

Sustainability of Architecture in the Desert: Between Design Principles and Unity of Elements

استدامة العمارة في الصحراء بين أسس التصميم ووحدانية العناصر

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Abstract:

The majority of Arab lands consist of desert regions which need full study of desert characteristics and suitable urban development patterns for desert living before they can transform into habitable spaces for urban expansion. The analysis aims to study these patterns through pattern analysis to determine their positive and negative aspects which will lead to the creation of desert planning guidelines and urban designs suited for desert cities. The research investigates environmental methods used in desert architecture to support the creation of complete development plans for Arab desert cities.

Humanity has practiced sustainability since ancient times by following this concept for numerous centuries. Traditional architecture worldwide contains environmental adaptation and resource management principles because builders established these methods through long-term trial and error testing. People have used architecture since ancient times to protect themselves from external dangers through natural power sources which include sunlight and wind and soil potential.

The Arab city alongside desert palaces demonstrated this concept through Islamic teachings which included various sustainability guidelines. The principles created enduring effects on social systems and human behavior which led to major architectural transformations that shaped both city design principles and Islamic architectural heritage.

The research paper aims to explain sustainability by using Islamic teachings to analyze human-environment interactions in traditional architecture and residential spaces. This method studies sustainable design principles which help create desert cities and residential buildings that follow traditional planning practices.

Keywords: Sustainability; Traditional Architecture; Desert Cities; Urban Planning.

ملخص:

عندما نفكر في جعل الصحراء التي تشكل غالبية الأراضي العربية أرضية ملائمة لاستيعاب التوسع العمراني، فإن هذا لا يتم إلا بدراسة سمات البيئة الصحراوية وكذلك دراسة ما يلاءم تلك البيئة من أنماط عمرانية تناسب الحياة في المناطق الصحراوية، لذلك يسعى هذا البحث إلى دراسة الأنماط العمرانية من خلال التعرف على إيجابياتها وسلبياتها لتتمكن من وضع أسس تخطيطية للتعامل مع البيئة الصحراوية، وكذلك الوصول إلى تشكيل عمري يلائم المدن الصحراوية، وأيضاً نتعرف على بعض المعالجات البيئية المستخدمة في المباني الصحراوية عندها نتمكن من تحقيق التنمية الشاملة للمدن العربية الصحراوية.

مما لا شك فيه، أنه ما يصطلح عليه الاستدامة وهو لا يعتبر مصطلحاً جديداً أو مبتكراً، بل هو مفهوم جسدهته العمارة التقليدية في مختلف أرجاء العالم منذ القدم عبر التوافق العفوي التجريبي المترابط مع البيئة والاستغلال الكفء لمصادر البيئة الطبيعية وفق تطور حثيث من التجربة والخطأ على مر السنين. لقد كانت العمارة الوسيلة الأساسية التي ابتكرها الإنسان لحمايته من ظروف البيئة الخارجية القاسية

وذلك باستغلال مصادر الطاقة الطبيعية كالشمس والرياح وإمكانيات التربة.

وتجسدت في المدينة العربية بشكل عام والقصور الصحراوية بشكل خاص وفق تعاليم الدين الإسلامي التي تضمنت الكثير من مبادئ الاستدامة التي تداخلت مع التنظيم الاجتماعي والسلوك الإنساني للمجتمع والتي انعكست على النتائج العمرانية سواء على مستوى المعايير التخطيطية للمدن والتجمعات الحضرية أو ملامح العمارة التقليدية التي استمدت مضمونها من تعاليم الدين الإسلامي الذي كان شريعة الدين والدنيا للمجتمع. تهدف هذه الورقة البحثية لتحديد مفهوم الاستدامة في مراجع العمارة التقليدية عموماً، والمسكن بشكل خاص، من خلال استعراض العلاقة بين الإنسان والبيئة والحفاظ عليها في المنظور الإسلامي لاستخلاص مبادئ الاستدامة في تخطيط المدينة التقليدية الصحراوية والوحدة السكنية.

كلمات مفتاحية: الاستدامة؛ العمارة التقليدية؛ المدن الصحراوية؛ التخطيط العمراني، مواد البناء.

Introduction

Architecture emerged in ancient times as a means of fulfilling one of humanity's fundamental needs: shelter. It first developed in a spontaneous and evolving manner, with the primary aim of creating spaces that allowed individuals to carry out their activities while remaining protected from harmful environmental elements. Consequently, the human effort to shape and adapt space evolved alongside continuous interaction with surrounding conditions, striving to achieve the most comfortable and functional forms.

