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Elucidating a Passive Architecture-Based Energy Optimization Model with Emphasis on the Climatic Characteristics of Shiraz

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Abstract

The increasing energy consumption in contemporary buildings in Shiraz, along with the declining consideration of vernacular and climate-responsive architectural principles, has highlighted the urgent need to reconsider current building design strategies. In this context, passive architecture, which relies on climatic conditions and indigenous knowledge, is recognized as one of the most effective approaches to improving energy efficiency and reducing dependence on mechanical systems. However, many of its fundamental principles have been neglected in the design process of modern buildings. This study aims to identify and analyze the key factors affecting energy consumption optimization in the passive architecture of Shiraz. The research adopts a qualitative review approach, and the required data were collected through a systematic review of library resources, peer-reviewed scientific publications, and documents related to the vernacular architecture of Shiraz. Data were analyzed using a descriptive–analytical method. The findings indicate that seven key components, including appropriate building orientation, an optimal window-to-wall ratio, central courtyards, deep verandas (Iwans), sand catchers, wind catchers (Badgirs), and the use of indigenous building materials with high thermal mass, have the greatest impact on reducing energy consumption. Furthermore, the results reveal that the integrated application of these components can significantly reduce the demand for active heating and cooling systems. Therefore, the proposed framework can serve as a practical guideline for designing climate-responsive buildings and enhancing energy efficiency in Shiraz, providing valuable insights for architects, researchers, and building designers.

Keywords: Passive architecture, Vernacular architecture of Shiraz, Energy efficiency, Energy consumption optimization, Climate-responsive design.

1 | Introduction

In recent years, the increasing energy consumption in the residential sector, particularly in hot and dry climates, has become one of the major challenges in architectural design. The city of Shiraz, with characteristics such as hot summers, mild winters, high solar radiation intensity, and significant diurnal

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temperature fluctuations, provides a suitable context for applying passive architectural strategies. In response to climatic conditions, the vernacular architecture of this city has developed a set of intelligent solutions through introverted spatial organization, solar radiation control, the use of thermal mass, natural ventilation, and the selection of appropriate materials. These strategies can play an effective role in reducing the dependence on fossil fuels for heating and cooling.

Despite these potentials, vernacular patterns are often overlooked in many contemporary designs or are applied without accurate quantitative analysis. Moreover, the thermal performance of buildings is the result of the simultaneous interaction of multiple variables, including form, orientation, window-to-wall ratio, material properties, site configuration, and shading patterns. This complexity highlights the necessity of employing multivariate analysis approaches.

The present study adopts a passive architecture-based approach to conduct a multivariate analysis of the factors affecting energy consumption optimization in the vernacular design of Shiraz. The research methodology is based on a case study analysis of several selected vernacular houses in Shiraz. After extracting climatic and physical indicators, their thermal performance is evaluated under different design scenarios. The primary objective of this research is to identify the most effective combination of design variables for reducing heating and cooling loads and to provide practical strategies for contemporary design, particularly in residential villa projects. In this way, a sustainable balance can be established between vernacular identity and energy consumption optimization requirements.

2 | Literature Review

A review of previous studies indicates that numerous investigations have been conducted on climate-responsive architecture and energy consumption optimization in Iran and worldwide.

Among domestic studies [1], a study entitled "Investigation of passive design patterns in traditional houses of Shiraz," demonstrated that elements such as central courtyards, northern and southern verandas, and traditional wind catchers have a direct impact on moderating indoor temperatures. The study reported a summer temperature reduction of 4 to 7°C in the summer living rooms of traditional Shiraz houses.

Furthermore, Keshavarz et al. [2], through a field study of 10 traditional houses in Shiraz, including Zinat al-Molk house and Salehi house, concluded that the window-to-wall ratio on the southern façade should not exceed 25%. They also found that the use of vertical and horizontal shading devices could reduce direct solar radiation by up to 60% during peak hours.

In a multivariate approach, [3] employed DesignBuilder software to simulate the simultaneous effects of orientation, insulation, glazing type, and natural ventilation in a sample building in Shiraz. The results indicated that the optimal combination of these four variables could reduce annual cooling loads by 35% and heating loads by 28% compared with the baseline condition.

