characteristics of *Shanashir* are discussed by presenting the data collected from the field and those that can be found through literature searches. Using DesignBuilder and Ladybug software, the effect of various parameters of *Shanashirs* on their thermal behavior was investigated. These physical components are *Shanashir*'s pattern type (fence or louver), facade height, facade orientation, presence or absence of a roof, roof orientation, and the depth of *Shanashir*.

Background

Despite the extensive amount of research conducted on the climatic characteristics of the Bushehr's *Shanashirs*, the effects of their physical parameters on temperature control and thermal comfort within the semi-open space behind them have not yet been investigated. In (Bahrani 2018), the natural ventilation through *Shanashirs* has been simulated in fluent software. The results demonstrated that the wind speed increases as it passes through the *Shanashir* louvers. Moreover, *Shanashir* louvers change the wind direction and guide it to the living space. Another study offers a reinterpretation of *Shanashir* (Mashrabiya) by analyzing data collected from a controlled test room (Di Turi et al. 2017). It was suggested that *Shanashir* could improve the internal conditions, including the wind speed and the rate of air circulation in the room. This study concluded that *Shanashirs* could be a powerful tool for natural ventilation in the buildings in summer while providing natural light control and shading. The simulation results represent that the *Shanashir* system works well during the hottest hours of summer days. *Shanashir* is an important element in terms of the Bushehr historical context's climatic function, aesthetic, social, and identity (Fani et al. 2020). Most of the previous studies have examined this unique element of Bushehr architecture descriptively. In this research, after reviewing previous studies and conducting field research, the effect of the physical parameters of the *Shanashirs* on thermal comfort and operative temperature of the semi-open space behind the *Shanashir* facade have been investigated.

***Shanashir* and its functions in vernacular houses**

Shanashir is considered one of the unique features of Bushehr's native architecture, which provides privacy by covering windows that overlook public spaces or main streets and, at the same time, connecting the interior building spaces to the urban life and make the introverted-extroverted architecture of Bushehr port (Fani et al. 2022, Hedayat et al. 2017, Dehdashti et al. 2014). Its history goes back to the late 18th and early 19th centuries. *Shanashirs* are commonly seen in the architecture of the Middle East, particularly in Egypt and Saudi Arabia. In Iran, these elements are only used in the traditional homes of Bushehr city, located in the south of Iran (Hedayat et al. 2017).

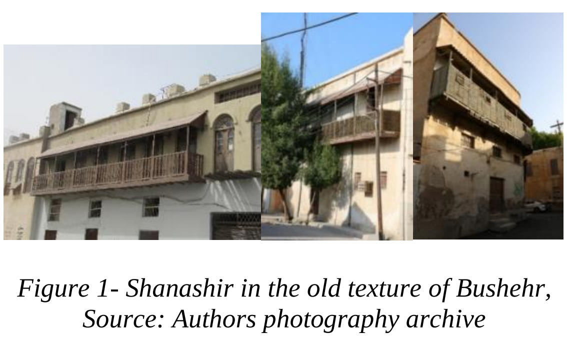


Figure 1- Shanashir in the old texture of Bushehr, Source: Authors photography archive

Shanashir is a balcony with a small width and a particular wooden shading facade. It is installed on the upper levels of the building facade, creating a cool and shady space (Hamidi 2010). Since the word "*Shanashir*" does not exist in Dehkhoda, Amid, and Amin's Persian dictionaries, it is concluded that the word *Shanashir* is not Persian, and some consider this word to be equivalent to the word" *Shanashil*" in Arabic (Hedayat et al. 2017). There are different names for *Shanashir* worldwide (Fani et al. 2022, Alothman 2017). In Egypt, Saudi Arabia, Syria, and Palestine, for example, it is called" *Mashrabiyah*," in India" *Roshna*" and" *Jali*," in Iraq" *Shanashil*," in Bahrain" *Agassi*" and Turkey" *Kumba*". Despite differences in their appearance, their functionality is more or less the same (Hedayat et al. 2017, Alothman 2017). The most appropriate material for the construction of the *Shanashir* is wood (Fani et al. 2022). Any alternative material must have the same properties as wood; it should be firm, easily propagated, and able to withstand extreme humidity and heat. According to the studies there are some types of *Shanashirs* constructed from materials other than wood, such as marble, brick, and plaster, in Egypt, India, and Spain. In Iran, they are only made of wood (Almerbati 2014, Alothman 2017).

