# Adaptation of an architectonic tradition for a sustainable future in the Middle East: a case study of three building typologies in Riyadh City.

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# ADAPTATION OF AN ARCHITECTONIC TRADITION FOR A SUSTAINABLE FUTURE IN THE MIDDLE EAST: A CASE STUDY OF THREE BUILDING TYPOLOGIES IN RIYADH CITY

**ISRA'A SALIM FARDOUS**

# ADAPTATION OF AN ARCHITECTONIC TRADITION FOR A SUSTAINABLE FUTURE IN THE MIDDLE EAST: A CASE STUDY OF THREE BUILDING TYPOLOGIES IN RIYADH CITY

ISRA'A SALIM FARDOUS

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Declaration of Original Work

I, Isra'a Salim Fardous, the undersigned, a graduate student at the Robert Gordon University, Scott Sutherland School of Architecture and Built Environment, and the author of this dissertation, Adaptation of architectonic tradition for a sustainable future in the Middle East: A Case study of three building typologies in Riyadh City, hereby, solemnly declare that this dissertation is my own original research work that has been done and prepared by me under the supervision of Dr Amar Bennadji, in the College of Scott Sutherland School of Architecture and Built Environment at RGU. This work has not previously been presented or published, nor formed the basis for the award of any academic degree, diploma or similar title at this or any other university. Any materials borrowed from other sources (whether published or unpublished) and relied upon or included in my dissertation have been properly cited and acknowledged in accordance with appropriate academic conventions. I further declare that there is no potential conflict of interest with respect to the research, data collection, authorship, presentation or publication of this dissertation.

Student's Signature: _____ Date: _____

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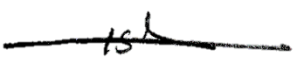
Sincerely yours,



**ABSTRACT**

The present research assesses the environmental response and adaption qualities and capacities of Arabic vernacular architecture in providing suitable thermal comfort, psychological needs, and preferences of inhabitants. The primary purpose is to analyse the features of traditional and modern architectures and assess which one suits better in the hot arid climatic condition in the Middle East. In particular, the research also purported to analyse how combinations of traditional techniques with modern technology can provide for a better thermal control inside the building. The research was carried out in two cities of Saudi Arabia; Riyadh and Al Madinah. In particular the chosen sites were Addiriyah, Landform house, and Al Madinah. The first and the last site provided the researcher with an insight into the traditional architectonic forms, while the Landform House depicted transitory or hybrid housing patterns. The questionnaire was distributed to 200 respondents. Data were gathered further from 14 participants in semi-structured interviews who are coded as interviewee 1 to 14 for ethical purposes. The research found that a combination of modern and traditional features can provide for better thermal control inside the house and thus it is more comfortable for the dwellers and also enhances psychological wellbeing. The research also analysed the recent green building frameworks and its necessity to incorporate in the building constructions. Based on the findings of the study, it is recommended that for indoor spaces, architects consider the use of traditional spatial organization in Arab homes to improve the internal circulation of air to cool the various spaces homogenously. Saudi Arabian regions can benefit from recognizing the need to have designs that address to the effects of both warm temperature and humidity level.

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## LIST OF ABBREVATIONS AND ACRONYMS

| | |
|---|---|
| AC | Air Conditioning |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers. |
| ANSI | American National Standards Institute |
| BREEAM | Building Research Establishment Environmental Assessment Method. |
| DPT | Dew Point Temperature |
| GCC | Gulf Cooperation Council. |
| HVAC | Heating, ventilation, and air conditioning. |
| LEED | Leadership in Energy and Environmental Design. |
| SASO | Saudi Standards, Metrology and Quality organization |
| SBC | Saudi Building code |
| SPSS | Statistical Package for the Social Sciences |
| VOC | Volatile Organic Compound. |
| WCED | World Commission on Environment and Development. |

# CHAPTER ONE: INTRODUCTION

## 1.1 Introduction

The Middle East region is experiencing rapid economic growth and infrastructural development during the last three decades. Major cities in the area, such as Riyadh, Jeddah, Dubai, and Doha, currently boast high-rises and modern villas. The tallest buildings in the world are found in this region. However, one cannot miss the glaring absence of architectonic traditions in these new structures. Architectonic means relating to the main beliefs of architecture. Most of the residential places depicts architectural styles that are similar to western countries. However, in doing so, they completely disregard the cultural and environmental aspect of Middle East. At the same time, the aspect of sustainability has also not received much attention in the construction boom that has been taking place in the region. Rapid development across various industries, including transportation, communication, and construction, has radically transformed the Middle Eastern landscape. This transformation has occurred at the expense of socio-cultural and environmental sustainability.

Architecture plays an essential role in sustainability as it relates to resource consumption, emissions during construction, and the utility of the infrastructure. Traditional architectural styles incorporate elements that enhance the environmental sustainability and cultural suitability of dwelling places. In past, the structure of a building functioned as protection against harsh weather. Building designs had to rely on renewable resources such as wind, water, and sunlight for passive energy. Energy passively extracted from renewable resources is highly sustainable, both in terms of economic costs and in terms of environmental health. Traditional architecture in the Gulf Cooperation Council (GCC) region has always represented the suitability of architecture to the local environment, incorporating aspects of sustainability and cultural relevance.

This research recognizes that the social and demographical aspects have undergone visible changes in the recent times. The big cities in the region is witnessing rapid population growth, which made the traditional architectural designs less appropriate and increased the reliance on western designs. This research entails a deeper

understanding on how recent innovations and technologies can be utilized and adapted in the architectonic traditions. This study identifies how sustainability characteristics that are inherent in the traditional architecture can be incorporated with contemporary architectural studies to support the adoption culturally relevant and sustainable dwellings in the Middle East region. Traditionally, the house is where Middle Eastern families spent maximum time in conducting their private activities. In the hot desert, which is widespread in the region, the house served as a place of release for the family. The ambient environment in the houses was achieved principally through the use of natural resources sustainably and economically. Traditional Middle Eastern architecture is premised on building a successful relationship between architecture and natural resources such as high seasonal temperature, wind, sun, topography, cultural values, and building materials.

*Figure 1: Traditional and Modern Mashrabiya in Middle East (Source: Ajaj and Pugnaloni, 2014, p.228)*

## 1.2 Statement of Problem

Over the past four decades, the population of the Middle East has grown substantially. This growth has led to increased demand for housing, but due to various limitations local builders and architects have not responded to this demand. Such limitations include a shortage of local engineers familiar with the cultural aspects of the region, for instance that construction must be completed as quickly as possible. Additionally, globalization has caused the construction of traditional architecture to decline in the

Middle East. The researcher attempted to examine how innovation and technology can help in adapting architectonic tradition to foster a sustainable future in the region.

This research investigates traditional houses in Saudi Arabia that has a dry and hot weather (i.e., tropical desert). Saudi Arabia serves as the location for this research given its long history in traditional architecture and the proliferation of Western-style architecture since the 1990s. For instance, Jeddah's suburban environment has undergone massive change and so much so that the city's identity almost has been changed. In its planning and architecture, it has come to resemble a Western city. However, authorities, professionals, and residents are developing a tendency to bring back the traditional heritage of the region. Given the harsh climatic environment, there has to be some protection from excessive solar radiation, dusty winds, high level of relative humidity, and extreme temperatures. The sustainability of architecture in the region traditionally emanated from modification and adaptation of environmental factors, leading to comfortable interior living environments for dwellers.

In the Middle East, the climate has been a significant factor in the construction of traditional architecture. Depending on the region, several adaptive features have been used to create a comfortable internal environment. For instance, in traditional architecture, courtyard was at the heart of the design of the houses. Also, palm-tree-leave houses were built in the coastal regions or around oases. For the Bedouins, tents offered shelter and a home in the desert. On the mountains, stone houses with high-pitched roofs were most common.

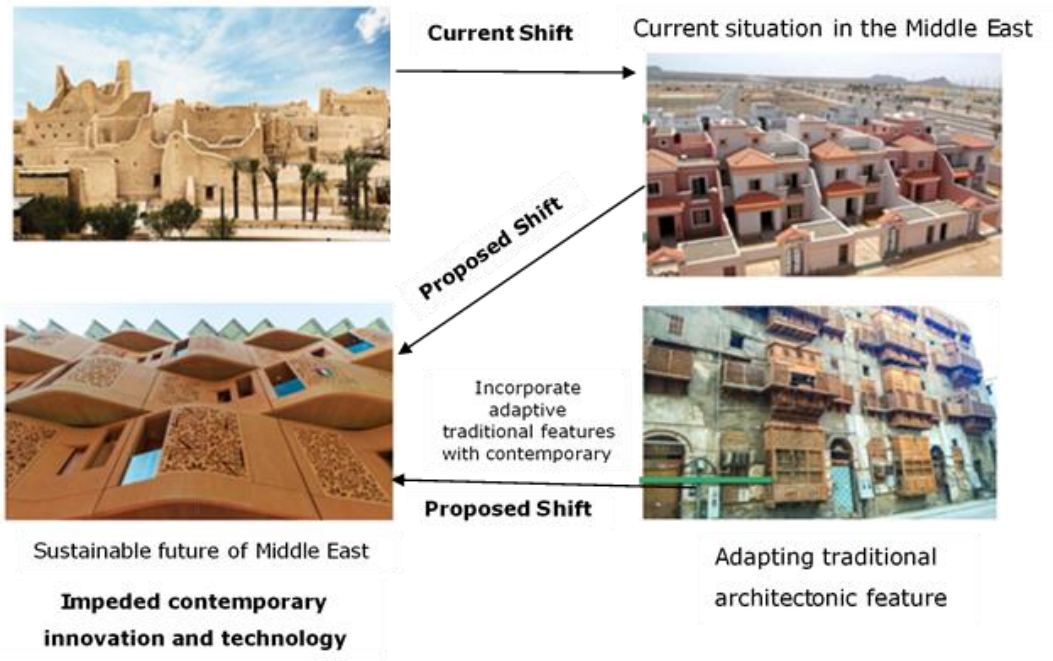


*Figure 2: Statement of problem in the Middle East*

## 1.3 Aim

The research aims to assess the environmental response, adaption qualities and capacities of vernacular architecture in supporting thermal comfort and meeting occupants' preferences and psychological needs. People's preferences might include, for example, architectural trends that give occupants indoor and outdoor comfort while addressing sustainability and climate change, which also affect the policies of the city. Additionally, the research seeks to understand building performance, with a focus on what is appropriate for housing applications based on climate control and thermal comfort as indicators, along with other psychological considerations. It is important to validate psychological and physical inputs. The spaces with different typologies and schemes will be the unit of analysis.

## 1.4 Research Questions

The researcher aims to address the following research objectives in order to address the research problems identified earlier. They are as follows:

1 To what extent does traditional architecture with modern adaptation adjust occupants' psychological comfort and wellbeing?

2 As design parameters relevant to building design in the study location in the Arabic region, does a hot, arid climate influence occupants' wellbeing?

3 What are the suitable design approaches that can be used to improve thermal conditions in building architecture to increase occupants' thermal comfort?

## 1.5 Research Objectives

1 to assess the importance of traditional environmental architecture to thermal comfort;

2 to identify combinations of traditional techniques with modern technology;

3 to understand the impact of the rising awareness of traditional techniques combined with modern technology;

4 to study traditional environmental techniques and modern applications of technology, which can enhance building design and performance based in the Middle Eastern cultural context, with its modern aspirations;

5 to investigate traditional, hybrid, and modern spaces to measure building parameters and people's behaviour, to demonstrate relevant typologies that respond positively to current buildings' demands; and

6 to explore the impact of the balance between traditional architecture and a contemporary context on occupants and on building performance.