Farrokhzad and Choobdar Saadabad [4], in their review article entitled "passive architecture in the hot and semi-humid climate of Iran," emphasized that previous studies have mainly focused on physical and morphological variables. In contrast, behavioral and cultural variables of occupants have received less attention. They identified the lack of integrated multivariate models as a major research gap.

In the field of vernacular materials, Daryavazi Sorva and Heydari [5], through an experimental study, evaluated the thermal performance of traditional Shiraz adobe and brick compared with modern cement blocks and clay blocks. They demonstrated that the high thermal mass of adobe, with a time lag of approximately 6 hours, reduces indoor temperature fluctuations compared with contemporary materials, which typically provide a time lag of only 2 to 3 hours.

At the international level, Chenvidyakarn [6], in a multivariate evaluation model for passive design in hot climates, introduced six key variables, including orientation, shading, natural ventilation, thermal mass, insulation, and surface-to-volume ratio. This framework has subsequently been used as an initial reference model for multivariate analyses in later studies.

Cojocaru and Isopescu [7], through a review of 120 studies related to vernacular architecture in the Middle East, concluded that the success of passive systems depends on the simultaneous interaction of at least three categories of factors: climatic factors (solar radiation, temperature, and humidity), physical factors (form, openings, and materials), and behavioral factors (lifestyle patterns and expected comfort levels). This finding is fully consistent with the multivariate approach adopted in the present study.

Furthermore, Nasrollahi et al. [8], in a comparative study of vernacular architecture in Shiraz and Riyadh, demonstrated that despite climatic similarities, differences in material properties, veranda depth, and courtyard configuration resulted in different thermal performances. They emphasized that international passive design solutions cannot be effectively applied in Shiraz without regional adaptation.

The literature review indicates that an integrated multivariate analysis of the simultaneous interaction between physical, climatic, and material-related factors in the passive architecture of Shiraz has not yet been comprehensively conducted. Therefore, the present study attempts to address this research gap through a qualitative review approach and analyze the multivariate relationships among these factors.

3 | Theoretical Foundations

3.1 | Vernacular Architecture of Shiraz and Passive Architecture

3.1.1 | Vernacular architecture of Shiraz

According to the Köppen climate classification, the city of Shiraz is located within a hot semi-arid climate zone. This Climate is characterized by hot and relatively dry summers and mild winters. Relatively high diurnal temperature variations, intense solar radiation, limited annual precipitation, and significant differences between daytime and nighttime temperatures are among the key climatic features of this region, which have played a decisive role in shaping its vernacular architecture [2], [9].

The traditional architecture of Shiraz represents profound evidence of the climatic understanding developed by the inhabitants of this region over centuries. In response to the hot and dry Climate of Shiraz, characterized by long summers with high temperatures and relatively mild winters, vernacular approaches have been intelligently developed to reduce energy demands and enhance thermal comfort in buildings.

The use of materials with high thermal mass, such as adobe and brick, along with thick walls, provides the capacity to absorb and store solar heat during the day and gradually release it at night, thereby moderating temperature fluctuations. Furthermore, optimal building orientation, the density of urban fabric in some areas, and the presence of elements such as central courtyards with gardens and water features significantly contribute to creating favorable microclimates and reducing direct solar heat gain.

These achievements provide a foundation for understanding the principles of sustainable architecture in the region. Some researchers believe that traditional Iranian houses and their construction have been based on climatic considerations and environmental factors [2], [10].

3.1.2 | Climate and its characteristics

Shiraz is located in a hot and dry climatic region, characterized by long, hot summers, mild winters, seasonal precipitation, and intense solar radiation. Accordingly, the main design challenge in this Climate is addressing the need for cooling during summer and heating during winter.

Dr. Tavousi et al. [11], in a study examining the Relationship between Climate and the architecture of newly constructed schools in Isfahan, concluded that the orientation and arrangement of buildings (east–west elongation) were consistent with the climatic standards of the city. Moreover, considering the placement of windows, which were predominantly oriented toward the north and south, natural ventilation in most schools was found to be appropriate.

Location, boundaries, and extent of Shiraz

Shiraz, as the capital of Fars province, is located on an approximately rectangular plain at 29°37' north latitude and 52°32' east longitude. The city is situated at an elevation of approximately 1540 meters above sea level and is located 895 kilometers from Tehran, the capital of Iran [3], [12].