Shanashir has a rich history, but it does not mean that it is just a cultural decorative element. Over the years, *Shanashir* has become a significant environmental element with its design criteria and physical parameters. The flowchart presented in Figure 3 provides an overview of *Shanashir's* most essential functions in both urban and building scales. According to Hasan Fathy's theory (Fathy 1986), although *Shanashir* has aesthetic, social, and spatial properties while providing privacy for the interior spaces, it has considerable environmental functions, including 1- Light Control, 2- Airflow Regulation, 3- Humidity Control, and 4- Temperature Regulation. Previous studies have discussed and highlighted the significance of these environmental functions (Hedayat et al. 2017, Fani et al. 2022, Almerbati 2014, Alothman 2017, Fathy 1986, Feeny 1974, Kazerooni 2002, Motealleh et al. 2018). These functions, which are schematically shown in Figure 2, are briefly discussed in the following sections (Figures 3and 4).

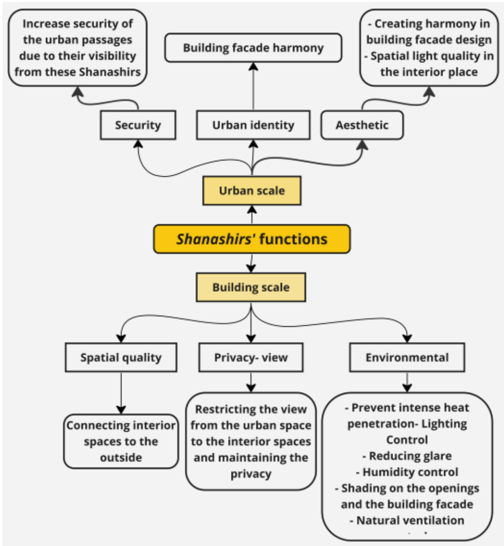


Figure 2- Shanashir's function, Source: Authors

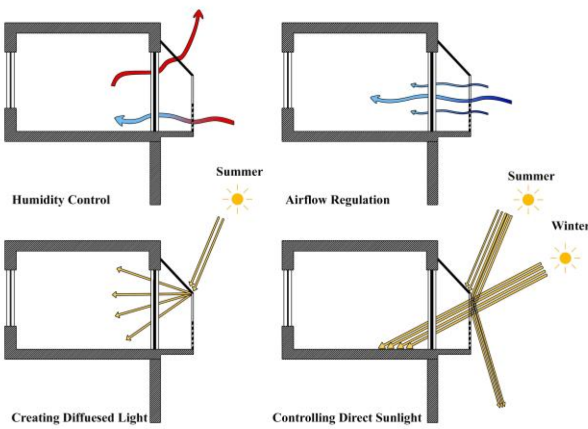


Figure 3- Diagram of Shanashir's environmental functions, Source: Authors

Lighting control

Natural light is one of the most essential aspects of architecture. *Shanashir* can effectively deal with three types of daylight: direct sunlight, diffuse skylight, and reflected glare (Alothman 2017) and address the problems by changing the harsh and undesirable light to a highly favorable indoor illuminance (Fathy 1986).

Temperature regulation

Direct sunlight leads to high temperatures. During the hot summer months, the incoming solar radiation is more direct (radiation angle is close to 90 degrees), *Shanashir*'s roof blocks the direct sunlight from entering the room and, thus, plays a vital role in controlling temperature by limiting the solar gain and shading the inner spaces. During the cold months of the year, *Shanashir* can supply some heat by allowing direct daylight to enter the internal space due to the lower winter sun angle (Fathy 1986).

Airflow regulation

Through passing *Shanashir* louvers, wind speed increases, and its direction changes and is guided towards the living space (Bahrani et al. 2018).

Humidity Control

As *Shanashir's* surface is cold during the nighttime, the air passes through it and loses some of its humidity by the absorption property of the wooden *Shanashir*'s louvers. During the daytime, the surface of *Shanashir* is heated by direct sunlight, and through the evaporation process, this humidity is absorbed by the air, which flows through the porous wooden *Shanashir* (Alothman 2017). This mechanism is illustrated in Figure 5.

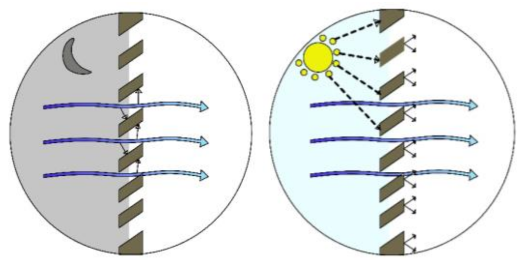


Figure 4- Shanashir's role in regulating relative humidity throughout the day and night , Source: Authors

The climatic characteristics of Bushehr City

The focus of this study is Bushehr port, situated in southern Iran at an altitude of 8 meters above sea level. Climatic studies in this region have revealed a significant variance in dry bulb temperature between summer and winter. Data collected from 2003 to 2017 shows the highest recorded temperature reaching 42°C in July, contrasting with a minimum of 8.4°C during the colder months of December, January, and February. The Bushehr dry bulb temperature chart illustrates that the warmest temperatures typically occur from mid-July to mid-September, while the coldest temperatures are experienced from mid-December to late February (Figure 5 and 6).