The development of architecture started at this point with specific construction methods which evolved differently based on the natural elements of each region. The development of architectural spaces emerged from the combined effects of social requirements and religious doctrines and cultural customs and intellectual movements. The evolution of architectural forms and techniques and movements showed a growing tendency to express human characteristics while creating spaces that blend with nature for better human comfort.

The Arab world contains large desert regions which extend across different climate zones and multiple geographical terrains. People from these regions developed architectural concepts which suited the harsh desert climate. The designs achieved their purpose by meeting operational needs while considering psychological elements and economic factors and maintaining social bonds and respecting cultural traditions and religious values.

Research Methodology

In this paper, we present:

- An overview of the climate in desert areas to study architectural styles that work well in these places and compare them to find the best building model.
- An explanation of planning methods used in desert architecture, such as compact or clustered planning, including what they mean and whether or not they work in desert settings.
- A study of building typologies categorized by height into two types: vertical and horizontal. The horizontal type may be inward-oriented or outward-oriented. This research will focus on the two variations of horizontal building.
- An outline of the advantages and disadvantages of each type, based on social, economic, and other considerations.
- A conclusion and recommendations to support the development of strategies for urban expansion in desert regions.

1. Climate of Desert Regions

The desert climate produces scorching summer heat which reaches extreme levels every summer. The temperature reaches up to 45°C in the shade during the day and it can get as high as 50°C and the temperature at night stays above 20°C. The extreme climate patterns emerge from the absence of clouds and vegetation since these elements produce strong sunlight exposure during daytime and create substantial cooling after sunset. The atmosphere holds minimal humidity because relative humidity stays at about 20 percent during midday before it increases to roughly 40 percent during nighttime. The area receives infrequent rainfall which occurs without warning through flash floods that rapidly move into surrounding valleys and low-lying areas. The local winds bring hot dry air that carries dust which leads to sandstorms and dust storms these two weather events define the desert climate.

The natural environment creates a direct impact on architectural design according to established knowledge. The desert climate forced people to create specific architectural structures which adapted to the various desert weather patterns.

1.1 Planning of Desert Architecture

Throughout history, architecture has reflected the cultural environment of each period. Since ancient times, settlements were built along the fringes of deserts, where the hot climate, combined with natural and social constraints, shaped distinct urban and architectural patterns suited to such conditions. The desert

environment directed architecture inward—whether at the scale of neighborhoods, individual dwellings, or entire cities—to ensure protection from extreme climatic factors.

Architectural forms and spatial arrangements often emerged spontaneously and organically, without prior adherence to specific aesthetic or formal principles. In this way, traditional architecture authentically expressed the functional, natural, cultural, and social contexts in which it developed. It also devised effective solutions to mitigate the impact of harsh environmental conditions. Buildings were typically contiguous or semi-contiguous, arranged in an irregular fabric clustered around internal courtyards that maximized shaded areas. The integration and interconnection of these interior spaces represent one of the most significant planning and design values of traditional architecture, particularly in residential buildings.

This organic form of planning minimized the exposure of architectural components—such as houses, streets, and passageways—to environmental influences like direct solar radiation, radiant heat, and airborne dust. Compact and cohesive planning patterns were therefore most suitable for hot-arid and desert climates, as they reduced exposure to severe external conditions. The question then arises: What is meant by compact or cohesive planning?

1.1.1 Compact or Clustered Planning

This refers to the compact organization of cities, where buildings are placed close together, clustered and aligned in contiguous rows. In arid desert environments, where temperature differences between summer and winter, as well as day and night, are considerable, compact and cohesive planning becomes necessary. This approach maximizes the shading that buildings cast on one another, created by variations in height and projections of external walls, ensuring that only minimal portions of facades and roofs are exposed to direct sunlight. As a result, heat gain and thermal infiltration into buildings are kept to the lowest possible levels.

1.1.2 Characteristics of Compact Urban Planning

One of the defining features of this type of planning is the design of narrow, winding streets. Such an arrangement reduces areas exposed to direct sunlight, contributing to thermal stability and helping retain cool air within street corridors. These streets are also oriented perpendicular to prevailing winds to reduce the impact of sand and dust, which can raise indoor temperatures.

The thermal stability of non-compact residential layouts encounters problems because their narrow street patterns and passageway designs do not provide effective solutions. The streets experience temperature increases because sunlight reaches the area directly while the ground absorbs heat and the walls bounce back the heat and the streets lack proper air movement. The combination of these elements results in narrow streets which function as heat storage areas that move their accumulated warmth into building walls through conduction.