Solar radiation

The most significant natural factor responsible for continuous variations in the climatic conditions of a location on Earth is solar energy. Since solar energy is not only the primary source of light and illumination but is also ultimately converted into heat, it has a substantial impact on the climatic conditions of a region.

Considering the exposure of different building façades at various times of the day and the varying amounts of received solar energy, it can be concluded that the favorable solar exposure of the southern and southeastern façades allows the creation of desirable indoor conditions in both summer and winter with minimum solar gain.

Morning sunlight from the east façade is desirable during winter; however, it should be controlled during the early morning hours in summer. On the western façade, spaces that are not used during the afternoon can be considered. The northern façade does not receive direct solar radiation at any time of the year but benefits from sufficient daylight.

Solar radiation control through shading devices is particularly important for the southern windows of residential buildings. North-facing windows and openings contribute less to solar heat gain and are primarily effective in providing natural ventilation for interior spaces. Therefore, by reducing and minimizing east- and west-facing openings, shading design should be carefully considered for southern windows.

Wind

Shiraz is influenced by northwestern, southern, and local winds, which can be classified into four categories. Northern winds, originating from Siberia, are cold and dry. Western winds, originating from the Atlantic Ocean and the Mediterranean Sea and moving toward the Zagros mountains, are moisture-bearing and associated with rainfall. Southern air masses, originating from Arabia and moving toward Fars province and Shiraz, are warm and dry [13].

Designing streets and alleys along favorable wind directions can facilitate the penetration of cool air into the urban fabric and, on the other hand, contribute to the removal of urban air pollution.

Relative humidity

Due to Shiraz's distance from the sea, relative humidity levels remain moderate. The dominance of dry months during the summer half of the year and the lack of or reduction in precipitation during these months lead to a significant decrease in relative humidity. The minimum relative humidity during the hottest months of the year, namely June, July, and August, is approximately 10%, while the maximum reaches 33%. During winter months, particularly December and January, the maximum relative humidity can reach 81%.

However, due to relatively favorable vegetation growth resulting from sufficient annual precipitation, part of the atmospheric moisture is supplied through plant evaporation and transpiration. In addition, the presence of Qasr al-Dasht gardens and northwestern areas of Shiraz plays an important role in improving air quality and moderating the Climate of municipal districts 1 and 6. Nevertheless, appropriate measures should be considered for other areas of Shiraz.

Precipitation

The precipitation pattern in the urban region of Shiraz, similar to the Iranian central plateau, is predominantly winter-based. Annual precipitation varies from year to year, and rainfall occurs periodically. Some years experience relatively high precipitation, while other consecutive years may be associated with reduced rainfall and drought conditions. In general, rainfall is irregular and may vary significantly annually.

The integration of architecture and urban fabric in Iranian cities, including Shiraz, demonstrates that climatic factors have played a major role in shaping the logical structure of urban patterns and architectural compositions in these regions. Climatic issues have always been considered significant challenges for the inhabitants of these areas. Over thousands of years, these challenges have encouraged people to develop solutions that remarkably reduce unfavorable climatic effects while taking advantage of beneficial climatic conditions [2], [14].

Formation of Shiraz's urban fabric and architecture in relation to the physical and climatic environment

Among the factors influencing the structure and appearance of cities, environmental factors play a significant role in shaping urban form. These factors affect cities through the following aspects:

I. Allowing the entry of favorable winds into the urban fabric.

II. Providing appropriate building orientations to maximize the use of sunlight according to climatic conditions.

III. Blocking the penetration of undesirable winds.

IV. Influencing the selection and type of construction materials.

V. Adjusting the amount of glazing used according to temperature conditions and solar angles.

VI. Affecting the selection and type of urban systems, such as cooling and heating facilities.

VII. Influencing street networks through the creation of shaded surfaces, narrow pathways, and similar features.

3.1.3 | Passive architecture

Definition of passive architecture

Passive design refers to a set of architectural and engineering strategies in which the form, physical structure, and materials of a building are selected and organized in such a way that they can automatically provide environmental comfort conditions without relying on fossil fuels or electrical energy.

In this approach, the building itself functions as an energy conversion and storage system rather than merely serving as an enclosure for mechanical equipment. In general, passive design refers to the design of buildings that maximize the use of natural energy sources (such as solar energy and wind) while reducing dependence on active mechanical systems for heating, cooling, and lighting.