Moreover, Figure 5 and 6 depict the annual cycle of relative humidity in Bushehr, highlighting peaks of approximately 95% to 100% during cold nights in January and February. In the hotter months, the sensation of heat is intensified due to the combination of high humidity (ranging from 53% to 75%) and average temperatures around 37°C. This climatic condition poses unique challenges in maintaining thermal comfort.

The variation in temperature and humidity in Bushehr necessitates an adaptive approach to thermal comfort. For instance, in the hot and humid months, traditional architectural features such as *Shanashirs*, which enhance ventilation and shade, become crucial in reducing indoor temperatures naturally. Similarly, during colder months, these features help in trapping heat and maintaining a comfortable indoor environment.

In practical terms, these climatic elements directly influence the design and construction of buildings in Bushehr. Architects and urban planners must consider these factors to create spaces that remain comfortable throughout the year without excessive reliance on artificial heating or cooling systems. Additionally, the broader range of thermal comfort thresholds observed among residents, as opposed to the standard ranges suggested by ASHRAE 55 (Nikghadam 2015), indicates a potential for more flexible and context-specific design standards. This adaptability not only caters to the local climate but also aligns with sustainable building practices, reducing energy consumption and enhancing overall environmental compatibility.

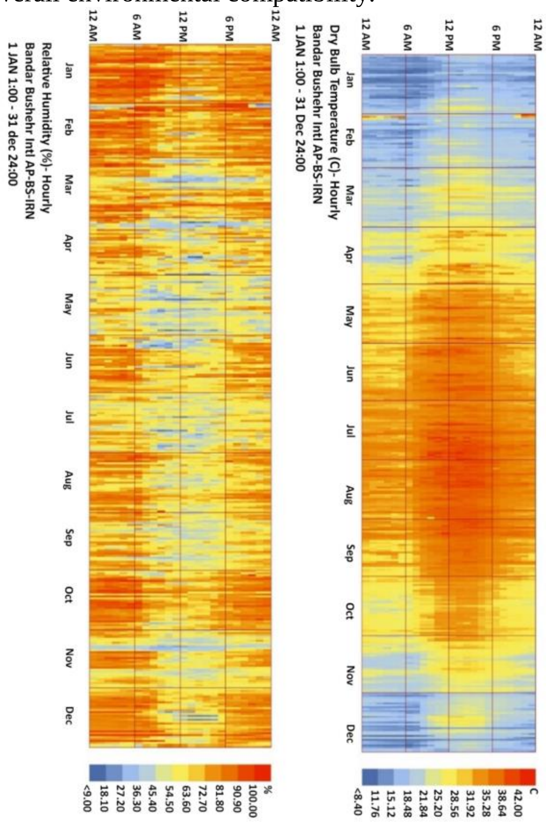


Figure 5 and 6- Left: Dry bulb temperature- Bushehr Right: Relative humidity- Bushehr

UTCI (a metric to assess thermal comfort)

Human thermal comfort is "the condition of mind which expresses satisfaction with the thermal environment" (Bröde et al. 2012). There are various methods used to indicate human thermal comfort levels (Burton et al. 2009). In 1994, the Universal thermal climate index (UTCI) was introduced, considering various parameters including dry temperature, relative humidity, mean radiation temperature, and wind speed in the height of 10 meters (Baaghideh 2016, Zare 2018). It is known as the reference environmental temperature by which strain is caused (Farajzadeh et al. 2016) and is one of the most thorough indices to calculate heat stress in outdoor spaces (Bröde et al. 2012). UTCI aims to assess outdoor thermal condition and is valid for extreme climate conditions (Bröde et al. 2012). It was developed based on heat exchange theory and divided into ten categories of thermal sensation with+46 °C as extreme heat stress, −46 °C as extreme cold stress, and 9 °C to 26 °C is the threshold for neutral sensation (Figure 7) (Bröde et al. 2013).