The wider streets which most people view as harmful because they raise temperatures become more effective at reducing heat when street trees operate together with proper air movement.

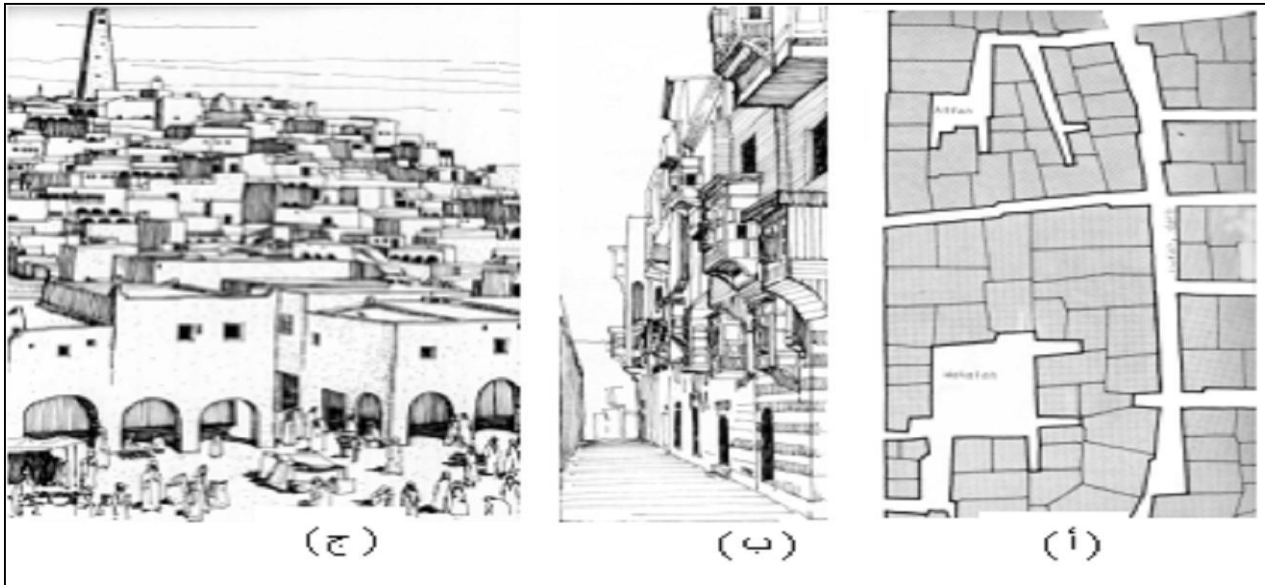
The planning method established during that time created beneficial social benefits for desert city neighborhoods which modern desert urban planning fails to address. The term "desert cities" fits these settlements because their origins trace back to ancient desert construction practices.

The research paper examines horizontal construction methods to evaluate their environmental adaptation for desert building sustainability. The model requires buildings to spread out horizontally while keeping their height between two and three stories with all structures facing inward toward central courtyards which function as main domestic areas. The design structure enables people to form closer social connections while allowing more people to live together than traditional open planning systems and it works well in desert areas.



An image of one of the desert palaces illustrating the principles of compact (or consolidated) urban planning.

Source: Compiled by the researcher



Figures A (أ) and B (ب) illustrate the urban fabric of the desert city, which emerged from local traditions and customs while remaining in harmony with the surrounding environment.

Figure C (ج) shows an example demonstrating the sequential arrangement of built forms and open spaces.

Source: Compiled by the researcher.

Before addressing the characteristics of traditional desert architecture, it is necessary to highlight the reality facing desert architecture today. In almost any neighborhood, multi-story apartment buildings dominate the landscape. Even those with the financial means to construct private residences often build multi-level houses that, in form and character, are entirely inconsistent with the principles of desert architecture. In effect, this represents a deliberate erasure of a rich material heritage, carried out with intent and persistence. This leads us to the following conclusions:

2. Compatibility and Adaptation to the Desert Environment and Climate

Our contemporary cities fail to achieve compatibility and adaptation with the desert environment for several reasons:

- Residential buildings are highly exposed to dust storms, glare, and an increased extent of surfaces subject to solar radiation.
- Open spaces and streets are uncovered and unshaded, limiting movement and mobility, particularly during daylight hours.
- The majority of building façades and ground surfaces are directly exposed to sunlight and external climatic factors. Moreover, the absence of sufficient shading during pedestrian movement is exacerbated by the fact that streets occupy a large proportion of the urban surface.