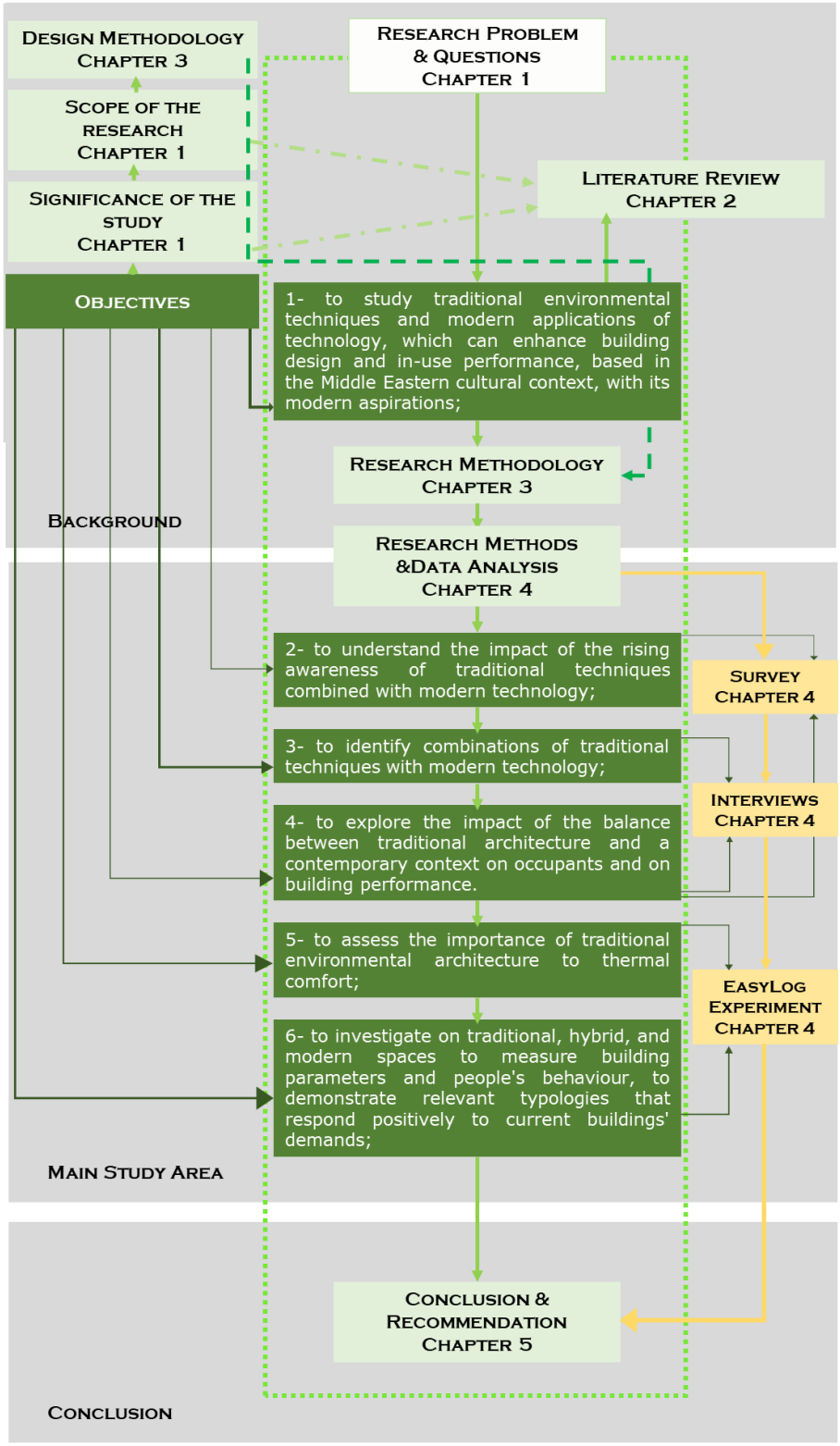


*Figure 3: Thesis Structure and Objectives*

## 1.6 Signifiance of the Study

The current study is based on the increase in engineers from different countries, who do not have the knowledge to construct buildings aligning the cultural aspects of the Middle East. However, whether the technological innovations can be utilized to preserve the architectonic traditions is questionable. In addition, the study also attempts to understand how technological innovations can be combined with modern architectural designs, for a sustainable future in the Middle East.

Oliver (2003, p. 13) argues that studying traditional architecture is necessary to understand its form but how the form is motivated by function. Oliver (2003) quoted Frank Lloyd Wright, who defined traditional architecture as folk buildings developed in direct response to actual needs. According to Oliver (2003), traditional buildings were constructed by people whose primary focus was to develop dwelling places that offered the best fit with their environment and a native feel. Oliver considered traditional architecture as aesthetically and functionally superior to bland and artificial modern architecture. These views are echoed by Le Corbusier, who considers traditional architecture as ideal, given that it fulfils both the social and the physical needs of the occupants (Oliver, 2003). For Le Corbusier, traditional architecture epitomizes the attainment of harmony between human needs and the environment. Rudofsky (1964) argues that there is much learn from architecture as it was approached before it become the domain of experts alone. The current study assesses the physical environment and other design features. According to Rudofsky, the immediate physical environment is only one aspect of how the environment should be perceived and experienced. It is thus important to conduct an all-inclusive exploration of the architectural designs between modern and traditional architecture. Architects should have deeper knowledge to understand the cultural and social connotations of architecture in people's daily lives and their communities.

Traditional architecture has also been defined as an architecture that is developed from the cultural and natural environment of a habitation (Kennedy, 2004). The nature of traditional architecture is such that it places great emphasis on the harmonious relationship between what is built and the environment and socio-culture. For this reason, traditional architecture must be studied and applied to contemporary

architecture. Oliver (1997) argues that each character and feature of the traditional architecture is intimately linked with both economic and social imperatives. Traditional architecture was developed to serve the specific needs of each culture. The role of architecture in traditional contexts was visible in the organization of villages, towns, and hamlets. Oliver (1997) argues that when one evaluates how villages and hamlets were physically structured, the socio-cultural structure is visible in the spatial organization of the settlements. Aspects such as proximity to kin and clan, ancestral burial sites, inheritance rights, and other customary norms broadly influenced the organization of dwelling places.

Traditional architectural styles incorporated many aspects of social and cultural values. Culture and physical needs were translated into architectural requirements, and constructed buildings reflected the cultural and functional needs of the people. As such, traditional architecture should be preserved, handled and studied with the goal of enhancing modern building- and spatial-planning strategies (Bukhash, 2001). Hinrichs (1987) argues that re-evaluation and analysis of traditional architecture provides a solid foundation for policymakers, as concerns infrastructural development and societal needs. According to Hinrich (1987), re-evaluation of traditional systems will enhance policymaking, promoting self-respect and regional identity even as it serves to re-align policymaking with the interests of the people. Thomas (2002) concurs, arguing that traditional architecture can inform contemporary architecture. According to Thomas (2002), the timelessness of traditional architecture can be a source of inspiration for contemporary architecture, given its inherent sustainability and cultural relevance.

The importance of studying traditional architecture and its relevance in contemporary architecture are heightened by increasing concern for Arabic heritage and tradition (Bukhash, 2001). Calls for the preservation for historic buildings and early artistic forms have been increasing around the world. Therefore, studying traditional architecture, especially as concerns how it can be utilized in modern contexts, has never been more relevant. According to Asfour (2008), architects can learn from the past, when local natural resources were the underpinning guiding principle for design across the Arab world. Traditional houses were designed for a comfortable living, taking into account climatic, cultural, social, and human needs. At the same time, traditional house design

and decorative features served to enhance privacy, temperature control, and security. All of these are aspects that can be incorporated into contemporary structures.

The study seeks to understand whether the Middle East community still cherishes traditional environmental architecture in spite of the increase in modern architectural development along with its numerous benefits, such as indoor thermal control system. Traditional architecture has value in many ways. In the Middle East, it indicates how people inhabited in an area and translated their requirements into building design with distinctive characteristics. Bukhash (2001) argues that these architectonic traditions must be learned, handled, conserved, and improved in modern building practices and planning policies.

The old architecture carries vibrant design structures, which if adopted, can immensely help in improving the recent architectural projects. Thomas (2002) stated that it is essential that the Arab world revisits their traditional architectural typologies. Sustainability will increase with incorporation of traditional architectural identity in current architecture. The study highlights the problem of the expat engineers who have very little knowledge of building construction keeping in mind the cultural context of Middle East. Therefore, it will be interesting to explore if the modern techniques can be employed to preserve the archaic traditions while balancing it with the modern architectural formations to build a sustainable future.

### 1.6.1 Theoretical Contributions

It is anticipated that the theoretical contributions of the proposed study will emphasize the impact of innovative technology applied to traditional architecture in terms of thermal comfort and for the occupants' well-being. This emphasis will enable me to demonstrate the possibility of obtaining traditional and modern adaptation in terms of building standards, with local expertise and consent. The research will contribute new to knowledge of this subject and increase awareness of environmental factors as they relate to cultural values. The physical features are protected, but not the way an individual inhabits a building. Thus, the primary theoretical contribution is expected to be the assessment of how, in ideal typological settings, occupants' well-being is

affected. An assessment between traditional techniques and 21st century technology will enable realization of this contribution.

### 1.6.2 Practical Contributions

This research aims to contribute to a better environmental architectural design for human well-being in the Middle East. Additionally, the proposed study may be applied to improve the relationship between people and their environment, along with addressing compromises in these relationships with the built environment to foster a sustainable future in the Middle East. The findings of the proposed study may further apply at a global level for countries who want to enrich modern architecture with traditional designs while preserving sustainability.

## 1.7 Study Context

Architecture and built environment are supposed to reflect the cultural and social aspects of a society. Social and cultural impact on architecture can be understood best when the society is undergoing significant cultural changes (Mahgoub, 1997). According to past studies (Mahgoub, 1997; Al-Jamea, 2014; El-Shorbagy, 2010; Traditional Islamic-Arab House, 2010; Kamal, 2014; Sacchi, 2013; and Saied et al., 2013) the role of culture in architecture can be observed from several perspectives, through

- comparison of varieties of buildings built by society over time,
- consideration of typological variations,
- analysis of ranges of buildings constructed by society,
- identification of what societal subcultures have built,
- comparison of different building output of the people living in the same place, and
- Comparison of how space is used across cultures.

This study evaluates traditional Saudi Arabian architecture from the earliest buildings up to the state of Saudi architecture 50 years ago, when Saudi Arabia exhibited a tradition of earth architecture that was unique in style, culture, and sustainability; this study emphasises, in particular, the sustainability and socio-cultural suitability of this historical architecture. This study draws upon a general evaluation of the architectural

history of Saudi Arabia and the socio-culture. It emphasizes how social, cultural, and environmental factors have influenced architectural styles in the region and how these traditional styles can be integrated with modern styles. To this end, a mixed-methods research approach was adopted, entailing an experimental evaluation of both traditional and contemporary houses.

This study belongs in the context of traditions merging modern and traditional ideas, with the goal of developing an architecture that is both socio-culturally relevant and sustainable. Tradition is an aspect of culture that is passed on from one generation to the next. In essence, societal identity is primarily premised on its traditional heritage. It is for the same reason that most societies attach much value to their heritage. In the Arab world, tradition is not merely a uniform manifestation of past cultural practices; instead, it is a complex, multi-layered set of differentiated practices existing across several subcultures (Kultermann, 1999). Asquith and Vellinga (2006) describe traditions as an observable creative process whereby people, as creative agents, review and interpret historical experience and knowledge to face current challenges and demands. According to Abel (2000), traditional architectural practices and styles have strong potential to aid the development of appropriate and viable regional architectural, of high quality. At the same time, traditional architecture also offers a wide variety of styles, especially if combined with modern architectural styles. Abel further argues that the richness of Arab heritage created over centuries offers a strong potential for architectural diversity. This diversity can be achieved only if traditional architecture is integrated with modern architecture.

### 1.7.1 Architecture and Sustainability

Sustainability is a topical issue in economic development around the world. Sustainability can be understood in various ways, depending on the political, social, psychological, or economic lens applied. The conceptualization of the term “sustainable” has also evolved over the years, with socio-economic changes and the improvement of people’s knowledge of the world. Overall, sustainability focusses on the integrated characteristics of human activities and the need to comprehensively plan and coordinate across multiple sectors, with the objective of ensuring available resources

are utilized as efficiently as possible. This subsection identifies and discusses the multiple definitions of "sustainable" and how each of these definitions' interfaces with the role of traditional architecture in contemporary architecture.

According to Beatley (1995), there is no one accepted definition of the term "sustainability"; instead, sustainability is defined in various ways, depending on the specific area of application. Sustainability has been defined as development that is socially conscious (Vallance et al., 2011); as the utilization of resources in a manner that supports the health of the broader ecological environment (Goodland, 1995); initiatives that leads to continuous business success (Mort, 2010); and activities that are suited for the betterment of broader macroeconomic success. Among these many definitions is an underlying theme: the need to ensure that resources are used in a manner that preserves them for future use (Harrison, Wheeler, Whitehead, 2004). The core and fundamental aspect of sustainability is the combination of human well-being and the well-being of the planet as the world continues to grow and develop.

The World Commission on Environment and Development (WCED; also popularly known as "the Brundtland Commission") defines sustainable development as development that takes care of the needs of the current generation without undermining or comprising the needs and aspirations of future generations. This definition by the WCED has been widely adopted in international development. It is cognizant of the necessity of development as opposed to being focussed on strategies to maintain present conditions. Therefore, the WCED's definition stresses areas of development that are most important. The international agenda on sustainable development has thus focussed on the protection of the environment through sustainable resource use.

Sustainable development is also widely applied, encompassing everything and everyone in the whole world, both present and future. Sustainable development cannot be limited to just a few industries. The conception of "development" applied in this sense presupposes advancement premised on two main concepts. First, sustainable development is cognizant of human needs, including the conditions needed to maintain an acceptable living standard for everyone. Second, it appreciates the limits of current environmental capacity to meet the needs of both current and future generations, as

determined by social organization and existing technological capacity (Tony, 2005). In essence, sustainable development should not undermine basic human needs such as clothing, food, employment, and housing. At the same time, sustainable development must also recognize the right of all individuals to their living standards beyond the absolute minimum. Efforts towards and ideas of sustainable development should not eliminate the opportunities that individuals have for enhancement of their living standards. Furthermore, sustainable development is also limited to natural capacity, given the fact that the environment consists of finite resources and is becoming less productive. Due to overexploitation, declining water quality, and shrinking biodiversity, the environment's ability to meet the needs of the present and the future is becoming increasingly constrained.

The concept of sustainable development is not without its critics. It's very definition, and the entire agenda of sustainable development, has been broadly criticized by both opponents and proponents. Proponents have argued that when sustainable development is vaguely defined to serve the interests of all stakeholders, it loses its core objective. Once sustainable development has been defined vaguely, businesses find opportunities to continue with their operations without any environmental concerns, even as they continue positioning themselves as sustainable businesses (Jacobs, 1999). According to Jacobs (1999), focus on development in poor areas often ignores the need for restraint in resource consumption in affluent areas. There is a strong consensus among sustainable development groups that the WCED's definition is deliberately vague and thus mostly ineffective in meeting the objective of sustainable development. According to Slessor (2000), the WCED's definition presents a useful starting point in understanding sustainability; however, it is largely inadequate as a basis for policy guidance and direction. According to Slessor (2000), sustainability should not be a merely corrective measure of force; instead, it should be mandated for architecture. Heartfield (2001) concurs, arguing that it is in the best interest of everyone to develop the world sustainably; thus, there is no need for a "friendly" conceptualization of sustainable development. According to Heartfield (2001), sustainability is not about nostalgia and should not lead only to the past ways of doing things. It is imperative that practitioners in the industry make use of available

technological and physical capabilities in the transformation of how natural resources are used.