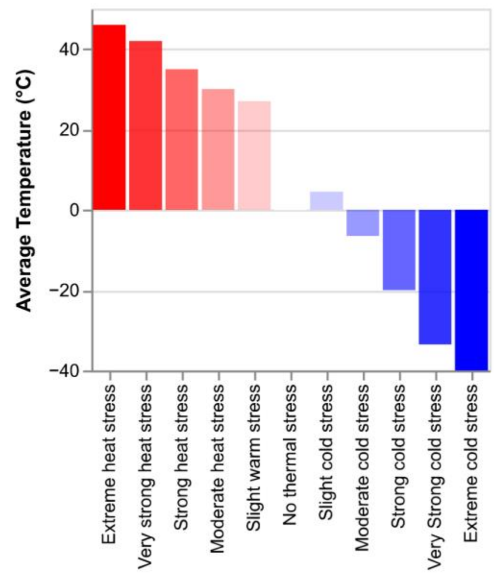


Figure 7. UTCI thermal sensation category, Source: Authors based on the data reported in (Bröde et al. 2013)

Simulations of the selected case studies

Different types of Bushehr's *Shanashirs* (Conducted from the documents of existing buildings besides field surveys) were classified in terms of their physical characteristics, including the facade pattern (fence, Louvre with 45 degrees orientation), the height of facade, facade orientation, presence or absence of a roof, roof orientation, and the depth of the balcony. Among the buildings located in the old texture of Bushehr, a mansion with *Shanashir* (*Tabib* mansion) situated near the sea has been selected as the main study site for this project (Figure 8).

Figure 8- Tabib mansion in Bushehr, Source: Authors photography archive

All *Shanashir* simulations (including different physical characteristics, which are explained in detail in tables 2 and 3) have been modeled in this building. Simulations were conducted in Design Builder software to investigate the effect of various physical characteristics of *Shanashir* on the temperature in the semi-open space behind the *Shanashir*. These temperature results were then imported as the input data for Ladybug software to calculate the thermal comfort in the semi-open space according to the UTCI index. The performance of different elements of *Shanashirs* has been analyzed to maximize its cooling effect and enhance the thermal comfort within the balcony space. Table 1 shows the various physical parameters of *Shanashir* that were used as variables for simulations and Table 2 presents the main assumptions of the model (remained constant for all simulations).

Table 1 The variables in simulated models

Shanashir parameters	Variables
Roof	roof with a 45-degree angle, roof with a 30-degree angle, without a roof
Facade height	1.2 m height 2.4 m height
Pattern	Fence louver (with a spacing of 7cm)
Balcony depth	1.0 m 1.5 m 2.0 m
Facade angle	Vertical, angled

Table 2 The equal assumptions of Shanashir details on all simulation models

Property	Description
balcony	9.5 m length, and variable (1.0 to 2.0 m) depth
Window number and dimension	4 windows, 1.0 m by 1.30 m
Type of glass and number of panes	Ordinary- Single pane
Window Shading device	Slatted blinds
Window frame material	Wooden- 6 cm
Shanashir's material	Wooden- 6 cm
Heat transfer coefficient of Shanashir's material	0.3 W/m^{2}K
The thickness of external walls	80 cm
Material of external walls	Gypsum plaster, porous rock
Heat transfer coefficient of the external walls	0.84 W/m^{2}K
Dimensions of the openings of the Shanashir	Wooden louvers of 7.5 * 1.0 * 50 cm and spacing of 7.0 cm
Natural ventilation schedule	On

Model validation

To calibrate our model and ensure its precision, we utilized the observational field data reported in the study (Mohammadi et al. 2017). This particular study provided detailed recordings of temperature measurements, obtained through sophisticated instruments such as the wind data logger (TES-AVM-07), along with temperature and humidity sensors and data loggers (MCI-98583). These measurements were taken from two distinct environments within a building, referred to as the 'summer zone' and 'winter zone', over a span of 36 days distributed evenly across the year (3 days per month).

Our objective was to assess whether our model could accurately replicate these real-world measurements, thereby confirming the validity of our simulation results. To achieve this, we meticulously recreated the physical structure and material properties of the test site in Bushehr, as detailed in (Mohammadi et al. 2017), using the DesignBuilder software. In Table 3, we present a side-by-side comparison of our simulation outcomes, the actual field measurements, and the computed error for the monitored period, as delineated in (Mohammadi et al. 2017).

We simulated our case study using the predefined materials and characteristics for the same 36-day period within the year, results of which are encapsulated in Table 3. These simulations revealed that the average errors in simulating indoor temperatures for the summer and winter zones were 2.57% and 2.7%, respectively. It is important to note that these error margins fall within an acceptable range for simulation purposes, as corroborated by (Mohammadi et al. 2017).