2.1 Privacy Considerations

This urban pattern fails to ensure the level of privacy residents require, primarily because of the lack of regulations governing the placement of external openings and projections. As a result, residents often find their privacy compromised. To address this, they install screens in front of openings or avoid opening windows altogether, relying instead on artificial lighting and mechanical ventilation to achieve visual isolation. In addition, the distances between buildings do not adequately protect privacy.

2.2 Street Planning

The street network is characterized by parallel through-streets with open ends. The permissible built-up area is about 60% of the total land plot. External doors and windows are installed without restrictions or regulations regarding neighboring properties, while all housing units share vertical and horizontal circulation elements as well as public services within the building. This planning approach has produced elongated streets and, consequently, increased through traffic. Such high volumes of vehicular movement have become one of the most disruptive sources of noise.

2.3 Noise Insulation

Urban buildings today lack tranquility, largely due to their outward orientation and the absence of a hierarchical street system in most cases.

2.4 Safety

This pattern fails to provide a sense of safety, as it lacks semi-private open spaces for children to play and offers no secure pedestrian pathways because of the overlap between pedestrian and vehicular movement. Moreover, residences that open directly to the exterior face security risks, most notably burglary. The planning model also leaves residential neighborhoods open to all passersby, diminishing their sanctity and making them vulnerable to intrusion.

2.5 Use and Distribution

Safe, shaded pedestrian pathways are not provided, as the planning scheme prioritizes automobile movement. Consequently, the design addresses the needs of vehicles rather than those of pedestrians.

2.6 Economic Aspects

This model increases demand for energy, as most building facades and surfaces are exposed to sunlight throughout the day, which raises reliance on air conditioning and electricity. Cars are also used for even the simplest errands. Excessive water consumption is another concern, since large uncovered yards and outdoor gardens require heavy irrigation under direct sunlight. The pattern has also produced dispersed housing in the form of villas, built within a grid-based land subdivision system. This has increased the costs of infrastructure, roads, sidewalks, and their maintenance.

In this model, the automobile is the dominant force shaping urban planning. Roads, parking spaces, and building entrances are designed mainly to serve vehicle movement and facilitate its flow. As a result, the human aspect of movement has been neglected: pedestrian mobility is overlooked, residential units are set far

apart to accommodate cars, and the proportion between building heights and street widths has become imbalanced, removing the shading that once protected pedestrians (Edwards & Turrent, 2000, p. 26).

2.7 Compatibility with Social Factors

This model does not foster deeply rooted human relationships; instead, it has contributed to the disintegration of social bonds. As a result, connections based on communal integration have weakened. Moreover, the buildings in this model fail to provide even the minimum conditions for interpersonal interaction, leading to social isolation. Consequently, the humanistic idea that individuals should be part of an integrated social system—embedded in the neighborhood or city and bound by shared values and principles—has been lost.

3. Sustainability and Desert Urban Planning

The construction of palaces and traditional desert cities relied on an analytical approach to climatic adaptation and on design principles for selecting building materials and construction methods for traditional housing units. This approach was based on an understanding of environmental factors and their impact on design. In addition, a procedural method was used, in which field measurements from samples of both traditional and modern housing units were converted into graphical representations. These data were used to evaluate the environmental performance of the buildings, particularly the thermal properties of the materials—such as heat capacity, thermal lag, and thermal resistance—selected to suit the hot-arid climate.

The concept of sustainability was inherently part of the lifestyle of traditional communities. The natural environment was their primary source of sustenance, so they did not define sustainability as a separate term. Instead, they embodied it intuitively in daily practices, resource management, and building techniques. Their interaction with the environment, along with their efficient use of natural resources, enabled survival through harmony with their surroundings. This included adapting to harsh conditions such as extreme climates and resource scarcity. For them, sustainability was a natural and unselfconscious way of life.

It is important to note, however, that this interaction with the environment was neither random nor purely instinctive. It was grounded in a rich legacy of knowledge accumulated over centuries of trial and error, guided by creative insight and perceptive understanding. Modern studies have confirmed the depth and long-term effectiveness of these practices.

Elements of sustainable design align closely with the principles of traditional architecture. The use of locally sourced materials and simple, well-considered techniques—developed directly from the local context—produced solutions that were both effective and environmentally responsive. These solutions relied on available resources without requiring the transformation or domination of nature.