The WCED's definition and overall conceptualization of sustainable development have also been criticized for its lack of emphasis on the role of humanities in resolving environmental sustainability problems. It has given greater prominence to the sciences and new technology at the expense of humanities. Scholars in the humanities and social sciences have always considered sustainability as one of the issues most relevant to their work (National Academy of the Humanities, N/D) Thus, they have suggested a re-evaluation of sustainability to incorporate elements of socio-culture into the conceptualization of sustainable development. According to the National Academy of the Humanities, the issue of ecological sustainability is fundamentally a social and political issue as much as it is a technical one. They further argue that the journey towards a world that is environmentally sustainable will rely not on emerging knowledge of ecosystems and natural resources but on the ability of humanity to initiate, advocate for, and incorporate radical changes in lifestyle, technology, and values. This aspect is particularly important in the context of this study. People's adaptability to change broadly touches on social and cultural values. Traditional architecture and its incorporation into modern architecture largely touch on the role of culture in the creation of sustainable living spaces. The National Academy of the Humanities believes strongly that environmental problems are inherent in human activities both historical and current.

In the context of architecture, Ruckelshaus (2005) argues that sustainable development seeks a balance between economic development and environmental conservation. As an emergent doctrine, sustainability is premised on the idea that both economic developments must happen over time and be carried out considering the ecological limits. Ruckelshaus (2005) further argues that this balanced form of development can be achieved only when the relationship between human beings and their economic activities, physical environment, and biosphere are properly managed. In essence, economic growth and development should be complementary and not inherently antagonistic.

In the contemporary environment, sustainable development has been widely used to refer to the prudent utility of fossil energy and not necessarily to mean sustainable use. At the level of household, sustainable development implies the ability to attain a reasonable standard of living without unleashing adverse impacts on the environment. Broadly, the goal of sustainable development is to attain of equilibrium between human activities and the health of the immediate environment. This goal can be achieved through the adoption of recent technologies or utilization of traditional approaches that have always worked in tandem with nature. According to Best Practice Energy Efficiency (2005), sustainable entails combining economic, social, and environmental goals. It must involve all economic sectors of the economy, including communities, individuals, and government. In the realm of architecture, traditional architectural styles provide an opportunity to incorporate historically functional and sustainable approaches in building modern dwelling places.

Sustainable development is an inherently multi-dimensional construct encompassing elements of environmental, social, and economic development. It must be recognized that sustainable development should not result in the loss of quality of living. However, it does require reform in how people think and the values that people hold towards their consumption behaviour. Environmental health, social cohesion, and economic development are the three pillars of sustainable development geared towards enhanced human well-being. Hancock (1993) argues that attaining sustainable development at both social and environmental levels requires that the economic system is put in place. Such a system should be destructive to neither social nor ecological systems. Both are critical aspects of quality of living and well-being. Thus, any talk of sustainable development must inevitably consider both the physical design aspect of the community as well as the adopted economic system.

### 1.7.2 Collaboration of Modern Architecture and Traditional Values and Designs

In the Arab World, a re-evaluation of traditional architecture would assist policymakers in encouraging Arabic identity and pride and fostering them among their people. The traditional architect has boundless potential in the Middle East as a way to inform

modern architecture. According to Al-Mansouri and Al-Naim (2005), traditional Arabic architecture provides endless practices from which modern architecture can draw inspiration. Therefore, a collaboration between modern architecture and traditional architectonic designs should be encouraged. With respect to sustainability, countries in the Middle East have been called to re-examine traditional models to merge Arabic identity with modern architecture. Rashid (2004) argues that this rising concern for traditional architecture relates to preserving famous historic buildings, since they are antique artefacts and traces of historical forms of art. Given the cultural value of these buildings, it is vital for their integrity to be conserved and refurbished object be of authenticity.

Debate in Arabic countries continues on whether to embrace tradition or adapt to the prevailing trends. According to Eldemery (2009), architects are in continuous dialogue with society, especially as concerns the role and place of globalization in the design and construction of buildings. On one side, architects view globalization as a distinctive trend of this era. On the other side, architectural theorists view globalization in two ways (Eldemery, 2009). First, they see globalization as a positive and necessary vehicle for driving global progress and enhancing diversity. Secondly, globalization is viewed as a force for rapid global homogenization and the destruction of established norms and traditions. Overall, there is a constant ideological tension between maintaining traditions and adapting to prevailing trends. However, it does not need to be a case of "either-or"; emergent trends and traditions can co-exist and complement each other.

El-Husseiny (2004) argues that architecture seeks to resolve philosophical, metaphysical, and cultural identities in the physical context. Architecture challenges humanity to review its history and thus look at architecture in the context of history and the present moment (El-Husseiny, 2004). Historically, architectural movements have always sought to oppose aesthetic and cultural diversity while promoting and reinforcing the adoption of specific architectural philosophies at both national and international levels (Eldemery, 2009). Pro-global schools of thought including governments have sought to use architecture for symbolism. At the corporate level, companies are using architecture for product identification and branding. At the same time, some individual architects seek to promote their architectural theories. As such,

diverse perspectives compete for attention or opposing each other. This tension creates a situation whereby collaboration offers the best strategy for incorporating diversity while retaining traditional strategies.

New technologies have transformed the nature of life and work for billions of people around the world. Nevertheless, Eldemery (2009) argues that innovation and rapid change have for centuries been aspects of modernity. Presently, technological development and expansion continue to define global engagement and interaction. The emergence of global culture can be directly attributed to new information technologies. In the field of architecture, emergent forms of architecture easily cross-national boundaries, forming an integral part of the new global culture. According to Lo and Yeung (1998), robotics, electronic technologies, telecommunications, biotechnology, and new materials have shaped the new global paradigm and continue to define how global cities are designed and constructed. Consequently, it is only natural that architects adopt new technologies in their building projects. Moreover, Western architectural models have been established as best practices across industrialised nations; the spread of a Western paradigm makes these models particularly attractive for rapidly urbanizing nations with limited time and resources to develop homegrown architectural solutions (Vassigh, 2004).

In sum, both traditional and contemporary architectural styles have their merits and demerits. The underlying objective of this study is to identify the best of each through actual field experiments. This objective is then followed by the identification of options for integration and collaboration, with the objective of creating sustainable architecture that is also culturally relevant.

### 1.7.3 Sustainability and Traditional Architecture

When civilizations were first established in the Middle East, people living in the Middle East depended heavily on the natural world to learn common guiding principles that encouraged architectural sustainability. Architects believe that the current human population can learn much from the same principles, which can encourage the concept of sustainability (Asfour, 1998). In past, people used to live in very comfortable environments; they had no problem with the social, cultural, or climatic conditions. The

ability to live in this way is something today's humans would benefit from learning. There are three major attributes which predominantly dominated any decorative and design feature in early human life: privacy, security, and temperature control.

For example, colonnades and courtyards were two fundamental aspects of ancient Arabic architecture. The former provided ventilation and indirect light to living areas, while the latter provided shelter from both sun and wind. Regional architectures feature doors, roof parapets, windows, shutters, columns, capitals, screens, and wind-towers as common motifs. Asfour (1998) believes that literature lacks sufficient traditional architecture in the Middle East world. Coming up with an eloquent architectural design similar to those used in the past would mean a complete overhaul of current architectural designs. An ideal way to realize this vision is to encourage current architectural students to study a traditional mindset. This exposure to tradition could help students to compare and contrast old historical settings with the current ones to conceive convenient and sustainable solutions.

For the community to function sustainably, it must be possible for existent environmental resources to meet the needs of the people. About social sustainability, a society should be able to maintain and develop the needed resources and have the resilience to prevent future problems for her people. Cities have two kinds of resources by which to establish sustainability. The first is the human capacity or the individual capacity to develop the required levels of resiliency. Second is the social or communal capacity to establish and maintain sustainable measures (such as reduced energy consumption and use of recycled water).

Sustainable development can benefit much from past building design which applied the traditional concepts (Buchanan, 2005). According to Buchanan (2005), the perception that using past information is backsliding is unfounded, especially in the context of sustainable development. He argues that historically successful civilizations and cultures owe much of their success to re-interpretation of history. For instance, the renaissance period emerged out of the rediscovery of architectural history. Similarly, the desire for sustainable development has made the societies around the world more welcoming and accepting of wisdom from the past. Sustainable design can borrow much

from the past, where the development of infrastructure was centrally motivated by function, aesthetics, and sustainability. According to Boake (1996), traditional architectural constructions are primarily based on building techniques that are time-tested; as such, they can be used as a basis for sustainable design.

Historically, people also utilized readily available materials from their immediate environment, and they built their own houses by their hands. Technically, traditional architecture is an embodiment of sustainable development. According to Klinker (2004), traditional societies are the real pioneers of sustainable development. For instance, people inhabiting a particular area extracted their water and food from their immediate environment. Their survival depended on their ability to maintain equilibrium with their environment and natural cycles. Thus, Klinker (2004) argues that traditional architectures are sustainable, that can be used to develop environmentally friendly buildings. As the world increasingly seeks sustainable solutions for growth and development, there is a need to respect environmental balance much in the same way as did people of the past. The rediscovery of traditional architecture can provide know-how in the development of ecologically adequate buildings. These traditional building technologies can be integrated with contemporary technologies to develop buildings suitable for both rural and urban needs (Klinker, 2004). However, there is a need first to document traditional knowledge of building design. This study documents the benefits of traditional buildings in Saudi Arabia.

Modern architecture has been increasingly viewed as less ethical than was traditional architecture (Hagan, 1998). This understanding has been the premise of the anti-modernity movement where traditional architecture has been expressed in literal terms. Architects who are pre-occupied with new technologies tend to dismiss proponents of conventional architectural styles as retrogressive. Similarly, anti-modernists continue to castigate as unethical those architects who embrace contemporary technologies. Hagan (1998) argues that architects following traditional approaches are more likely to deliver cost-effective, sustainable, and cultural relevant structures. However, practitioners must also be aware of the fact that new technologies offer new opportunities to enhance the capabilities of traditional architectural techniques. Therefore, conventional methods should not be pitted against modern

techniques. Instead, efforts should be made to utilize both to deliver the most appropriate spaces for humans.

As the society works towards integrating the best of both traditional and contemporary architectural styles, the capabilities of conventional architecture must be rediscovered, reworked and extended. According to Stonehouse (1998), the re-working of conventional patterns and types is essential for the process of change and continuity towards sustainability. Environments must be made not only physically sustainable but also culturally suitable for the individuals and communities who dwell in these places.

In the Arab world, some studies have been done on traditional architecture. Most of these studies link traditional architecture in the region with its dominant religion, Islam. This linkage has been made primarily because Islam originated in the area and then flourished and expanded outwards to Asia, Africa, and Europe. These previous studies have evaluated the impact of Islam and Islamic laws on architecture and urban planning in the region, especially how they respond to social needs and environmental realities. One cannot fail to notice the foundational role of Islam in shaping architecture and social life. As argued by Mortada (2003) traditional Islam outlines many principles of social behaviour and social organization. These principles did not emerge from a vacuum; instead, they were established to make the lives of believers aligned with the message and objectives of Islam. To this end, pioneering Muslim societies sought to create harmonious physical and social environments.

Consequently, the environment was primarily influenced by the religious beliefs and actions of residents in a manner that complied with Islamic traditions (Mortada, 2003). Thus, architecture in the region embodies Islamic values. Ozkan (2002) describes the architectural landscape of the area as one aptly suited for the development of elegant contemporary architecture. Ozkan (2002) considers the cultural history of the region as one integrated with modern technology, which will drive the growth of the finest contemporary architecture.

In addition to its cultural and social elements, Islamic architecture created a sustainable model for utilizing resources. According to Nasr (1978), Islamic architecture is faithful to the use of local building materials and the utilization of forces of nature such as wind

and light as sources of energy. Islamic architecture re-created view in cities through the adoption of architectural styles that delivered calm and peace, along with a sense of harmony with the natural environment through the use of courtyards in homes and mosques. Some studies in Islam have advocated for environmental sustainability especially as concerns conservation and resource use. Some of these studies exist in the Quran and Hadith.

Nevertheless, none of these previous studies conducted experiments on the various benefits of traditional architecture relative to modern architecture. These benefits include environmental sustainability and adherence to Islam principles. Studies by De Chatel (2003) and Faruqui et al. (2001) evaluated sustainability tenets and principles of Islam. They both heavily refer to Quranic concepts and teachings, touching elements of stewardship, trust, and unity. However, none of these studies have conducted actual experiments on traditional architecture.

In the Islamic traditional architectural forms, the concern for environment is quite evident (Al-Zubaidi, 2007). As noted by Nasr (1978) architecture of the Middle East primarily used simple building materials and emphasized natural elements such as air and sunlight in their constructions. In addition, the concept of environmental sustainability was linked to the teachings of Quran including stewardship, unity, and trust (De Schater, 2003). Terms such as ecology, durability, and environmental awareness are relatively recent, formulated as reactions to increasing depletion of natural resources. However, cultural practices in the Arab world, and indeed the Islamic world, have always prioritized sustainability (Mortada, 2003). Mortada (2003, p. 157) details the antecedents of sustainability in Islamic traditions and cultures. According to the author, sustainable living draws its essence from the traditional customs and combines present needs with the future prospect. Sustainable living means utilizing resources purposefully while conserving it for the future generations. It also emphasizes on the issues of environmental pollution and resource recycling to improve quality of life.