Table 3 The average of the simulated and monitored indoor temperature in summer and winter zones of the model

Months	JAN 4-6	FEB 3-5	MAR 4-6	APR 2-4	MAY 3-5	JUNE 3-5
Monitored (Summer zone)	19.2	20.1	21.6	23.7	26	26.4
Simulation (Summer zone)	19.86	20.51	21.09	23.35	25.71	26.14
Error	3.3%	1%	2%	1%	1%	0.9%
Monitored (Winter zone)	19.6	19.2	20.8	22.2	26.2	27.1
Simulation (Winter zone)	21.12	19.25	20.52	23.27	27.02	27.73
Error	7%	0.2%	1.3%	4.5%	3%	2.2%
Months	JULY 4-6	AUG 4-6	SEP 4-6	OCT 5-7	NOV 4-6	DEC 4-6
Monitored (Summer zone)	26.4	27.6	27.5	26.5	24.4	23.1
Simulation (Summer zone)	26.35	26.45	26.58	26.03	23.55	21.05
Error	0.18%	4.3%	3.4%	1.8%	3%	9%
Monitored (Winter zone)	28.1	28.5	28.4	28.1	26.9	24.2
Simulation (Winter zone)	27.89	27.98	28.1	27.67	26.66	22.10
Error	0.7%	1%	1%	1.5%	0.9%	10%

Error= | ((Simulation- monitored)/ Simulation)*100|

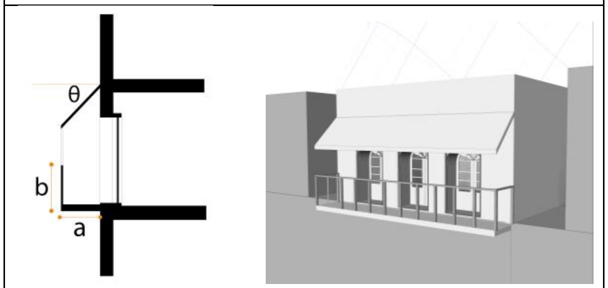
Results and discussion

All different types of *Shanashirs* presented in Table 4 were simulated in Design Builder software and operative temperature in different models, were compared separately for the cold months (Jan, Feb, Dec), moderate months (March, Apr, Oct, Nov), and warm months (May to Sep). Mean radiant temperature, wind speed, and relative humidity were calculated in the form of hourly data (8760 hours for the total year) in Design builder software which was used to calculate thermal comfort based on UTCI metric in Ladybug software. As an example, UTCI stress category data (outputs of Ladybug software) for *Shanashir* type "C" is demonstrated in Figure 9. Thermal sensation in different groups of UTCI (Figure 8) was compared in the balcony of *Shanashir* in all models and presented in Tables 5 and 6.

In the present study, the UTCI threshold between slight cold stress to strong heat stress (indicated as -1 to 3 in Figure 9) is considered based on the temperature threshold in Bushehr port.

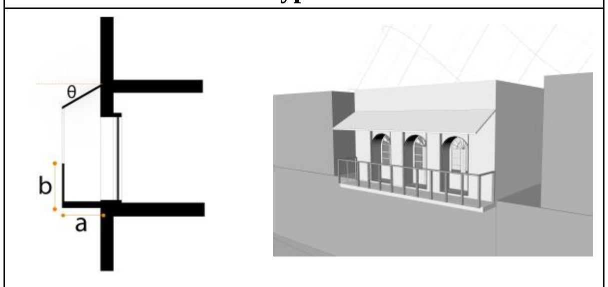
Table 4 Simulated models' properties

Type A



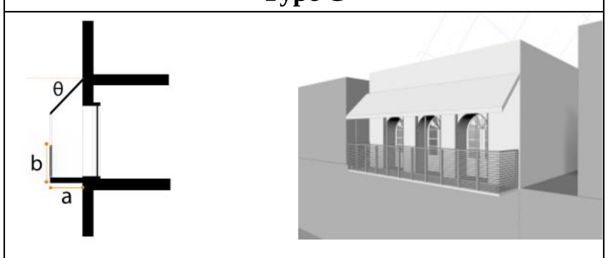
Pattern type: Fence/ a=1m/ b=1.2m/ θ=45

Type B



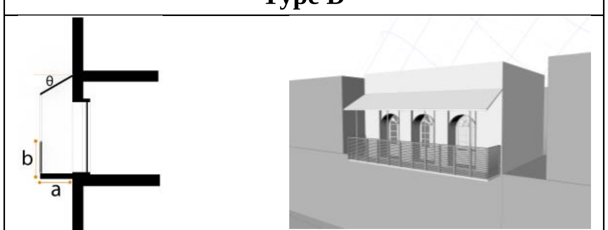
Pattern type: Fence/ a=1m/ b=1.2m/ θ=30

Type C



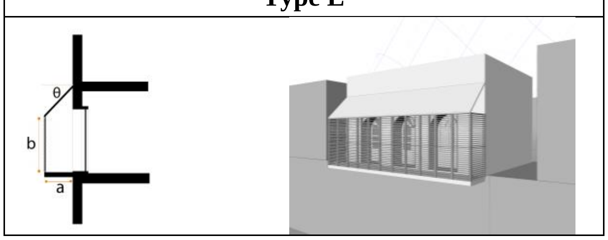
Pattern type: Louver/ a=1m/ b=1.2m/ θ=45