The success of traditional architecture according to (Oliver, 1997, p. 23) in his Encyclopedia of Vernacular Architecture of the World comes from its rational adaptation to natural resources and weather conditions and community requirements. According to Brian Edwards sustainable architecture stems from the historical building methods which he explains in his research on sustainability and green architecture. The author explains that traditional architectural design brought together environmental needs with social sustainability elements to develop built spaces which blend with natural surroundings.

3.1 Interest in Sustainability and Traditional Architecture in the Arab World

Numerous sustainability advocates have demonstrated strong interest in preserving traditional Arab architectural heritage throughout the Arab world. The increasing focus on desert architecture appears in the expanding body of research about its elements including central courtyards and wind towers and their potential application in desert-like environments. Architects together with local populations now choose natural building materials like mud and straw because these resources help decrease reliance on limited and harmful conventional energy sources (Mortada, 2003, p. 156).

When we study traditional architecture, “we are essentially seeking the intellectual framework behind its construction to guide future building” (Gissen, 2003, p. 81).

The core principles of traditional desert architecture match the modern sustainability framework which integrates these principles. The essential purpose of sustainability demands organizations to fulfill their present requirements without damaging the capacity of upcoming generations to achieve their personal goals. Scholars who study history find that the Qur'an together with the Sunnah established sustainability principles which match modern environmental protection values since 1,400 years ago. People must use resources at a sustainable rate to protect future communities from resource shortages. The practice of sustainability requires organizations to reduce their harmful effects from resource usage which impact both human health and environmental systems.

3.2 Reflection of Sustainability Principles in Traditional Desert Urban Planning

The compact fabric of desert cities is a great example of how to use sustainability on a large scale. City planning, especially how circulation patterns are handled in terms of width, shape, length, orientation, and changes in direction, is a key step in adapting to the environment.

The cohesive urban fabric moderates the impact of harsh climatic factors and mitigates their effects, especially extreme heat, solar radiation, and dusty hot winds. Consequently, it reduces the thermal load on building façades, especially housing units, which make up most of the built environment in Arab cities. Housing, by virtue of its scale and prevalence, becomes a decisive factor influencing environmental outcomes.

Through such strategies, the traditional desert city illustrates how sustainability can be effectively embedded in urban form, not through abstract theory but through centuries of adaptation, practical ingenuity, and harmony with the environment.

3.3 From a Planning Perspective

Residential quarters were composed of clusters of housing units organized around central courtyards, forming an organically woven fabric. Between them lay alleys and circulation paths that were narrow, winding, and bordered by shaded semi-solid walls. Along with the internal courtyards of the houses, these elements functioned as thermal regulators for both individual dwellings and the city as a whole.

The vaulted, shaded alleys contained openings for lighting and ventilation at intervals of 12–15 meters. These created zones of high and low pressure, facilitating natural air movement that mitigated the severity of the hot, arid climate characteristic of desert regions in North Africa (Al-Zubaidi M. S., 2002, p. 12).

The traditional dwelling was an integral part of the urban fabric, not isolated or architecturally distinct. The homes of the wealthy and the poor coexisted within the same neighborhood unit without social or class-based distinction, whether in layout or external treatment. Differences lay only in the interior, reflecting one of the key features of traditional architecture: unity of outward form with internal diversity.

The distinction between rich and poor households was expressed through variations in size, area, and the number of courtyards. This, in turn, influenced the diversity of spatial organization, adding environmental advantages to the overall urban design. By creating zones of varied air pressure and circulation, the fabric facilitated natural air movement both across the urban context and within the dwellings themselves, between their multiple interior spaces.

3.4 Principles of Sustainability

Based on in-depth academic research into desert palaces in regions such as the M'zab Valley, the Mya Valley, the Righ Valley, Touat, and Gourara, the following key principles of sustainability emerge:

3.4.1 Planning and Site Integration:

Traditional architecture treated the site as an integral part of the urban fabric. The city's structure was organically compact, composed of building masses and residential quarters linked by streets and circulation paths. These varied in width and length according to their importance, the areas they served, and their level of privacy, whether public or residential.