Most of these previous studies have focussed on the role of culture, especially Islamic culture, in sustainable development; they have offered only limited evaluation of how

traditional architecture ensured sustainability. Mahgoub's (1997) survey evaluated the correlation between society, environment, economy, and the principles of classical architecture. This evaluation led him to conclude that traditional architecture is more sustainable than is modern architecture. For Mahgoub (1997), the sustainability of traditional societies is evident not only in building methods but also in how people lived in their houses. The primary focus of builders was to create structures that adapted to the environment without necessarily changing or controlling the situation. Al Zubaidi (2004) concurs, arguing that elements of sustainability were manifested in how traditional people approached resource utilization.

Assad (2006) has studied elements of sustainability in traditional Islamic architectural styles. According to the author there are seven sustainability aspects in traditional form of architecture: (a) respect for the local environment and site of construction, (b) respect for the way of life of the inhabitants, (c) utilisation of locally available materials, construction of buildings with materials that utilise less energy, (d) conservation of energy, (e) development of structures that will last, (f) adoption of recycling, and (g) desert plantation. However, despite the rich, sustainable traditional architectural history, sustainability in contemporary buildings remains problematic in the region. Antonio (1998) argues that despite its abundance of wealth and energy compared to other areas in the world, the Middle East region relies mostly on artificial resources for its sustenance. The contemporary lives of inhabitants in the region show little reference to or resemblance of the lives of past inhabitants who were exceptionally well adapted to the area. The goal of this study is to help with the process of re-discovering of traditional architectural styles and how they can be integrated with modern techniques to deliver sustainable and culturally relevant architecture.

## 1.8 Scope of the Research

This research's design involves three stages. The first stage focusses on the historical background of traditional architecture and how the continually changing environment has affected the evolution of architecture in the region. It offers an understanding of the intersection between architecture and socio-economic, cultural, and environmental factors. The second part of the investigation analyses contemporary architecture, its fundamental innovation and technology, and in the process identifies opportunities for

collaboration between modern and traditional architectural styles and techniques. The third stage of the study focuses on primary data collection. This entails actual experiments, interviews, and surveys.

First data was collected from a private villa called Landmark House for the architectural firm the Other Dada (Dada, 2013). This data was obtained from the loggers in three different spaces: an indoor, modern, inhabited house, an indoor transitional-scheme tea room/ library spaces, and an outdoor space. Secondary data was collected from traditional Addiriyah site from three data loggers, covering indoor traditional living, a traditional court, and an outdoor area. Third, formal interviews were conducted with people living in conventional Modern or transitional houses around the site to see how they dealt with climate control (interviews with around 10 to 15 households). The interviews were intended to discover how these people cope with the change of having more places related to their culture, in terms of psychological comfort and public acceptance and resistance.

Additionally, online surveys were employed to find out the housing applications that are environmentally sustainable however, taking into consideration the visual aspects. The data collected from the loggers helps to demonstrate why people prefer different types of buildings. The researcher also completed a field visit to a refurbished site, Addiriyah, to show that people relate traditional structures with their immediate culture.

This study adopted a deductive interview process. It sought specific responses to the questions of interest; this approach was adopted to predetermine all content areas in the primary research question (Creswell et al., 2007). According to Bryman and Bell (2011), a theme comes into place when one tries to capture the fundamental importance or meaning of a select component of the narrative text. For this study, I relied on the themes as the primary resource for its conclusions.

In order to develop a strong research foundation and arriving at a definite answer to the research questions, this study will extensively review previous studies on traditional architectures, building sustainability, assessment methods for durability, and contemporary design in the context of Saudi Arabia. The following are some of the themes that will be broadly tackled by the study.

## 1.9 Conclusion

The chapter provided a brief background of the research topic and its context. It highlighted the architectonic tradition of the Middle East and sheds light on its evolutionary aspect and modern-day architectural formations. The chapter also highlighted modern construction and its disregard the core Islamic values, beliefs, tradition, and heritage. The issue of environmental sustainability has also been discussed in this chapter. Drawing on the discussion, it highlighted the research problem and stated the core aim and objectives of the research. The chapter also covered an analysis of the significance of the research, contextual relevance, and indicates the research scope. Based on this discussion, the next chapter attempted to analyse the perspective of the existing scholars and critically analyses the same to identify the research gaps.

# 2 CHAPTER TWO: LITERATURE REVIEW

## 2.1 Introduction

The most exceptional examples of vernacular architecture can be observed in the Middle East region that is a result of arid climate and an architectural focus on using indigenous techniques and material (Naciri, 2007). The concept of vernacular architecture can be traced back to the works of Hassan Fathy who proposed a collaboration between the local craftsmen and modern architect to preserve the premodern tradition of architect instead of concrete houses (Pyla, 2007). Fathy's conception of vernacular architecture was although economical were more suited to the rural lifestyle (Pyla, 2007). Thus, the Gourna project, in Egypt as envisaged by Fathy failed because of the resistance from the locals and government's land usage policies (Pyla, 2007). However, the author stated that such vernacular architecture may lead to homogenization of the building tradition in Egypt. Various authors have also studied Abdel-Wahed El-Wakil's architectural vocabulary in relation to his renovation of Quba Mosque. As noted by Macca and Aryanti (2017) the architectural conception of Abdel-Wahed El-Wakil is in stark contrast between traditionalism and modernism. Steele (1996) noted that El-Wakil's stand was against modernism and according to him architectural modernism must borrow and preserve the tradition and improvise based on the current requirement. Therefore, from this discussion it can be stated that there is a constant dilemma between preserving the traditional heritage and confirming the modern architectural formats.

A wide range of studies have been done on the intersection between traditional architecture and modern approaches to building and construction. The debate has always been how to balance the benefits of traditional and contemporary approaches, often from Western architecture. Ideally, the choice of architectural approach should be driven by factors such as social environment, religious practices, cultural factors, and economic considerations. This study focusses on socio-cultural and socio-environmental factors. Arabic cultural expectations dictate that architecture should be authentic and sustainable in the local environment. At the same time, adopted architectural approaches should be adequately progressive in terms of adoption of the latest construction technologies. Thus, the present research proposes an amalgamation

of traditional and modern architecture and calls for a transitional "Hybrid" form of architecture that upholds tradition, nationalistic culture while also keep up to the present-day changing needs and requirements.

This chapter comprehensively and critically reviews previous studies focusing on the amalgamation between recent architectural formations and traditional designs. It explores the role and essence of conventional architectural values in communicating the identity and authenticity of occupants. Its focus is on how different elements of traditional buildings are interpreted and inter-linked and how they ultimately shape the physical environment and behaviours of dwellers. This chapter also explores the need for sustainability for homes and other dwellings and how traditional approaches can combine with modern methods to create an ideal environment for daily life, work, and play.

Ultimately, the literature review highlights how architectural approaches hugely influence people's perceptions of their homes in terms of social status and domestic space utility. Architecture reflects family values, ethnicity, and social status.

## 2.2 Relationships Between Modern Architecture and Traditional Values and Designs

### 2.2.1 Introduction

Technological advancement coupled with rapid urbanization has led to increased standardization of dwellings and other built environments. Consequently, over the past several decades, human habitats have become deprived of their regional and cultural identity (Eldemery, 2009). In the era of globalization and rapid urbanization, the same types of materials, building approaches, and styles are used everywhere, regardless of history and tradition (Lo & Yeung, 1998; Lewis, 2002). However, in recent years, stakeholders have conducted conferences for the purpose of reversing the trend. Communities are increasingly seeking strategies to create fairer and more sustainable cities. Architects, social scientists, and economic geographers are keenly observing global cities with the objective of understanding how emergent technologies drive global, spatial, and economic development (Eldemery, 2009).

The traditional architectural designs of Jeddah owe to the discovery of oil in terms of rapid urbanization and transformation to an oil-based economy Saudi Arabia. However, as noted by Wang et al. (2018), concomitant to this rapid urbanization there emerged issues like unplanned construction, illegal residents, planning weakness of the municipal corporation, population growth, migration and price rise of the urban lands. Oil sector development brought with it demand of new buildings along with new designs that merely failed to address environmental sustainability and keep up the cultural aspect of the inhabitants. The remarkable economic development failed to reinforce environmental security and the traditional cultural values.

There have been increase in the academic interest towards studying the evolving architectural paradigm globally. Scholars are continuously exploring strategies to promote sustainable urban development. This exploration includes critical analysis of current practices, focusing both the pros and cons of either traditional or modern approaches to architecture (Lo and Yeung, 1998). For most scholars, the solution lies in the effective integration of traditional and contemporary building methods and design. This section critically reviews studies on the potential to integrate modern and traditional architectural values, at the same time identifying gaps in previous studies.

### 2.2.2 Globalization and Architecture

According to Eldemery (2009), homes and other forms of dwelling exist not only as physical locations but also as memories in people's minds. Individual places become interesting only when they deliver an absolutely unique experience that evokes memories or associations. The globalization of architecture deprives dwellings of their regional identity and uniqueness. However, modern architectural approaches that have become globalized also introduce capabilities needed for sustainability and for housing the growing populations concentrated in urban areas. In essence, globalization has both negative and positive potentials for local Arab architecture. Advanced technology of modern architecture needs to be utilized in a manner that reflects local cultures and traditions, however (Eldemery, 2009; Abel, 2000). For the Arab world, the negative and positive ramifications of modern architecture must be understood, including how to attain the benefits of globalization while retaining the core values and benefits of the

traditional architecture. In essence, nations should conduct a cost-benefit analysis in the short and long term while putting in place measures to minimize risks.

Globalization has exerted considerable resource and development pressure on cities and specific regions. Globalization as a phenomenon has elicited significant global attention than has any other issue in the recent past (Chris, 2006). It means different things to different people in different contexts and is used for varied purposes. Globalization has been defined as a more profound increase in worldwide relations, such that distant locations are closely linked with local occurrences, shaping local activities (Chris; 2006; Sklair, 2006; Eldemery, 2009). In this regard, globalization has increased the diffusion of ideas. Adam (2008) describes globalization as a process whereby everyday life experience becomes standardized throughout the world. Naturally, the concept of globalization has held various and contrasting meanings, often depending on pro- or anti-globalization perspectives.

In the architectural realm, there have been tensions between global and anti-global forces. The anti-global school of thought fights for the safeguarding and promulgation of established traditional architectural traditions, technologies, decorative motifs, and forms (Adam, 2008; Eldemery, 2009). This group also strongly advocates for cultural diversity, historical continuity, and identity preservation. The anti-global group believes strongly that architectural vocabulary should impart identity just as much as local dialects do (Lewis, 2002). In contrast, the pro-global group seeks to promote invention and distribution of new technologies and materials as informed by evolving functional user needs and sensibilities (Lewis, 2002). This group places greater emphasis on the need for standardization, flexibility, systemization, and the ability to interchange materials, parts, and processes.

In sum, the pro-global groups favour the globalization of architecture and architectural homogeneity, while the anti-global group sees globalization as culturally disruptive and aesthetically inappropriate. Yet, there is also another group of industry players who believe in hybridization with the goal of promoting diversity and heterogeneity. According to Sklair (2009), globalization has presented a wide range of problems, which have severely undermined the abilities of cities and governments to achieve sustainable

development. However, these problems have no single cause, and they exhibit discontinuous spatial behaviour. Therefore, any workable solution must address the connections between local and global forces. Neither modern nor traditional values will solve the evolving challenges of housing in a rapidly urbanizing world. A combination of both in varying levels is needed.

However, few of the pro- or anti-globalization schools of thought have explicitly conducted field studies or experiments to substantiate their arguments (Ren, 2011; Martin, 2011). Most of the previous studies have been case studies on how new technology and trends can be adapted to traditional architecture. Eldemery (2009) conducted a survey of how trends and new technology can be applied in preserving locality and promoting place identity. The survey focussed on the Prophet's Mosque extension in Alexandria, Egypt. Other studies, such as by Lewis (2002) and Adam (2008), are mainly theoretical. None of the above studies conducted experiments to determine the differential living characteristics and conditions that traditional architecture offers in relation to modern architectural trends for dwellers in the Middle East. This lack empirical study is one of the main gaps that this study seeks to fill, conducting empirical experiments on the specific benefits that traditional architecture offers and how modern architectural trends can be used to enhance these benefits without a loss of socio-cultural identity.

### 2.2.3 History of Islamic Architecture

To appreciate the relevance of traditional architectural values in the construction of contemporary buildings in Arab countries, one must understand the history of Islamic architecture. Islamic architecture developed from social, cultural, religious, and functional needs over the years, which is why it must be integrated into contemporary architecture. Islamic geometrical patterns are a distinctive element of Arab and Islam architecture. These patterns have been used for centuries as decorative elements on ceilings, over walls, grilles, openings, doors, minarets, and domes, among other things (Abdullahi, 2013). However, one of the challenges in their use has been the absence of guidelines and codes of practice. According to Abdullahi (2013), this lack of codes to follow has often resulted in inappropriate use by practitioners in regards to time-scale

accuracy, architectural style, and identity. In some instances, the use of Islamic geometrical patterns has been undermined by misunderstandings of the history and origin the decorative patterns (Abdullahi, 2013). Islamic geometrical patterns are an integral element of Arab architecture that continues to be eroded by modern approaches. At the same time, the socio-cultural and physical benefits of Islamic geometrical patterns have not been quantified by previous studies. Thus, through its experiments, this study seeks to provide hard data on the environmental benefits of traditional architecture.