Type D



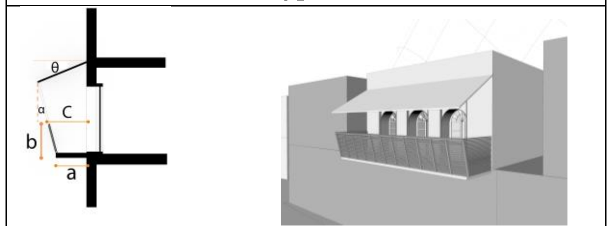
Pattern type: Louver/ a=1m/ b=1.2m/ θ=30

Type E



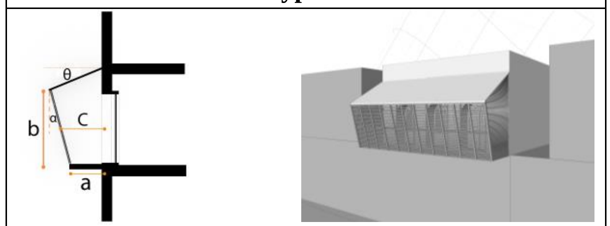
Pattern type: Louver/ a=1m/ b=2.4m/ θ=45

Type F



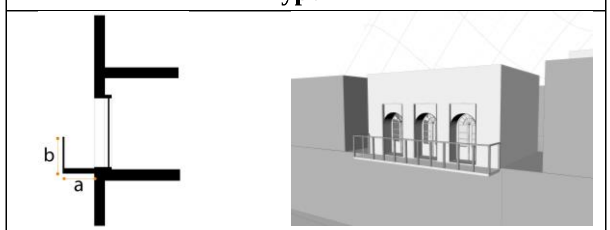
Pattern type: Louver/ a=1m/ b=1.2m/c=1.5m/ θ=30/ α=15

Type G



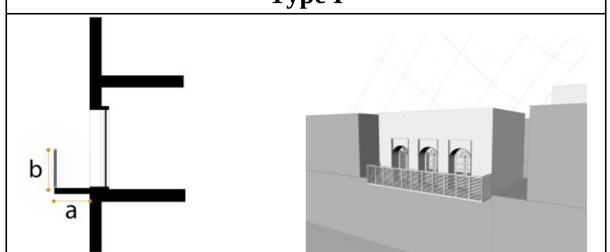
Pattern type: Louver/ a=1m/ b=2.4m/ c=1.5m/ θ=30/α=15

Type H



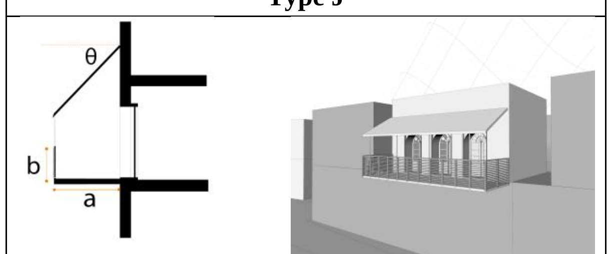
Pattern type: Fence/ a=1m/ b=1.2m/ without roof

Type I



Pattern type: Louver/ a=1m/ b=1.2m/ without roof

Type J



Pattern type: Louver/ a=2m/ b=1.2m/ θ=45

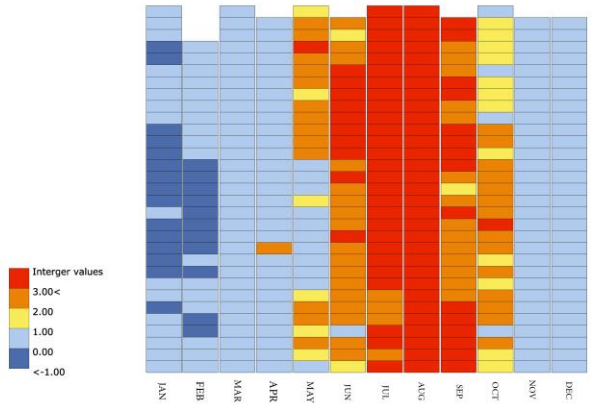


Figure 9- Shanashir Type C- UTCI stress category-daily

The effectiveness of *Shanashir*'s pattern: Two types of *Shanashir*'s pattern were modeled 1) with ordinary fence (A) and 2) with wooden louver pattern with 7 cm spacing (C) As presented in table7, the results have demonstrated that *Shanashir* type "C" provides 11 more days with no thermal stress according to UTCI stress category compared to *Shanashir* type "A." Strong heat stress is also decreased by 31 days for *Shanashir* type "C." Type C creates 10 more days with slight cold stress despite this improvement during warm and moderate months. While *Shanashir* type "C" is much more suitable for the mild and warm months of the year, it creates below the comfort zone condition on some days of the cold months of the year (February and March).