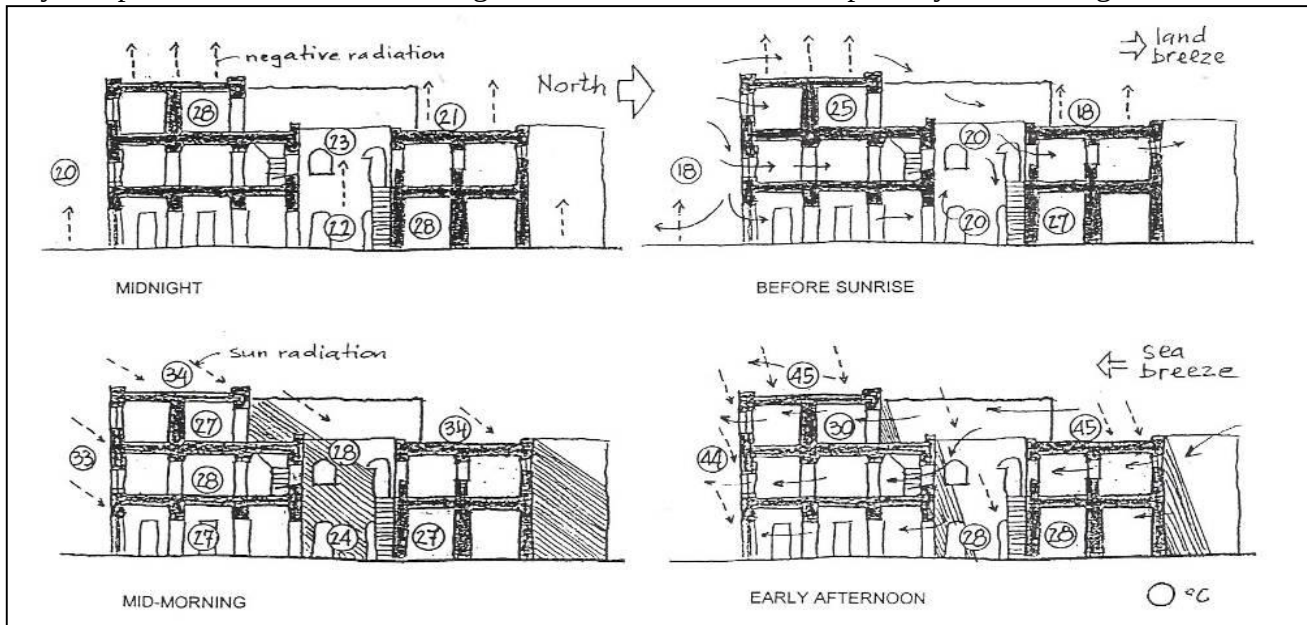
Adaptation to the surrounding environment began at the city planning level, with the degree of adaptation depending on privacy, location, and construction type. Traditional residential architecture relied on self-shading, achieved through adjacent housing units, narrow residential paths, and shaded passageways with vaulted roofs or rooms extending over alleyways from the upper floor. The central courtyard provided additional shading through its high walls, vegetation, and palm trees.



Source: Compiled by the researcher based on (Ragette, 2003, p. 44).

3.4.2 The Design Concept of the Traditional Dwelling

The traditional home design relied on the central courtyard as its main element to create an inward-focused architectural structure. The courtyard stands as a fundamental design element which has shaped architectural development across various civilizations throughout history despite different cultural settings and environmental conditions. The courtyard building demonstrates adaptability to various environments because it fulfills environmental needs and cultural and aesthetic requirements and social needs which include privacy and protection from outside dangers and weather extremes especially in warm regions.



Source: Compiled by the researcher based on (Ragette, 2003, p. 43).

3.4.3 Environmental Design and Energy Conservation

Environmental design functions as a system which supports passive energy consumption and decreases dependence on traditional energy sources because of its positive effects on financial stability and environmental protection and public health benefits and renewable energy promotion.

The goal becomes achievable through the combination of natural elements with geographical features which produce power and create living spaces that preserve the environment's original state. The traditional home demonstrates environmental design excellence through its construction methods and building materials and natural energy-based environmental solutions which create comfortable indoor settings .

The traditional home functioned in harmony with its environment according to sustainability principles through its use of natural elements like sunlight and wind and local materials and topography and it respected community traditions and values.

3.4.4 Natural Ventilation in Traditional Systems

Natural ventilation is one of the key strategies in traditional housing for reducing thermal loads and releasing stored heat from the building envelope, thereby creating a comfortable indoor environment. While windows on the ground floor are minimal or entirely absent on façades facing streets or alleys, traditional architecture developed innovative methods to ensure natural ventilation.

The central courtyard functions as the “lung” of the dwelling, acting as its main thermal regulator by taking advantage of the pronounced day–night temperature differences. Wind catchers (malqaf) are the primary devices for capturing breezes and directing them into interior spaces. They work by creating pressure differences between indoors and outdoors, allowing air to enter, be filtered and humidified, and then exit through higher openings or through additional suction wind catchers in the courtyards. At night, the process often reverses, with air moving through these openings and circulating within the living spaces.