Islamic architecture and, indeed, architecture in general, benefit immensely from techniques and approaches borrowed from other regions and cultures. Historically, new technologies have also widely influenced architectural plans in the Middle East. For instance, the expansion and development of Islamic culture and architecture can be linked to the significant enhancement of technological and scientific innovations in the ninth century (Turner, 1997). According to Turner (1997), technological changes in Asia, Iran, and the Middle East widely influenced the development of Islamic architecture, as shown by translations of ancient texts from Sanskrit and Greek to Arabic. In essence, even the traditional Islamic architecture has always relied on external influence to grow and thrive. However, the adoption of foreign technologies did not result in near-total disregard of indigenous approaches, as is currently being witnessed.

As of the 10th century, original contributions to science by Muslim countries increased significantly. Works by scholars such as Ibnal-Haytham, Abu Mansur al-Khwarizmi, and Abu’l Wafa al-Buzjani provided the foundation for the establishment of geometry as an applied mathematical concept (Mohamed, 2000). One of the earliest books ever written on geometry was Khwarizmi's The Compendious Book on Calculation by Completion and Balancing. This book was written in the early ninth century (Mohamed, 2000). Similarly, pioneering decorative geometric patterns have been traced to the same period, as observed in surviving structures in the Muslim world. Critical analysis of surviving architecture shows that the use of Islamic geometrical patterns evolved tremendously from the ninth century to the late 18th century with varied influences

from other regions (Abdullahi, 2013). In essence, architectural collaboration has always been an essential element of Islamic structural development.

Even traditional Arab architecture has evolved; in the period, it adopted foreign influences but without losing its local cultural authenticity and relevance. The evolution of from traditional to modern architecture has participated in loss of cultural authencity. Previous studies (Mohamed, 2000; Turner, 1997; Abdullahi, 2013) of the evolution and integration of local architecture with foreign influences have been mainly historical or have been case studies limited to socio-culture. None of the above studies have sought to determine how evolution interfaced with the actual physical living conditions in the Arab world. In general, previous studies have not asked why specific technologies from a foreign region were adopted while others were ignored at both the decorative and functional levels. The study therefore, attempted to fill this gap and analyse how technology can assist in creating a hybrid form of architecture preserving local, national, as well as foreign elements to create an ideal setting for the dwellers.

### 2.2.4 Trends vs Tradition

Dialogue among architects has continued with respect to whether to embrace tradition or adapt to the prevailing trends. Architects are in a constant dialogue with the society, especially as concerns the role and place of globalization in the design and construction of buildings (Carmona, 2010; Mahgoub, 2004). On one side, architects view globalization as a trend distinctive of the present time. On the other hand, theorists view globalization in two ways (Eldemery, 2009). First, they see globalization as a positive and necessary vehicle to drive global progress and enhancing diversity. Secondly, they view it as a force for rapid global homogenization and the destruction of established norms and traditions. Overall, constant ideological struggle persists between maintaining traditions and adapting to prevailing trends. However, the dilemma can be resolved; emergent patterns and cultures can co-exist and complement each other.

El-Husseiny (2004) argues that architecture seeks to resolve philosophical, metaphysical, and cultural identities in the physical context. Architecture challenges humanity to view architecture in the context of both history and the present (El-

Husseiny, 2004). Historically, architectural movements have always sought to oppose aesthetic and cultural diversity while promoting and reinforcing the adoption of specific architectural philosophies at both national and international levels (Eldemery, 2009). Pro-global schools of thought, including within governments, have sought to use architecture as symbolism. At the corporate level, companies use architecture for product identification and branding. At the same time, some individual architects seek to promote their architectural theories. As such, diverse perspectives on architecture often compete for attention and oppose one each other. This contrast creates a situation whereby collaboration offers the best strategy for incorporating diversity while retaining tradition.

Overall, none of the previous studies (El-Husseiny, 2004; Eldemery, 2009) focussing on Arab architecture have empirically tested the potential benefits of integration of both traditional and Western architectural thoughts. There is strong advocacy for the inclusion of modern and traditional architecture; however, very few previous studies have empirically evaluated how dwellings constructed on integrated technologies are perceived or deliver on the physical and aesthetic benefits promised. This lack of empirical evaluation is one of the gaps that this study seeks to fill by conducted experiments on a variety of dwelling places.

At the beginning of the 20th century, the majority of architects thought that the new century (i.e., modern architecture) required doing away with traditional aspects. They argued that the new industry, increased mobility, and the modern social and political order demanded new building technologies and approaches (Eldemery, 2009). This argument led to prolific architects of the time such Walter Gropius and Mies van der Rohe, to coin the term “international style”. This marked the beginning of the drive to globalize architecture around the world. As of today, forces promoting the globalization of architecture primarily emanate from the growing commerce culture and culture of design (Cowen, 2009). Commerce culture is underpinned by profiteering, evolving consumer needs, and a variety of market and business dynamics. Commerce culture is epitomized by the iconic high-rises, banks and hotel chains, oversized malls, standardized and visually homogenous restaurant chains. The desire, and sometimes the need, to brand with architecture have ensured that the architectural styles used in

Europe and America are the same ones being adopted in the Middle East (Cowen, 2009; Eldemery, 2009). For banks, sky-scrapers are their iconic image; this is their preferred architectural style.

Global design culture has also been a dominant force in shaping architectural trends. According to Eldemery (2009), global design culture is mainly driven by architects who evaluate and the works of other architects regardless of their location in the world. Slick photographic magazines published offline or online, industry journals, and social media pages of celebrity designers are the primary media through which global design culture is perpetuated and distributed. The above media is used to establish trends by offering information on design concepts and materials. Certain kinds of materials are generally preferred and widely hyped. For instance, global design culture favours glass, stainless steel, aluminium, titanium, copper, and natural stones, which are universally available (Cowan, 2009). The result is that local materials that have been used regionally have gradually become neglected.

According to Evans (2003), globalization of architecture is best manifested by the glossy facades of the world's leading capitals. Previously historic and culturally authentic cities were converted into sky-scrapers within a concise period (Oncu and Weyland, 1997). As multinationals establish regional headquarters, across the world officer towers, trade, and mega hotels have also expanded. In the process, traditional architectural styles have been mainly ignored. However, Eldemery (2009) argues that globalization has created the imperatives for structural standardization that cannot be overlooked. For instance, rapid urbanization, especially the development of sky-scrapers and malls, has been efficiently achieved through globalized architectural styles. Nevertheless, this achievement does not mean that traditional approaches are completely outmoded. At the same time, there have been no investigations or studies as concerns the potential for incorporating traditional architectural styles in modern utility buildings. In the United Arab Emirates (UAE), efforts have been made towards architectural localization of the malls with Bedouin tents and replica villages (Pager, 2015). However, there have been no empirical studies on the impacts of these belated efforts on the perception of locals and whether these efforts are adequate in developing and enhancing locals' sense of identity and place.

### 2.2.5 Technological Trends in Architecture and Traditional Values

In the last three decades, the world has experienced rapid technological evolution. Technological evolution and the restructuring of companies' global operating dynamics have delivered an unprecedented socio-economic change of the 20th century (Brewer, 2011; Perez, 2009). Global cities emerged and persistently reinforced their position as the centres of civilization, underpinned by scientific and material innovation. In many ways, technological innovation has been the primary driver of the globalization of entertainment, transport, consumer tastes, and even architecture. Technological innovation is happening at an incredible pace and is distributed at an even faster pace around the world. The rapid growth of urban areas and metropolis around the world has been principally powered by modern technology. High-density housing and mass transit systems have been made possible by technological innovation.

In the field of architecture, the pace at which technology has enabled the development of urban centres reduced interest in traditional architectural values. However, in most instances, too much dependence on new technology has not necessarily yielded human-focussed dwellings. Pioneering tenets of architecture underline three essential aspects of any good architectural output namely: firmitas, venustas, and utilitas (Morgan, 1914). Primarily, the quality of a building is determined by the technical capabilities, functional requirements, and practical aspects of the building, and finally its aesthetic needs.

Originally, architecture was meant to be neither static nor fundamentally disconnected from the culture of the immediate populace. Perret, a pioneering architect in the use of reinforcing concrete, defined architecture as a living art that diligently seeks to express and visualize its time in the embodiment of modern building techniques (Schoon, 1992). According to Perret, contemporary technology should underpin the construction techniques of the time. This baseline importance is evidenced by the fact that contemporary buildings are complex and require considerable mastery of construction technologies and structural engineering techniques. However, Addington (2006, p. 64) writes that technology is the "handmaiden of design and as such, is meant to be subordinate to design." According to Addington (2006), the design is "the what" and

"the why", while technology is the enabler. As such, emergent technologies should not override traditional architectural approaches; instead, they should serve to enable and enhance their utility and scalability. However, as concerns Arab architecture, no empirical studies have sought to determine how new technologies and Western architectural approaches optimally interface with local structural orientations.

New technologies have undoubtedly transformed the nature of life and work for billions of people around the world. Virtual reality and hyperreality provided by cyberspace have created new models of entertainment and information distribution. Nevertheless, Eldemery (2009) argues that innovation and rapid change have been aspects of modernity for centuries. Presently, technological development and expansion continue to define global engagement and interaction. The emergence of global culture can be directly attributed to new information technologies. In the field of architecture, emergent forms of architecture are easily crossing national boundaries and forming an integral part of the new global culture. According to Lo and Yeung (1998), robotics, electronic technologies, telecommunications, biotechnology, and new materials have shaped the new worldwide paradigm and continue to define how global cities are designed and constructed. Consequently, it is only natural that architects adopt new technologies in their building projects. Moreover, Western architectural models have been established as best practices across industrialized nations; this standardization makes them particularly attractive for rapidly urbanizing countries with limited resources and time for developing homegrown architectural solutions (Vassigh, 2004). Eventually, architecture is both an art and a science, and architects must master both the artistic and the engineering skills. It is in this regard that traditional techniques can find a place in modern architecture. Architects can adopt the utility and functionality of Western architectural styles while also retaining the artistic orientation of conventional methods and approaches.

### 2.2.6 Architecture and Identity

Architecture is the most visible mark of cultural and regional identity. In the architectural realm, globalization has come to be associated with a loss of cultural identity (Tomlinson, 2003). It is generally considered that place identity is an essential

element of cultural continuity. The sights and sounds of a place define that place; thus, loss of identity essentially de-couples one from one's past (Altman & Low, 1992). Ensuring that a place retains and continues to perpetuate its cultural identity is the role of planners, social scientists, and architects. According to Eldemery (2008), the concept of "place identity" considers several dimensions, including the physical size of the building, its symbolism, and its function. In essence, the place should also embody cultural, social, and personal spatial aesthetics. Traditional architectural approaches tend to incorporate elements of cultural identity into design and construction techniques by default. However, globalization tends to undermine these cultural elements (Burd, 2008).

The role of place identity as an aspect of cultural identity is multi-dimensional in terms of psychological and physical environmental attributes. According to Nijman (1999), an individual's sense of place identity is conceived and perceived in varied ways. First, one can perceive space through what the individual experiences. Second, space can be a convergence of cognition. Third, space identity is reflected in how residents feel about their houses or towns. Overall, the ways people assess and interact with space determine the role of the space as an embodiment of cultural identity. When places are discordant with an occupants' perceptions of space, they will often be heard saying, "This is not the place for me." Space is an extension of an individual's both physical and psychological environment.

Proshansky (1978) describes place identity as a psychological structure that supports an individual's global categorization and social status. Place identity is a product of continuous engagement between people and place. Place identity is also how individuals conceptualize their self-identity. According to Proshansky (1978), no physical space is devoid of cultural, social, and psychological elements. Thus, Proshansky (1978) coined the term "place identity" to refer to how an individual self-identifies in his immediate physical environment. In essence, an individual's physical environment determines his or her sense of belonging. It is the linkage between self-identity and identification with the local community (Hummon, 1986). This association takes time to establish and is often highly symbolic but also prominent in an individual's subconscious. In contemporary UAE society, elements of globalization (modernity) and tradition exist

side by side. Consequently, peoples' sense of place has also evolved. Thus, there is a need for collaboration between emergent technologies and traditional approaches, to create spaces that reflect the evolving understanding of place identity.

### 2.2.7 Architectural Values of the Middle East Region

In the past two decades, Arab cities in the Middle East have undergone considerable transformation (Eldemery, 2009). Import of architectural ideas from the West, coupled with scientific progress, has resulted in fundamental structural changes. In most instances, the region has been forced to rapidly modernize, resulting in sharp conflict between imported ideas and traditional values. According to Saqaaf (1986), some of the fundamentalist movements in the region can be attributed to the conflict between traditional values and imported Western ideas. The architectural formations in some of the leading cities in the area, such as Dubai, are principally Western (Eldemery, 2009). The architectural vocabulary and language are mostly Western. One of the main reasons Western styles and techniques have become dominant is the strong association between architectural styles and stature of the Westerners, as well as associations between Western architecture and progress. Consequently, indigenous architectural practices are often perceived as retrogressive and less prestigious.

The concept of Sustainability primarily is understood from its idea of incorporating economic, social, cultural and environmental aspect. However, the present study seeks to differentiate all these mentioned elements by considering them as the fundamental constituents of the concept. Therefore, in order to understand the economic, social and cultural values of sustainability, it is important to understand it from the construction of building perspective. Houses are a vital component in the built environment and play a crucial role in sustainable development. A building exhibits social, economic, and cultural characteristic (Gou et al., 2018).