Difference between active and passive design in sustainable architecture

Active design: Active design relies on mechanical and electrical systems, such as chillers, boilers, pumps, and Building Management Systems (BMS), for heating, cooling, and ventilation. These systems require external energy inputs (such as electricity or gas) to operate.

Passive design: Passive design relies on building physics and natural forces. Examples include the use of solar radiation for heating (solar gain), wind flow for cooling (natural ventilation), and wall thickness for maintaining indoor temperatures. These systems do not require mechanical components and operate based on environmental renewable energy sources.

Key principles of passive architecture

Solar radiation management (orientation): using appropriate building orientation to optimize solar exposure. For the Climate of Shiraz, the most suitable orientation is aligned with the Isfahani axis (Roon-e Esfahani).

I. Designing effective shading devices (for windows, balconies, and louvers).

II. Managing solar radiation by allowing sunlight penetration during winter and preventing excessive solar gain during summer.

Utilization of thermal mass: using heavy-weight construction materials to absorb heat during the day and release it gradually at night (and vice versa during winter) to moderate indoor temperature fluctuations.

Natural ventilation: using temperature and air pressure differences to create airflow through mechanisms such as the stack effect and cross ventilation. Openings play a significant role in facilitating this process.

Thermal insulation: reducing unwanted heat transfer through building envelopes, including walls, roofs, and floors.

Energy efficiency in active systems (when used): optimizing energy consumption in cases where mechanical systems are required to maintain indoor comfort conditions.

3.1.4 | Relationship between vernacular architecture and passive architecture

Vernacular architecture and passive architecture are two deeply interconnected concepts. Vernacular architecture is the result of centuries of practical experience and the intelligent interaction between humans, Climate, and the natural environment [15]. In contrast, passive architecture refers to a design approach that provides thermal comfort without relying on mechanical systems by utilizing building elements such as orientation, appropriate materials, natural ventilation, and shading strategies [16].

The Relationship between these two concepts arises from the fact that vernacular architecture inherently and unconsciously incorporates passive design principles. Without access to modern scientific knowledge, past generations developed strategies through observation of nature and practical experience that are now recognized as passive techniques [17]. Central courtyards, wind catchers, shanashirs (traditional ventilation and shading elements), deep verandas, thick adobe walls, and double-layered domes are examples of passive strategies widely found in the vernacular architecture of Iran and other regions of the world [18].

Studies have shown that vernacular buildings can achieve thermal comfort through these systems without requiring mechanical equipment. For example, investigations of vernacular architecture in Iran's arid regions indicate that the use of high thermal mass adobe walls and wind catchers can reduce cooling loads by up to 70% [19]. Furthermore, the principles employed in vernacular architecture have the potential to be adapted and implemented in contemporary buildings [20].

Therefore, vernacular architecture should not be considered merely a historical style; rather, it represents a valuable source of operational and proven knowledge in passive design. Reinterpreting this knowledge can serve as a bridge between the past and the future of sustainable architecture.

To explain how the principles of Shiraz's vernacular architecture correspond with passive architecture principles, Zinat al-Molk House has been examined as a case study to demonstrate the alignment between vernacular architecture and passive design strategies. This building effectively illustrates the balance between aesthetic qualities and climatic performance.

Central courtyard: microclimate management

In Zinat al-Molk House, the central courtyard functions beyond a simple spatial organizer and acts as a thermal regulator. Through the presence of vegetation (particularly bitter orange trees) and a water pool, the courtyard becomes a cooler environment compared to the outdoor surroundings. From a passive architecture perspective, this represents an evaporative cooling strategy, in which increased humidity and air pressure differences within the courtyard contribute to the movement of cooler and more humid air toward the surrounding verandas and halls.

Veranda and Orosi windows: shading and solar control

The high verandas located on the southern side of Zinat al-Molk House are prominent examples of passive shading strategies. During summer, these verandas create deep shadows that prevent direct solar radiation from entering the halls. In winter, due to the lower solar altitude, they allow sunlight penetration and provide mild solar heat gain.

Furthermore, the use of Orosi windows with colored glass is not merely an aesthetic feature; it also functions as a light filter, controlling excessive solar glare and establishing a balance between daylight and thermal conditions in interior spaces.

Thermal inertia: adobe walls and brickwork

The thickness of the walls in Zinat al-Molk House maximizes the thermal capacity of the building. These adobe walls, by delaying heat transfer, function as a thermal battery: they absorb heat during the hot days of Shiraz and gradually release it into the interior spaces during cooler nighttime hours.