Source: Compiled by the researcher based on (Ragette, 2003, p. 69).

3.4.5 Building Materials and Thermal Performance of the Building Envelope

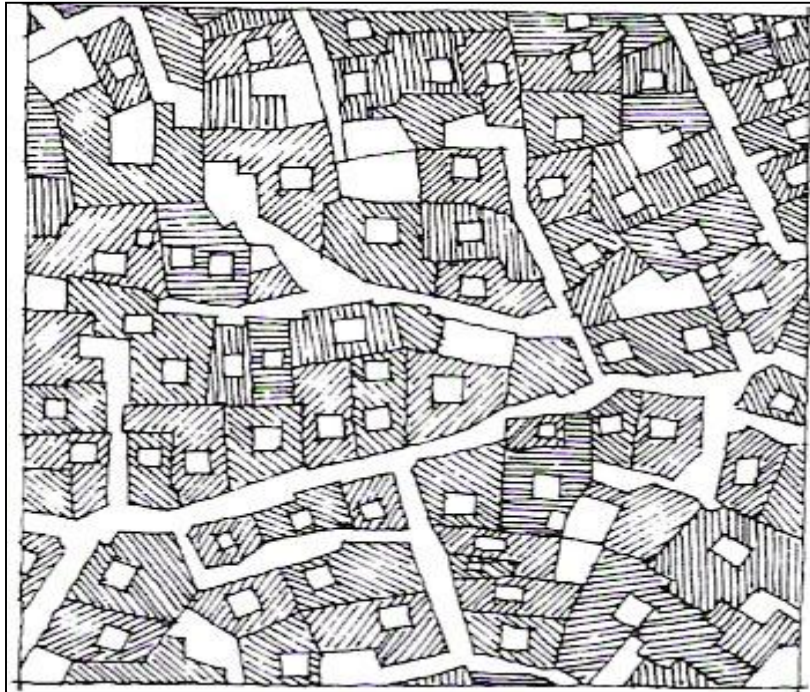
The building envelope functions as the main protective layer in traditional architecture which separates interior spaces from outside elements. The system protects indoor areas from extreme weather conditions by creating comfortable spaces inside. The envelope consists of multiple building materials which contain different physical and thermal characteristics. The evaluation of envelope thermal performance depends on material combinations because it shows how well heat transfer resistance and heat gain reduction work together (Hyde, 2001, p. 115).

Traditional dwellings relied on locally available, durable materials such as mud bricks, stone (lasting for centuries), gypsum, and palm trunks and fronds, which were used to build residential units and most architectural elements. These materials are generally massive in nature—mud bricks for walls and stone for foundations—and have high thermal capacity. Their thickness allowed them to store large amounts of solar heat during the day and gradually release it outdoors after sunset, once the heat source had disappeared. This cycle of storage and release balanced heat gain and loss through the envelope, producing a more uniform indoor temperature. In effect, it reduced the impact of external thermal loads by absorbing them within the mass of the envelope (Giovani, 1998, p. 120).

From this analysis, we can conclude that the thermal performance of traditional dwellings approached the threshold of human thermal comfort, achieving greater thermal stability without mechanical air-conditioning. This meant reduced energy consumption, lower operational costs, and minimal environmental impact. Such results were achieved through the effective use of locally available, environmentally compatible, and recyclable materials—principles that align with the foundations of sustainable architecture.

3.4.6 Achieving Privacy

In this architectural model, orienting the dwelling toward the internal courtyard offers several advantages. It ensures residents' privacy, creates a more temperate microclimate, and allows expansion according to family size. This inward orientation reduces external openings, thereby enhancing both visual and auditory privacy.



The Spatial Configuration of Internal Courtyards and Their Relationship to the Urban Fabric in Environmental Adaptation and the Achievement of Privacy

Source: Compiled by the researcher

3.4.7 Noise Insulation

The inward-facing courtyard protects the building from external noise by functioning as an essential part of the structure. The home contains an inner room which stands in the middle of the building and is surrounded by other construction elements to block out all outside noises. The courtyard creates a peaceful interior environment which allows people to perform their daily tasks without any outside disruptions .

Research indicates that courtyard houses defend their residents from outside noise because the walls around the courtyard function as sound barriers which create peaceful auditory conditions. The courtyard functions as a barrier between the inside and outside world to block noise from entering the home and to prevent sound from escaping to the outside. The system produces two effects which work together to control noise spread into nearby residential areas .