Casamo-Rosa et al. (2018) stated that sustainable development is an all-encompassing and integrative course that holistically considers ecologically sustainable way of life. In other words, sustainable settlements are characterized by environmental conditions, spatial and geographical location along with local cultural beliefs, organizational arrangements and human development (Gou et al., 2018). Thus, the primary concern

for housing development regarding sustainable development is to meet the needs of the people while secure the environment. Housing entails therefore more than merely satisfying human's basic needs. It rather has larger impact on the external environmental conditions (Casamo-Rosa et al., 2018). The housing needs changes along with changes in the population and their level of adaptability. Therefore, the housing constructions should also match this dynamism of social suitability. It is important that the residential architectural construction must embody both the need of the users while being environmentally sustainable. In addition, it also has to take into account the socio-cultural element of the land while assessing environmental risk and promoting safety, security and quality of life of the residents.

Rahman and Kojima (2018) noted that the social and cultural aspect of sustainability often overlaps substantially.; It is because of this reason it is difficult to separate the two and they go together. However, as observed by Chiu, these two components also are in considerable conflicts. the social aspect is rather tangible and includes the concept of social solidarity, equity, conflicts, social inclusion and equality. On the other hand, cultural dimension incorporates the aesthetics like music, literature, art, religion (Casamo-Rosa et al., 2018). Most of the cultural dimensions correspond to tangible elements. Form the viewpoint of sustainable house design, social and cultural aspects have the function of meeting both human needs while preserving the cultural and social environment. These two concepts bear major roles and effects to promote environmental sustainability. However, it must be borne in mind that the social and cultural needs are dynamic in nature and change along with environmental sustainability. Therefore, they are not universal. This is largely dependent of the peculiarities of a given social context as it attempts to integrate the sustainability components in the housing design solutions.

Gou et al. (2018) holds that 21st century should entail the concept smart cities; however, this vision is not yet realized, and thus the promotion of sustainability could not be achieved. One way to evaluate the appropriateness of a construction is to determine the intended role of sustainability in that construction. Environmental sustainability is a novel approach to design that embraces the concepts of greener infrastructure. The notion of sustainability establishes a link between the

implementation of a number of aspects that is in conformity with the environmental condition of current cities and their people, their economies, and the entire society.

Innovation and dramatic change have been aspects of modernity in society for centuries. As technology progresses and expands, societal practices evolve alongside. Even indigenous architectural practices reflect change in tastes. However, the rapid globalization and the adoption of foreign design have created a situation that necessitates a need to re-think social theory about culture (Bhabha, 2012; Eldemery, 2009). Architects are building structures that reflect their very own imaginations but are largely devoid of cultural identity and local relevance (Beck, 2002). The trend has been to erect structures that conform to universal best practices but fundamentally lack character and truth.

For a cross section of architects and architectural scholars, architecture needs to be globalized and standardized. This notion is perpetuated by global media such as TV promoting consumerism through the creation of "desired best practices" and preferable consumer items (Paek & Pan, 2004; Grainge, 2007). The adoption of “global best practices” leads to a “sameness” that has been described as boring and bland (Grainge, 2007). Traditional architectural practices in the Middle East are founded and premised on decorative beauty, something that imported techniques lack. However, this lack does not mean that Western techniques should be abandoned; instead, combining the approaches of both can create progressive structures in this rapid phase of modernization in this region.

Architects in the region find themselves in a conflicted position between local cultures and Western architectural methods (Abel, 2000). The conflicted position is reflected in the scholarly works of Middle Eastern architects. The two distinctly opposing positions between local cultures and Western methods compete for attention in defining the architectural direction of the region. Architects often find themselves at the centre of a cultural conflict between the present and indigenous religion and culture, as well as their divergent values and architectural expressions (Eldemery, 2009; Abel, 2000; Abel and Forster, 2012).

In this section, the present study identifies significant facts on amenities and comfort levels. Data for conducting this analysis has been gathered from the experiment developed between January 2015 and January 2016. It also integrated previous researches that are carried out on thermal conditions. The study measured the temperature, relative humidity and dew point temperature (DPT) continuously for a whole year. The understanding of the influence of relative humidity, temperature, and dew point temperature demonstrates the performance of the buildings and indicates their sustainability. It is because of this reason, these parameters have been chosen for this research. The study also adopted parameters from previous researches to monitor relative humidity as well as temperature. It used digital electronic monitors Easy Data Loggers to assess thermal performance and also to measure the relative humidity in the outside climate and record changes in temperature.

The method adopted for the study attempted to check if the air conditioning (AC) are running properly all the times, to assess the temperature performance in the traditional buildings like a house or a courtyard. Based on the information from the secondary data sources and the measurements obtained, the researcher found out that the level of relative humidity is lower during winter season but is higher in the month of January. Detailed information on the given timeframe's monthly averages are depicted in the following analysis. The study is relevant as it has incorporated the weather trends as collected for the previous two decades. This study seeks to show empirical evidence of the need to incorporate traditional architectural methods and techniques in modern architecture, beyond aesthetics, including also the functionality of the buildings.

### 2.2.8 Architectural Contradiction in the Arab World

The past two decades have seen large-scale development projects across most Arab countries. Most of these projects have been implemented without considering the fact that the physical forms being adopted are ideologically alien to local cultures (Doratly et al., 2009). According to Doratly et al. (2009), the architectural styles being adopted stem from different codes of behaviour and environmental realities. One of the reasons for the adoption of Western-style large-scale development projects in the Arab world is a desire to attain modernity by the state. In the process, Arab architecture, intentionally

or unintentionally, started to lose its uniqueness: local images and the ability to meet the specific needs of the locals. There have been dramatic changes as concerns the cultural relevance of architecture, with most people considering "modern" architecture in Arab cities to be Westernized and culturally alienated (Bianca, 2000). Interestingly, the transformation of Arab architecture towards Westernization has been termed "progress" and a search for national identity (Abel and Forster, 2012). Substantially, the underlying rapid loss of architectural culture is increasingly positioned as a search for a new national identity. This positioning occurs even though the adoption of Western architectural styles is a clear indication of a break from tradition and identity.

Arab countries have imported Western architectural forms without considering their consequent underlying cultural and social impacts. It must be understood that Western architecture emerged from specific socio-cultural realities, with certain global influences (Doratly et al., 2009). Those socio-cultural realities are not the same for the Arab world. As such the wholesale adoption of Western styles is in most instances inconsistent with the specific needs of Arab cities. Recently, as a consequence of the significant loss of Arab identity across Arab cities, some countries have pursued architectural regionalism (Eldemery, 2009). This pursuit has occurred through the adoption of architectural traditions within the framework of international architecture. At the same time, some countries have sought to develop traditional architectural styles using modern architectural forms. In essence, contemporary efforts towards bringing back traditional architectural styles are inherently contradictory.

The contradictory nature of contemporary architectural practices in the Arab world is not necessarily counter-productive, since "progress" calls for modern architectural styles. At the same time, there is a need to preserve local architectural styles. Through experimental approaches, this study seeks to determine which specific aspects of traditional architectural styles must be retained. This study will conduct experiments to identify the particular features of traditional architectural that ought to be kept for both functional and aesthetic purposes. Through identification of the elements that deliver physical and psychological comforts traditionally, it would be possible to determine the basis for collaboration between traditional and modern architectural styles.

At present, views on how best to embrace traditional architectural styles given the practical realities of modern imperatives are contradictory (Doratly et al., 2007). However, the contradiction is understandable, given pressures towards globalization. For most countries in the region, local traditions continue to provide cultural bonds and connections; however, Western economic, institutional, educational, and to some extent political systems directly contradict such beliefs and customs (Bianca, 2000). Thus, the practical route for future Arab architecture is integration and collaboration between traditional and modern approaches. This coordination of styles can be achieved only through a proper understanding of the comfort features of conventional architecture and how they can be integrated into modern architecture.

Overall, the architectural contradiction in the region can also be viewed in the evolving sense of identity amongst citizens in the area. Hummon (1986) defines place identity as "an interpretation of the self that uses place - a significant, symbolic locale... as a sign or locus of identity". In essence, place identity becomes an evolutionary construct that changes over time, as people change. How people identify with a place is a product of their traditional culture and present reality. Globalization has not spared the Arab world, with cities such as Riyadh, Dubai, Abu Dhabi, and Doha becoming global cultural melting pots. Thus, place identities for indigenous people have also evolved to reflect the globalized nature of these cities.

Hummon (1986) further argues that the environmental contexts within which people live pose real consequences for them and puts a great deal of stress on relations between the people and the place. Mostly, the contemporary lifestyles of Arab city dwellers have created needs and expectations that purely traditional architectural styles might not fully meet. At the same time, there are cultural connections and functional advantages in traditional architecture that most would prefer to retain. This mix in the needs of occupants results in a dynamic situation whereby the formulation of “place identity” becomes problematic. Proshansky et al. (1983, p. 62) extended identity theory to encompass environmental psychology; this identification led them to propose that place identity is "physical world socialization of the self." Thus, the definition of the concept of identity must recognize the fact that "place identity" formulation is a complicated matter in a highly globalized world.

Superficially, place identity has mainly been linked to ethnicity (Eldemery, 2009). It is generally assumed that the desired functional and symbolic linkage between people and their environment is premised on ethnicity above all else. Essentially, ethnicity is the basis upon which “place identity” is constructed. According to Rapoport and Hardie (1991), this relationship arises as such because culture is easily differentiated by ethnicity. This understanding is echoed by Mthethwa (2002), who argues that ethnicity is the springboard of culture and thus provides the basis for "place identity" formulation. However, it is easy to see why this kind of approach to "place identity" formulation becomes problematic in contemporary Arab society. Ethnicity alone does not define of "place identity." Global influences have permeated Arab culture at almost all levels. Consequently, peoples' sense of identity has also evolved to reflect global realities.

Place identity is further defined precisely as a set of cognitions about physical settings. The concept of place identity underpins the collective sense of cultural identification with a particular building and its design features. This concept considers the debate around decisions about buildings and the sources of architectural elements used in the design projects or constructions. It implies that essential natural characteristics identify a place and that, in effect, these are latent and without structure but can be released through sensitive design solutions.

Under the above criteria, a locally appropriate building or proposed project is determined by a consensus decision concerning on the structure or proposed a plan with the incorporation of an acceptable architectural language drawn from vernacular design aspects, including site, vernacular architectural forms, materials, and symbolism. It also considers the set of buildings and the sources of structural elements used in the design project or construction. Given these considerations, a locally appropriate structure or proposed project could be determined by a general political consensus on the proposed project with the incorporation of an acceptable architectural language drawn from the national vernacular language. Such a project would represent a totality made up of concrete things having material substance, shape, texture, and colour together determining the essence of the place and by which the site is seen as a product of physical attributes.

A survey questionnaire was developed for current study to determine the effect of buildings' condition on the lifestyles of the inhabitants. The questionnaire was based on the analysis of the existing literature. 200 residents were chosen as respondent to the survey questionnaire. Analysis of the responses sketched significant development on building suitability and their level of environmental awareness. Wang et al. (2018) noted that increase in the level of exposure to particulate matter can lead to chronic respiratory problems and the cardiovascular diseases and thus cause premature death or susceptibility to cancer.

Casamo-Rosa et al. (2018) stated that the shape and size of particulates are determining factors that control the degree to which these particles penetrate into a respiratory system. Furthermore, these authors maintained that the place these particles are deposited, reactive surface area and the rate at which these particles are cleared, are potential factors to identify the regions with high concentration. As per the respondents answers they make effort to identify these high concentrations areas. The respondents also indicated that geographical conditions, the particles suspension, and the overall atmospheric conditions all were critical considerations that shaped their decisions build structures.

## 2.3 Sustainability in Modern and Traditional Architecture

### 2.3.1 Introduction

A core in deciding how to support better living is the achievement of higher quality of life. Poor air quality and lighting conditions from buildings can pose adverse effects for occupants. Sustainable designs can support the well-being of dwellers through the reduction of indoor pollution (Abdel-Hadi and Abougheit, 2012). This reduction is generally achieved through the use of materials with low production, access to daylight, and control of lighting to optimize resident comfort. In general, the amount of energy consumed by a dwelling is proportional to its greenhouse gas emissions. A study conducted in Europe in 2008 established that buildings consume an average of 40% of the energy produced, accounting for the same percentage of greenhouse gas emissions (Abdel-Hadi and Abougheit, 2012). Globally, the International Energy Agency reports that buildings consume 40% of energy while accounting for 24% of global emissions

(Howe, 2010). The above serves to show why development of sustainable dwelling places is critical for both healthy comfortable living and planetary sustainability. Buildings can be made sustainable in a number of ways, including energy efficiency, water efficiency, and materials efficiency. Traditional architectural approaches have inherently been designed with considerations of durability.

Energy efficiency is achieved by reducing energy use during building operation, through the creation of barriers between conditioned and unconditioned spaces. Other structural elements include high-performance windows and extra insulation in ceilings, floors, and walls. Alternative strategies, such as passive solar building design, have also been adopted for low-energy buildings. This type of design usually entails designers orienting windows, porches, and walls and trees in a manner to shade windows and roofs during hot summers while at the same time retaining lighting, in some climatic regions (Simpson, 2002). Such designs are particularly used in traditional buildings, as will be shown in subsequent sections. Effective window placement can also optimize natural lighting and reduce the need for powered lighting during the day.