This phenomenon corresponds directly with the passive architecture principle of thermal stability, which aims to maintain indoor temperature stability and minimize the need for mechanical energy consumption.

3.1.5 | Zinat al-Molk house and Narenjestan-e Ghavam house (relationship with Climate)

These two houses, due to their proximity and similarity in architectural style, employ similar strategies for energy control:

Access hierarchy and privacy

The use of the Hashti (entrance vestibule) and Dalan (corridor) functions as thermal filters. These transitional spaces prevent the sudden penetration of hot and dry outdoor air into the cooler interior spaces, allowing the air to be gradually moderated before entering the main areas of the building.

Use of the central courtyard (sunken garden)

The courtyard serves as the functional core of these houses. By creating temperature differences between the ground level and lower spaces, along with the shading provided by surrounding walls, the courtyard establishes a cool microclimate.

The vegetation and water pool located within the central courtyard contribute to humidity regulation through evaporation and plant transpiration, supplying the required moisture to the air and significantly reducing the surrounding temperature.

Table 1. Climatic elements present in buildings.

Climatic Indicator	Narenjestan-e Ghavam House	Zinat al-Molk House
Central courtyard	Symmetrical central courtyard functioning as a regulator of environmental temperature and humidity; the presence of vegetation and water features contributes to microclimate improvement.	Central courtyard and sunken garden (Godal-Baghcheh) located below the surrounding ground level, enhancing thermal insulation and creating a cooler microclimate.
Solar radiation control	Deep columned verandas provide extensive shading during the day and reduce direct solar heat gain.	High ceilings and Orosi lattice windows filter sunlight, reduce glare, and regulate daylight and solar radiation penetration.
Materials and thermal mass	Thick adobe walls with brick finishing provide high thermal mass and delay heat transfer, reducing indoor temperature fluctuations.	Thick adobe walls and heavy construction elements provide thermal inertia, balancing indoor temperatures between day and night.
Ventilation and airflow	Spatial arrangement of verandas, halls, and transitional spaces facilitates natural airflow and passive cooling.	Intermediate spaces such as corridors and vestibules moderate incoming air and improve natural ventilation within the building.
Water and vegetation elements	Large pool house (Howz Khaneh), central pool, and surrounding gardens increase humidity through evaporation and contribute to a cooler microclimate.	Central pool and surrounding gardens enhance evaporative cooling and improve thermal comfort in interior and semi-open spaces.
Spatial organization and climatic buffering	Hierarchical spatial organization, including entrance vestibule (Hashti) and transitional spaces, reduces direct penetration of hot and dry outdoor air.	Use of transitional spaces and layered spatial organization creates climatic buffers between outdoor and indoor environments.

Fig.1. Narenjestan-e Ghavam house.

Fig. 2. Zinat al-Molk house.

Passive architecture represents a fundamental approach in sustainable design that utilizes natural principles and architectural elements to provide occupants with thermal and visual comfort without relying on energy-intensive mechanical systems. These strategies aim to minimize the building's need for heating during cold seasons and cooling during warm seasons.

Among the most important passive strategies are solar radiation control through the design of shading devices, balconies, and the use of appropriate vegetation. The application of natural ventilation through windows, ventilation shafts, and the stack effect facilitates air movement and helps remove excess heat.

Furthermore, selecting materials with suitable thermal properties, such as effective insulation and the use of thermal inertia in walls and floors, plays a crucial role in maintaining desirable indoor temperatures. This approach not only significantly reduces energy consumption but also enhances the quality of life and thermal comfort of building occupants.

Table 2. Passive architecture strategies.

Passive Design Strategy	Role / Function
Central courtyard	Regulating temperature, providing shading, and facilitating natural ventilation (through stack effect or cross ventilation)
Dense urban fabric and narrow streets	Creating shade and reducing direct solar radiation exposure
Connection with the ground (Basement / Cellar)	Utilizing the thermal mass of the ground for passive cooling
Verandas and balconies	Providing semi-open spaces for shading and promoting air movement
Materials	Using materials with high thermal mass (such as adobe, brick, and mud plaster) to absorb and gradually release heat
Walls	The thickness of walls and their role in delaying heat transfer (thermal lag)
Roofs	Different roof types and their role in thermal insulation
Openings (windows and doors)	Orientation of openings (mostly toward the courtyard), along with appropriate size and proportion to optimize daylight, ventilation, and solar control

3.1.6 | Parameters affecting energy consumption optimization in buildings

Optimizing energy consumption in building design is inherently dependent on a set of physical and geometric parameters that interact with one another to determine the thermal performance of a building. Climate, as one of the most significant environmental factors, directly affects human thermal comfort and building energy consumption. Climate-responsive design can minimize the need for active mechanical systems.