Research shows that internal courtyards prove better at noise reduction than external courtyard designs. The system produces sound levels which match human hearing comfort standards to create spaces that promote tranquility and livability.

3.4.8 The Social Dimension

This dimension supports social security for residents, which can be explained as follows:

- The program enables people to access protected areas.

- The design separates pedestrian routes which produces protected zones for social activities including meetings and human connections. The neighborhood gets better when people help each other which creates outdoor spaces for residents to use.
- The system establishes connections between residential pedestrian routes and neighborhood core pedestrian zones which contain public facilities. These areas need to function for neighborhood residents instead of taking control of the cityscape while promoting safe walking areas.

Research shows that this design pattern creates welcoming community spaces where people can conduct daily activities through protected areas which generate feelings of safety. The design functions as a protective barrier for residential areas against criminal activities because outsiders encounter major obstacles when trying to enter the area. The design integrates semi-private areas which allow neighbors to connect with each other while building community bonds. The residential space contains private rooms which provide absolute confidentiality.

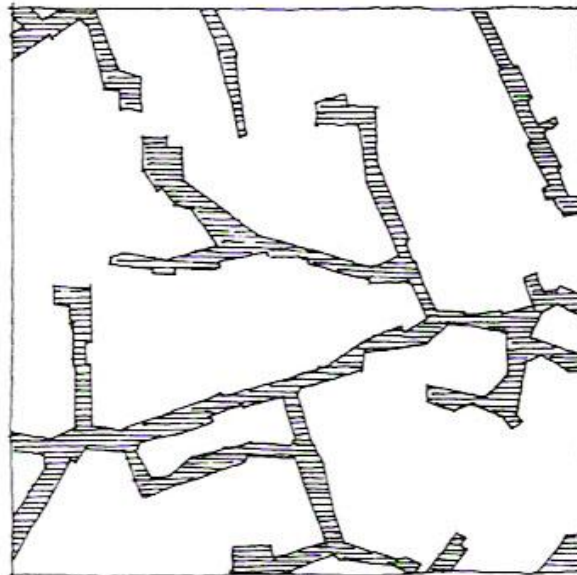
The design pattern arranges different spaces in a particular order which places residential play areas before community gathering spots and then public areas. The different levels of achievement create a sense of belonging among the members of the community.

This was evident in most layouts of desert palaces, which often featured cul-de-sac pathways, known as limited corridors. Social equality among community members was also a key goal of social sustainability, promoting justice, empowerment, and social cohesion.

The concept of the neighborhood unit was one of the most significant principles guiding the planning of desert cities, inspired by the importance of the neighbor in Islam and the moral obligation to treat them well. As the Qur'an states:

“Worship Allah and associate nothing with Him, and show kindness to parents, relatives, orphans, the needy, the near neighbor, the distant neighbor, the companion at your side”... (Surat al-Nisa, verse 36).

Many Prophetic traditions also emphasize respect for the neighbor's privacy. The Prophet Muhammad (peace be upon him) established the protection of the neighbor's environmental rights, saying: “Do not extend your building in such a way as to block your neighbor's air circulation, unless with his permission.” (Al-Nawawi, 2002).



Limited corridors and their role in ensuring social security.

Source: Compiled by the researcher.



The neighborhood unit within the concept of sustainability reflects social sustainability in the urban fabric. **Source:** Compiled by the researcher

3.4.9 The Economic Dimension

The economic benefits of this model appear in the reduced demand for energy, due to the internal courtyard, which functions as a thermal regulator within the dwelling. The courtyard also improves the microclimate by allowing cultivation and water use within it. At the urban scale, the city's compact form shields buildings from the full impact of constant wind and solar exposure. In addition, short, shaded distances between buildings enable residents to meet daily needs on foot. Surrounding oases also provide essential goods and resources for the inhabitants of these fortified settlements.

Conclusion:

The analysis of traditional architectural design and planning principles shows that this approach used local materials to create comfortable homes which protected natural resources by adapting to regional environmental elements. Traditional architecture shows its core design principles through fundamental methods which have stayed relevant since their inception in ancient times. The principles oppose numerous contemporary building techniques which fail to demonstrate superiority over established traditional construction methods.

The path toward sustainable development in modern architecture faces two major obstacles which block the achievement of environmental resource protection. Modern architecture needs to study traditional architectural principles by choosing appropriate elements for local environments and ecological conditions and uniting them with modern technological advancements. The method applies these principles to modern and future residential construction by using contemporary construction methods which enhance traditional building techniques for sustainable architectural development.



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