Water efficiency is a further strategy that can be used to reduce consumption while protecting water quality in buildings. For modern buildings, this efficiency is usually achieved through dual plumbing in the toilet to promote water recycling or through the use of ultra-low-flush toilets. The use of bidets, especially in the Arab world, has also been linked to water efficiency (Simpson, 2002). Materials efficiency is another of the main strategies for the development of sustainable buildings. For contemporary buildings, the concept of green materials has been widely adopted in ensuring building sustainability (Dennis, 2010). These materials usually entail use of timber from sustainable forests or use of easily-renewable, lumber such as bamboo, recycled stone, straw, recycled metal, and other recyclable materials such as sheep’s wool, coconut, calcium, wood fibre, and linoleum.

### 2.3.2 Sustainable Development in Architectural constructions

Environmental as well as socio-economic considerations are taken into consideration to address the issue of sustainability. The recent period has witnessed considerable interest regarding building sustainable architectures. According to Wang et al. (2018)

it can successfully address health issues that are dependent on the ecological condition of the buildings. While constructing buildings one must consider the design aspect as well as the climatic conditions particular to that region. A comfortable building thus, emphasizes both the systems, source of energy as well as the environmental conditions of that region. For example, placement of a window is critical as it provides ventilation, natural light and also regulates temperature (Gou et al., 2018).

Casamo-Rosa et al. (2018) noted that efforts of human being have tremendous effect on the conservation of the natural environment and climate of a particular region. Their actions for earning a living like agriculture, mining, urban development can have significant effect on the flora and fauna of the land. Therefore, such effects should be minimized to a level where it supports the livelihood and also promote ecological balance. The utilization of material should be done in a way that considers the prospect of the future generation (Rahman and Kojima, 2018).

Sustainable development is closely related to sustainability and stability, the external environment and sustainable architectural constructions therefore have close relationship. The idea of stability and sustainability emanated from the growing environmental concern and crisis that led to the search of suitable techniques that can solve this menace (Gou et al., 2018). The concept of sustainable architecture refers to the construction of an appropriate design that is tailored to restore the need of the economic, political cultural and social environment of that region.

By understanding the interrelationship between these concepts can helps us determine the possible measures that an architect can adopt for an environmentally sustainable design and in turn reduce the environmental impact. Sustainable development shows us the way to find solutions and measures that can ultimately guarantee humans a better quality of life and promote welfare. The architectural constructs of a particular place indicate the economic activities of the region. Wang et al. (2018) stated that architecture can also help in understanding average family income. The level of income of a family determines the desire to have a luxurious expensive house. In addition, the use of materials, spaciousness, garden and thermal conditions also indicates incomes of individuals. Therefore, a building bears the unique characteristics of human activities.

Buildings also have considerable impact on the ecology of the setting. Increase in the manufacturing processes also have a direct relationship with the place's ecological balance. It must be understood that the entire process of building construction and designing has tremendous influence on the natural environment that in turn contributes to the global ecological system (Gou et al., 2018).

### 2.3.3 Traditional Built Environment in the United Arab Emirates and its impact

According to Alkhalidi (2013), many drastic changes have been made in the United Arab Emirates (UAE) since the 1970s; among them, the increase in an urban inhabitant has resulted in a breakdown of traditional system. The transformation of towns and cities in the UAE has become more and more evident due to the process of rapid urbanization and modernization the expansion of which can be described as phenomenal. Along with the development of contemporary health, educational and recreational institutions and organizations comes an increase in the transportation, that has led to the transformation of the towns into cities in the country (Alkhalidi, 2013).

These changes have inevitable impact on the traditional values and the aesthetics, of the urban setting. The grid street pattern has led to enormous change in the appearance of the urban regions. Once a pedestrian-oriented pattern has given way to a strictly geometrically planned and vehicle-oriented urban area. Corresponding to these significant changes in the Emirates society, there have been the import of new advanced technologies, building materials, and new approaches to construction management. It thereby increased the possibilities to control the environment with the introduction of steel, (AC) and other improved technologies (Alkhalidi, 2013). The question these changes poses is, what are the characteristics of the environment that might allow us to establish a link between national identity and sustainable architecture while solving the practical dwelling needs of a rapidly expanding population?

In the UAE, the traditional architectural environment is the consequence of the continuous interaction between factors like culture (belief system, customary practices, rites and religion), surroundings (climate, soil, construction material and geographical landscape), and knowledge gained. Modern architects can take into consideration the

traditional built environment and learn from its structural patterns that will lead to building a sustainable environment. This understanding of traditional environment can only take place if one is considerate of the spatial and temporal organizations. it must also take into account the man-nature relationship. As per the psychologists and the anthropologists, people's behaviour is influenced by the physical environment. Change in the built environment in the UAE is dramatic because given the serious consequences of these transformations in terms of cultural and social damage. Many traditional structures are nowadays threatened as they are physically despoiled, and damaged by the modernization and urban development.

### 2.3.4 Regionalism

Traditional methods of construction have several advantages. Regionalism is the concept that emphasizes that any architectural structure must reflect the region's unique cultural characteristics and link the continuous change of time. In the era of globalization that is characterized by a bland sameness, regionalism through its architectural differentiation maintains heterogeneity and restores the uniqueness of culture and society. Hakim (1986) stated that architectural designs bear the special characteristics of a region and uphold the special qualities and richness of the context. In the education, regionalism emphasizes the importance of studying the culture.

In the urban setting, the traditional settlements can be deciphered from land usage pattern, the design of the streets and the house courtyard. In the Gulf region, the residential zones are defined as per the ethnicity of the inhabitants and the local mosques and shops cater to these zones. In the current structural arrangement, most of the shops are located on the ground floor. The proximity of these residential zones provides indoor comfort as well as allow formation of social relationships between the families. There are two types of streets. The open-ended ones are generally owned by the public and the dead-end ones are owned by the property owners. The traditional form of courtyard house with low rise and the inward-looking building types were the result of the climatic condition and privacy requirement. The materials use for housing are compact and is suitable for the hot climate of the country as well as the culture. It

provides room for social interaction in the private areas. Generally, the courtyard is at the centre of the house and the rest of the spaces are organized around it (Alkhalidi, 2013).

### 2.3.5 Religion Aspect

Urban construction usually in a wide-to-narrow structuration. There is open space inside the city gates that connect roads and then extend again into the social squares. This sort of pattern can be observed consistently throughout the city. The location of the mosque is around the social square. It connects the housing cluster to the mosque. The common characteristic of city planning, is the minaret of a mosque that can be seen clearly from the quarter crossroads. This serves as a landmark and a guide towards the mosque's location (Hakim, 1986).

Religion has significant influence on the traditional building structures in the Gulf area, similar to the other parts of the Islamic world. The mosque is not merely a space of worship. It is rather the focal point for organizing various community activities and space for social gatherings and showing respect of neighbours' privacy among the other community members. In Islam, any painting that contain representation of any creature with a spirit is forbidden. It is because of this reason plants, geometrical shapes or calligraphy are used as tools for decorating different spaces. Many houses in the region were designed in a way that projects the evolutionary process that is the growth and extension of the family. These peculiar Islamic traditions are the ones that modern architectural formations have not considered (Alkhalidi, 2013).

Similarly, the traditional buildings clearly bear the sign of Islamic religion and support of fairness between people. This sort of equity is reflected in the form of common treatment, construction methods, building materials, and the overall commonality between all the houses of the community. Community members are mostly involved in building the houses. Houses of the leaders are similar to the rest of the general people's houses; however, they are much bigger and decorated. (Alkhalidi, 2013).

### 2.3.6 Habitability of Built Environment

Since the inception of Environmental Design Research Association in 1969, there have been a movement towards forming environmental design. This has adopted a more social approach and has revealed significant development in the design process (Horayangkura, 2012). This is evident from the existence of the voluminous research that is available in the topic of environmentally sustainable design. Together with this there the previous literature also focuses on the relationship between environment and human behaviour (EDRA, 1969 – 2011). Previously, the emphasis is laid more on the technical aspects of design of a given project that primarily were concerned with, site inspection, project size, spatial need, financial factors, monetary constraints, regulations, and so on. However, in the recent times social design approaches has distinguished itself from formal designs, and are involved in the study of behavioural aspect that can cater to human requirements and needs (Horayangkura, 2012).

An urban structure that is sustainable represents a relationship between institutional procedures, urban structure, the economy of the region, and the people's livelihood that depict that the urban setting is transforming to a more sustainable arrangement (Gou et al., 2018). On another comprehension, sustainable structures a design is developed suitably and that depicts the characteristics of the particular context. Correspondingly, environmental assessments are a critical component that emphasizes that sustainable buildings should be matched to the environmental condition. Therefore, it is important that we consider the efficiency parameter. The key indicator of such environmental sustainability is that it will not affect the ecological balance. For instance, reduction in the energy levels will enhance energy efficiency level and utilize of those measures that contribute to the promotion of sustainability of the residential buildings. In an effort to reduce energy levels, a significant technique related to fostering sustainability and refining corresponding structural accuracy. In other words, sustainability can be understood as criteria for ascertaining the challenges and in response creating an integrated structure that can be referred for an integrative system.

Architects are primarily concerned with the social conditions of the office buildings in order to increase the work performance (Duffy & Hutton, 1998). This has led to the origination of the concept of "social cushion". In the industrialized society, this concept has relevance because no one is existing outside the society. Social design practitioners have played vital roles in matching people's behaviour with the settings in order to improve the quality of habitability of the built environment. The, psychological outcomes like individual satisfaction level, personal control, productivity and performance and social interaction and support, can be assessed during the phase of design and construction (Horayangkura, 2012). In the design cycle, habitability is the foremost important step that includes programming as well as the subsequent design, utilization, construction, and evaluation of the fabricated environment. Such evaluation of habitability provides room to integrate the necessary information like inputs of the occupants and take into consideration the broader social context into the design formation. If the spatial arrangements and needs are considered as primary requirements of a behavioural settings within the main project, then it is possible to arrive at a precise understanding of individual needs and activities that can be incorporated into the design of the constructed environment.

### 2.3.7 Sustainable Traditional Architecture

#### 2.3.7.1 Physical Elements of Sustainability in Traditional Architecture

A case-study analysis conducted by Parsaee (2014) on the ancient traditional city of Bushehr has showed how traditional architectural approaches enhance sustainability. Table 1 below shows some of the architectural features of the houses and their role in enhancing habitability.

| **Feature** | **Habitability Function** | **Description** |
|---|---|---|
| Central courtyard<br>  | Physical comfort | A solution to deal with harsh climatic conditions and also allows for cooling and air ventilation. |
| Tarmeh*<br>  | Physical comfort<br>Social relations | Adapting to climatic conditions and enhancing interaction and communications with each other (it creates a living-room-like environment) |
| Opening proportions<br>"Mashrabiya (Egypt), either shanshūl / Shansheel (Iraq) or rūshān." | Aesthetics and physical comfort | It creates favourable conditions for enhanced ventilation and interior spaces while also enhancing aesthetics |

| **Feature** | **Habitability Function** | **Description** |
|---|---|---|
|  | | |
| Shenashir *<br>  | Physical comfort | Making shadows and creating favourable living conditions in a walking corridors |
| Meshes and coloured glasses<br>  | Aesthetics and natural lighting | Emphasizes beauty, promoting vibrancy and vitality for dwellers |

| **Feature** | **Habitability Function** | **Description** |
|---|---|---|
| Railings and canopy  | Privacy and physical comfort | Fosters favourable conditions for living while also enhancing confidence and privacy in both public and private life |
| Multiple openings in interior spaces  | Physical comfort and internal lighting and transparency | Provides natural ventilation of interiors paces while also creating better living spaces; also has a controlled light access |
| Exterior facades | Climate control and visual connection | Provides natural ventilation; enhances connection to the natural environment |
| Roof | Optimization of physical comfort | Enables air circulation |

| Feature | Habitability Function | Description |
|---|---|---|
|  | | |
| Wind Catchers  | Provides for natural ventilation | Situated in the higher level from the ground to catch cool breeze and direct it in the building interiors |
| Iwan | Connecting other spaces, however does not have any specific function | A domed space used as an entrance facing a court in the mosque or madrasa. |

| Feature | Habitability Function | Description |
|---|---|---|
|  | | |
| Fountain in the courtyard  | Provides thermal comfort | Often the courtyard has fountain for ritual purification or as drinking water. |

*Table 1: City of Bushehr Sustainable Traditional Architecture-(Adapted from Parsaee et al., 2014)*

*The Tarmeh is a place which is opened on at least one side and sometimes has no roof. It is used as a temporary seasonal sitting place or as a corridor and place for connecting several spaces

*In the traditional architecture of the Bushehr, the Shenashir is a semi-open and interfacing space between interior and exterior spaces, and it is like a veranda that is made of railings and canopies made of wooden material

Various environmental factors (like topography and climate) and the social and cultural factors (like heritage, religion, customs and norms) have shaped the traditional architectural formation in the Arab World. Islamic ideals and values have a profound effect in the architectural formations in the Middle East region.

Traditional architecture in the Arab World was a reflection of Muslims' view of the environment as a living entity. This view is materialized at different levels, whether in city planning or architectural design shaped by the beliefs and actions of inhabitants who adhered to Islam as a way of life offering social ideals.

The urban setting of the traditional Islamic cities was a clear reflection of Islamic society, culture and ambience and not merely a structure of buildings and streets. Therefore, there is similarity to a great extent between the cities their conditions and characteristics (Mortada, 2003, p. 56). The housing patterns and the structures are well-suited to match the extreme climatic conditions of the region. City planning is at the core of promoting sustainable planning. Al-Zubaidi (2002) stated that city planning can be observed from the distinctive features of the urban setting, narrow passageways, and shady streets.