Multivariate analysis of these parameters provides a powerful tool for achieving a deeper understanding of these complex relationships and developing optimal solutions. Parameters such as the surface-to-volume ratio, which determines the extent of heat exchange between the building and its surrounding environment; the thermal transmittance coefficient (U-value) of materials used in the building envelope (walls, roofs, floors, and windows); air infiltration rate, which affects energy losses through building gaps and leaks; and the characteristics of openings (such as the Solar Heat Gain Coefficient (SHGC) and Visible Light Transmittance (VLT)) all play essential roles in determining the energy required for heating and cooling.

Understanding and analyzing these variables simultaneously enables informed design decisions and facilitates the development of buildings with minimum energy consumption.

4 | Conclusion

This paper was developed using a qualitative review approach with the aim of analyzing the factors affecting energy consumption optimization in the passive architecture of Shiraz. The research methodology was based on a systematic review of library resources, valid scientific articles, and documents related to the vernacular architecture of Shiraz. Information regarding significant examples, including Zinat al-Molk house, Narenjestan-e Ghavam house, and Salehi house, was collected through documentary studies and the review of published reports.

The results obtained from the qualitative review of the literature led to the identification of seven key factors that play a significant role in energy consumption optimization within the passive architecture of Shiraz: 1) north–south orientation with a maximum deviation of 10–15 degrees, which provides the highest efficiency in utilizing beneficial winter solar radiation while minimizing exposure to undesirable summer solar gains, 2) the window-to-wall ratio within the range of 20–25% on the southern façade, which has been confirmed in multiple studies, including investigations of Salehi House, 3) the central courtyard with water features and vegetation, which functions as a thermal regulator and appears as a consistent element in all examined case studies, 4) deep verandas with a minimum depth of approximately 1.5–2 meters, which have been identified in Narenjestan-e Ghavam House as an effective shading strategy, 5) vertical and horizontal shading devices, which, according to previous studies, can reduce direct solar radiation by up to 65% during peak hours, 6) traditional wind catchers and Shahneshin spaces, which function as key elements for natural cross-ventilation in Zinat al-Molk house, and 7) the use of heavy local materials (adobe and brick) with high thermal mass and a time lag of approximately 6 hours.

The most important finding of this study is that the success of Shiraz's passive architecture in optimizing energy consumption is not the result of a single factor; rather, it is achieved through the simultaneous, systematic, and intelligent interaction of these seven factors.

Since the methodology of this study is based on a qualitative review approach, the findings are derived from theoretical and analytical evidence available in the literature. Therefore, further research using quantitative methods and energy simulation tools is required to accurately generalize and validate these findings for contemporary buildings accurately.

Finally, contemporary architects and designers in Shiraz are recommended to avoid partial and single-factor adaptations of vernacular principles and instead consider this seven-factor model as an integrated framework in the design of new buildings. Future researchers are also encouraged to use the findings of this qualitative review as a theoretical foundation and employ quantitative methods, such as building energy simulation and field monitoring, to measure and prioritize the effectiveness of each factor in contemporary buildings of Shiraz.

Without the systematic reinterpretation and regeneration of these indigenous passive design patterns, which have been documented in numerous studies through valuable examples such as Zinat al-Molk house and Narenjestan-e Ghavam house, energy consumption in Shiraz's building sector will continue to increase. The valuable opportunity to benefit from the climatic wisdom embedded in these historical buildings will be lost.

Authors' Contributions

All aspects of the research and manuscript preparation were carried out by the author. The author has read and approved the final version of the manuscript.

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Data Availability

All data supporting the reported findings in this research paper are provided within the manuscript.

Conflict of Interest

The author declares that they do not have any conflict of interest.

Consent for Publication

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Ethics Approval and Consent to Participate

This article does not contain any studies with human participants performed by the author.

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