The effectiveness of *Shanashir*'s roof type: To analyze the roof effect, we created three models as 1) with a roof of 30 degrees (D), 2) a roof of 45 degrees (C), 3) without a roof (I). It was observed that *Shanashir* type "C" provides 12 more days with no thermal stress in comparison to *Shanashir* "I." Strong heat stress also decreases for 24 days, and there are five fewer days with slight cold stress in "C." Type "C" *Shanashir* showed a better performance than "I" in the mild and warm months of the year. It reduced the temperature by about 6 and 4.5 ℃ in the warm and moderate months of the year, respectively. However, it also showed about 2 ℃ reduction for cold months, which is not appropriate and needs attention. *Shanashir* type "C" provides five days more with no thermal stress in comparison to *Shanashir* "D," and strong heat stress also decreases for five days. In comparison to type D, type C is more suitable for the mild and warm months of the year as it reduces the temperature by about 2.5 ℃.

The results of modeling 3 types of *Shanashirs* with the ordinary fence were also compared in 3 models with different roofs, including 1) a roof of 30 degrees (B), 2) a roof 45 degrees (A), and 3) without a roof (H). *Shanashir* type "A" and "B" exhibit almost similar performance in terms of days with no thermal stress. However, strong heat stress decreases for four days for the 45-degree roof, which highlights its effectiveness. "A" is slightly performs better than "B" in the mild and warm months of the year by reducing the temperature by about 1 degree. *Shanashir* type "A" and "H" are roughly similar in days with no thermal stress because, in both models, the temperature is very high on the hot days of the year and is outside the comfort range; nevertheless, the presence or absence of a roof has reduced the number of days with strong heat stress by 20 days which is a significant number and shows the proper performance of the roof of the *Shanashirs*, particularly in hot and temperate days of the year. "A" is more suitable than "H" in the mild and warm months of the year, reducing the temperature by about 4 degrees in the warm months, but it is about 1 degree colder in cooler months. Overall in *Shanashirs* with both louver and fence patterns the roof of 45 degrees appears to be more compatible with this climate and context.

The effectiveness of *Shanashir*'s height: Two types of *Shanashir* with similar louver patterns and different heights were modeled: 1) *Shanashirs* with a height of 1.2m (C) 2) *Shanashirs* with a height of 2.4m (E). *Shanashir* type "C" and "E" are roughly similar in terms of days with no thermal stress and overall UTCI comfort percentage, but *Shanashirs* with smaller height is more appropriate, particularly in cold months with increasing the temperature by about 0.2 degrees.

The effectiveness of *Shanashir*'s depth: The results of modeling 2 types of Shanashirs with louver patterns and different depths were compared, including 1) *Shanashirs* with a depth of 1m (C) 2) *Shanashirs* with a depth of 2m (J). *Shanashir* type "C" decreases strong heat stress and provides one more day with no thermal stress in comparison with *Shanashir* "J". It also reduced the temperature by nearly 0.3 degrees which shows that the most efficient *Shanashirs* are the ones with less depth in this context.

The effectiveness of *Shanashir*'s facade angle: The results of 3 simulated *Shanashirs* including wooden louvered Shanashirs with vertical facade and 1.2m height (D), facade type of 15 degrees sloping and height of 1.2 m (F), and facade type of 15 degrees sloping and height of 2.4 m (G), were compared. *Shanashir* type "F" decreases strong heat stress and provides one more day with no thermal stress in comparison to *Shanashir* "G". The 0.5 degrees difference between two models (F, G) presents that *Shanashir* with facade type of 15 degrees sloping helps to decrease the semi-open space balcony's temperature which is appropriate in warm and moderate months but on the other hand, on some cold days the cold stress increases. *Shanashir* "D" also decreases the temperature by virtually 0.5 degrees in comparison to

"F" which highlights the effectiveness of sloping facades for *Shanashir*, particularly for warm months.

Table 5 Summary of simulation results for each Shanashir model type

Shanashir type	A	B	C	D	E
UTCI range: 3	116	120	85	90	84
UTCI range: 2	56	56	63	62	63
UTCI range: 1	19	16	21	22	22
UTCI range: 0	155	156	166	161	165
UTCI range: -1	19	17	29	29	30
% of comfortable time	42.3	41.7	45.5	44.1	45.2
Shanashir type	F	G	H	I	J
UTCI range: 3	88	88	136	109	86
UTCI range: 2	61	61	47	60	62
UTCI range: 1	24	23	13	18	22
UTCI range: 0	162	163	156	154	165
UTCI range: -1	29	29	13	24	29
% of comfortable time	44.4	44.7	41.7	42.2	45.2

Table 6 Average temperature for each simulated model(C)

Shanashir Models	A	B	C	D	E
Warm months (May-Sep)	37.3	38.3	30.9	32.5	30.7
Moderate months (Mar, Apr, Oct, Nov)	27.7	28.6	22.7	24.3	22.5
Cold months (Dec-Jan)	19.1	19.5	16.5	16.6	16.1
Shanashir Models	F	G	H	I	J
Warm months (May-Sep)	32.1	41.1	41.1	37.0	31.1
Moderate months (Mar, Apr, Oct, Nov)	23.9	30.4	30.4	27.4	22.9
Cold months (Dec-Jan)	16.6	20.2	20.2	18.5	16.4

Conclusion

This paper presents a detailed evaluation of the thermal performance of ten distinct types of *Shanashirs* found in the historical fabric of Bushehr city, Iran. These vernacular architectural elements, while known by various names, are prevalent in regions sharing the same latitude, including Saudi Arabia, Mexico, the Indian subcontinent, and South Africa. The study meticulously simulates and compares the impact of various architectural design parameters of *Shanashirs*. These parameters include roof type, façade height, pattern, balcony depth, and façade orientation. The effectiveness of these parameters has been analyzed separately for different times of the year, categorized as cold months (January, February, December), moderate months (March, April, October, November), and warm months (May to September).

Results indicate that, in terms of roof type, a 45-degree roof type is more compatible with this climate by reducing the temperature by about 6.2 degrees on warm days, 4.7 degrees on moderate days, and 2 degrees on cold days. Intense heat stress on the balcony also decreased by about 24 days (Although warm days are the main challenge in this climate and a 45degree roof is appropriate, authors recommend a movable roof to remove the roof during colder days). Analyzing two different facade heights presents that *Shanashir* with a 1.2 meters height is appropriate by reducing the temperature by about 0.2 to 0.5 degrees on warm and moderate days. In terms of *Shanashir*'s pattern, wooden louvers with 7 cm spacing can reduce the average temperature by about 7 degrees on warm days, 5 degrees on moderate days, and 2.6 degrees on cold days. This type of pattern helps to decrease the number of days under severe heat stress by 31 days (1 warm month of the whole year) and it can provide 10 more days with no thermal stress. By reducing the average temperature of 0.3 degrees *Shanashir* with a balcony of 1 to 1.2 meters depth is more appropriate. And, for models with more depth (up to 2 meters), the façade orientation of 15 degrees which reduces the temperature by 0.3 to 0.5 degrees would be more appropriate. Overall, results present that *Shanashir* type E in table 5 (with 1.2 meters height, wooden louvers, 1.2 m depth, and 45-degree roof angle) is the best model between simulated models for Bushehr's hot and humid climate.

Previous investigations into the functions of *Shanashirs* have predominantly been descriptive in nature, with a notable absence of studies that evaluate the physical attributes and thermal impacts of these architectural elements through simulation, particularly using data collected directly from the field. Predominantly found in the old quarters of Bushehr, *Shanashirs* are generally oriented towards the sea, facing North and Northwest. This directional preference has been mirrored in our simulated models, which align with the orientation of the case study under consideration.

One limitation of this study is employing the UTCI in the Middle Eastern context, acknowledging its potential inadequacy in fully capturing Bushehr's unique climatic nuances for thermal comfort. This highlights the necessity for future research using localized standards tailored to the region's specific conditions. Moreover, future studies should explore the effects of varying building orientations in relation to *Shanashirs*. In addition to their thermal benefits, *Shanashirs* are known to significantly influence indoor environments. They play a crucial role in moderating direct sunlight and glare, as well as in regulating relative humidity and air circulation.

There is a pressing need for comprehensive studies aimed at determining the optimal design parameters of *Shanashirs* and similar vernacular architectural features in other regions that share comparable climatic conditions and latitudes. Such studies should consider a range of environmental factors, including but not limited to thermal comfort. This approach would significantly contribute to our understanding and application of these traditional architectural elements in modern sustainable design.

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