The urban make-up of traditional Arab city is compact and the buildings are integrated into one complex structure in which it is hard to distinguish individual houses, in order to avoid the sharp sunlight during summer to protect against extreme temperatures and sand storms, minimizing the thermal load of the building envelopes, especially of houses.

The courtyard house is essentially an urban type of dwelling in a traditional city in the Arab World. Because it is introspective, its external walls can be shared with neighbouring houses, and it can be built next to areas of public domain. Put together, a series of courtyard houses creates a concentrated urban network offering a clear separation between public and private, open spaces. The relationships of rooms to the courtyard, and of the house to its neighbours and public areas, are a physical expression of the man in various roles as a family member and as a citizen. A cluster of courtyard houses has a cellular structure that suggests that inhabitants work in harmony with nature (Macintosh, 1973).

Studies like green design has attracted much attention given the widespread popularity of the concept of sustainable architecture. The result of such studies can be seen in building of the courtyard houses that match the climatic condition of the region and improve the performance of the housing as well. It is because of this reason; the

researchers nowadays are focusing on understanding the theoretical framework for sustainable buildings. The previous literature has highlighted the importance of green buildings and the need to focus on sustainable energy usages. Prior studies have specifically focused on construction of green buildings. Green building designs thus emerge as the most important concept in this context (Rahman and Kojima, 2018). Adoption of the concept of green design and sustainability entails promotion of energy conservation, material efficiency, and improved thermal control that are the primary constituents of the approach. These can also be used as parameters to evaluate performance of the buildings. The sustainable building effectiveness must focus on being energy efficient and reduce the effect on the environment. Adoption of suitable building materials and techniques are the important factors to consider while determining the energy distribution system in the residential places and apartments.

Privacy and protection are the underlying principles of the traditional building structures. The layout of the houses, spatial relations and the architectural nuances are all influenced by these two values. The courtyard of the house is at the centre of the house and all the rooms of the house is connected to the courtyard. The courtyard regulates the climatic condition and also provides social atmosphere in the open space (Bagnid, 1989, p. 45). This system of courtyard is a prominent feature that is present in all traditional architecture of the region where all the daily activities take place.

Although courtyard is a constant feature, it has been, formed in a number of different ways. The difference owes to the existing local practices, customs, traditions, building materials, and other environmental factors (Sibley, 2006, p.49). Courtyard houses have an ancient history in Mesopotamia and Egypt thousands of years almost between 3000–311 BC.

The courtyard house facilitates segregation of male and female as per the Islamic culture. The courtyard is confined to the family members and typically served to provide women the required privacy from the outsiders and also for the children who can freely play and live life freely. The courtyard house system is flexible and are able to make room for the extended families and meet their requirement.

From the environmental point of view, the courtyard also functioned as a thermal regulator. The courtyards usually are well-shaded with high walls, wide attics and foliage so that it can protect direct exposure to heat and sunlight (Macintosh, 1973, p.8). A courtyard has a three phase functions. It served as cooling the rooms with the soothing night air. The design and material used for forming courtyard are so that it emits heat soon by radiation at night (Moore, 1993, p.50). During midday, the sun forays the courtyard floor while the cool air from inside flows out of the rooms. This makes convection currents that contribute to further the level of comfort. It therefore serves as a chimney, at a time when temperature outside is highest.

#### 2.3.7.2 Philosophical and Religious Foundations of Sustainability in Traditional Architecture

The environmental philosophy of Prophet is holistic. It believes in the essential interdependency and link between the natural elements and states that if a particular natural resource is exploited by man then the inevitable consequences of the same will be felt by the whole world (De Chatel, 2003). The holy book of Quran advises against this despoliation of the earth Mankind is ignorant of the continuous exploitation of the nature and its resources and is not realizing that such disturbances will ultimately bang on human interest and work against us. Environmental pollution is disrupting the natural balance that has far-stretched consequences on the mother earth. Quran holds that the natural wealth that is bestowed upon us from Allah is solely for the benefit of humankind. It has been spoiled with selfishness and aggressive human actions, so much so that it is now full of corruption. (Ghoneim, 2000).

Being wary of both the needs of current and future generations is one of the significant aspects and virtue in Islam. Hadith says, "Act in your life as though you are living forever and act for the Hereafter as if you are dying tomorrow" (Izzi Deen, 1990, P.194). Therefore, it is evident that Islamic religion preaches for optimum usage of resources and minimize wastage and conserving the natural environment for the future generation. Just as a person will not be disregardful of his or her future, he should also not be ignorant about the needs of the future generations (Ameri, 2001). This sort of philosophy is well integrated with the concept of environmental sustainability and its goals. Therefore, it can be concluded by saying that religion of Islam has embodied the

concept of sustainability and environmental security in its very doctrines and holy books.

## 2.4 Architectural Identity Challenges in the Arab World

According to Abdelsalam and Rihan (2012), planning and designing green cities has been one of the most significant interests in recent years for planners and architects. However, most efforts made at both the theoretical and practical levels have focussed on the applications of sustainability principles rather than on the impact of such applications on a city's image architectural identity. The crisis of architectural identity is a global dilemma that has emerged as a result of globalization. In this sense, Abdelsalam and Rihan (2012) point out the dilemma that non-Western societies face due to the devastating invasion of Western culture into local societies and its negative impacts on local cultures. Roxana Waterson (1998) emphasizes the same dilemma as a result of the application of Western norms to address the problems of other regions, rather than drawing upon local solutions. The local–global conflict as an expression of high modernity has shifted people's notions of self-identity (Abdelsalam and Rihan, 2012). Abdelsalam and Rihan (2012) argue further that evolving self-identity is workable in the case of architectural identity; however, extreme modernity has resulted in great and extensive changes that have affected local societies negatively over the long term.

Arab cities have suffered major setbacks since the beginning of the 18th century, and, by early in the last century, Arab cities had begun to have their own identity denied due to the occupation by military who had different cultures. Arab cities have passed through four phases: (a) development that resulted from foreign interventions during the 19th century; (b) development that resulted from technology transfer influenced by industrialization; (c) development that resulted from rapid rural–urban migration after World War 2; and (d) development that resulted from the sudden inflow of oil wealth during the 1970s. This brief view helps us to understand the reasons for the historical and cultural decoupling of traditional culture that the Arab cities witnessed. This divergence played a major role in precipitating the current crisis in Arab architecture which has been a significant topic amongst architectural scholars. Some scholars continue to debate Arab architecture. According to Asfour (1998), certain kinds

of imported architecture are usually inappropriate and unsuitable for the Middle East region. Architects in the region copy styles from the West with minimal only consideration of their cultural and functional implications (Edgar, 2008). Edgar et al. (2008) advise that such imported ideas should be first revised before they can be used in Arab contexts. However, copying Western styles that disregard the cultural, climatic, and social realities of the region should be avoided. Ultimately, architects in the region should exercise creativity and create architectural works that are sustainable and culturally relevant (Abdesalam & Rihan, 2013). Similarly, Kultermann (1999) argues widespread architectural mimicry in the Arab world is signified by the widespread existence of Western architecture in the region.

In the past 20 years, significant changes have occurred in the way architectural work is conducted. According to Abdesalam and Rihan (2013), a dramatic increase in energy prices, embargoes, wars, resource depletion, increased levels of pollution, degradation of the environment, and climate change have all served changed what is expected of architects. Today, visionary architects have come to appreciate the fact that good architectural design is not limited only the creation of aesthetically pleasing buildings but also developing buildings that are environmentally responsive. In the present moment, the majority of buildings in the developing Arab world are not only devoid of cultural relevance but also climatically irresponsive (Abdesalam & Rihan, 2013). The developed Arab world (Dubai, Riyadh, Doha, Abu Dhabi) is characterized by the excessive use of concrete and glass and the heavy use of mechanical air-conditioning systems. Most of these new approaches have failed to incorporate traditional architectural techniques that can make psychologically and physically comfortable dwelling spaces sustainable. This study seeks to identify through experimental approaches the specific aspects of traditional architectural features that make traditional architecture suitable for the Middle East region. It furthers seeks to determine how traditional architectural approaches can be incorporated into modern techniques.

## 2.5 Conclusion

The present chapter provides a detailed analysis of the existing literature and draws out the perspective of the authors. It discussed the technological trends is Islamic

architecture, architectural values in the Middle East, as well as the architectural contradictions. In addition, it also covered a detailed analysis of the issue of sustainability and its place in the traditional and modern architecture. The critical analysis carried out in this chapter provided the researcher with a detailed insight into the area of research and help adopting the suitable methodological approach. Based on this, the next chapter sheds light on the methodological orientation of research and highlights on the research design, approach and philosophical standpoint.

# 3 CHAPTER THREE: METHODOLOGY

## 3.1 Introduction

With the main objective of the current research study being to assess environmental traditional architecture in its modern context to understand people's physical (thermal heat) and psychological needs and preferences, this section discusses the methodological approach undertaken for the purpose of attaining the objectives of research. The purpose is to determine the levels of its adherence to environmental security and conservation in terms of their architectonic structure, designs and functions. The section focuses primarily on two main components. First is the case study approach that entails a thorough assessment of three typologies of sampling. During this process of evaluation, the main aim was to measure the inside and outside environment temperature level of these buildings and to understand relative humidity level of the rooms within these constructions.

Second component is the mixed methodology study. For quantitative methodology, around 200 survey questionnaires were conducted. The purpose of selection of this approach was to determine level of comfort in the existing houses, one private and one now-refurbished and open to the public with regard to a number of environmental factors like, temperature and relative humidity. For the qualitative aspect of the methodology, the study conducted 14 interviews.

This study attempts to and explain the impact of the outdoor and indoor thermal comfort of traditional houses with transitional and modern spaces in Saudi Arabia that depicts a tropical desert climate, hot and dry. This chapter discusses the process of field work, highlighting on the data-collection methods, and sheds light on the methods adopted to ascertain relevance of information collected for the study. To ensure that the methodology of this research is replicable, I employed an onion methodology, which is crucial in ensuring that reliability, accuracy, and validity credentials are met (Sekaran, 2003). This study highlights data collection through observation and probes deep into various aspects of research methodology, including research philosophy, research strategy, study design, research instruments, respondents, and outlines the limitations of this methodological approach.

The research onion presents a successful development through which a study approach can be planned. It offers a useful research method of because any kind of research methods can utilize it in a variety of situations. This paper's examination of follows the diverse phases of the research onion, illustrating the model's application for each step in the collection of data (see Diagram 1).

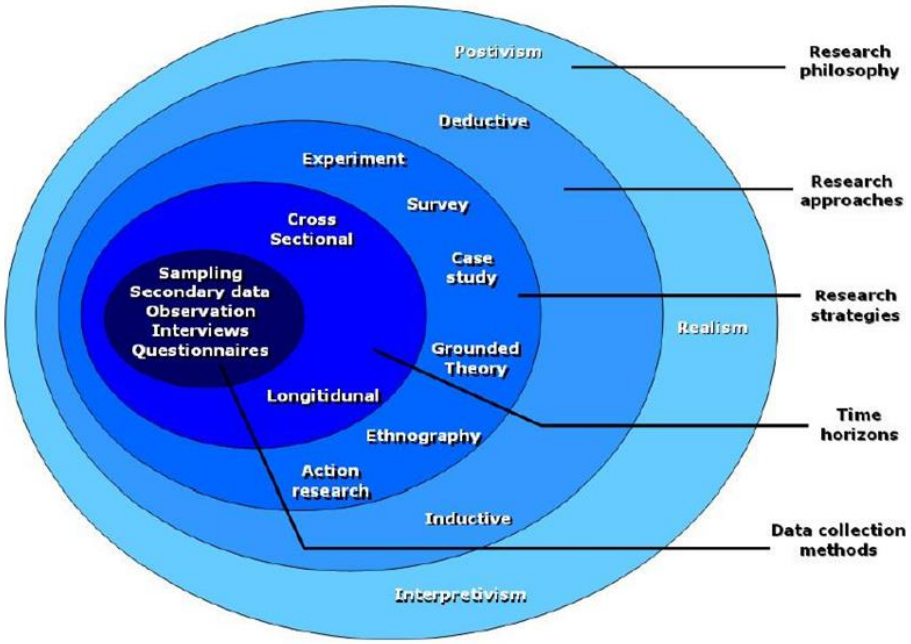


*Figure 4: Onion Methodology (Saunders, Lewis, & Thornhill, 2009)*

The diagram above illustrates the steps and types of approaches, philosophies or theories which the researcher relied upon in the entire data collection process.

The above framework has guided the researcher through different stages of research. For the purpose of this research a mixed method research design has been chosen that combines both the quantitative and qualitative research approach. The quantitative technique, i.e., survey was primarily employed to measure the opinion of the respondents on the use of traditional and modern techniques and their impacts. On the other hand, the qualitative interviews helped the researcher understand the impact of technology and innovation adoption on the architectonic tradition for a sustainable future in the Middle East. According to Cresswell and Plano Clark (2010), this sort of

mixed methodological approach provides the researcher with a detailed insight into the research subject and helps validate data from a number of different perspectives.

## 3.2 Research Purpose

Saunders, Lewis, and Thornhill (2009) affirm that studies are usually based on one (or more) of three main goals, exploratory, explanatory, and descriptive.

The study continued by exploring some of the impacts of thermal adaptation on thermal comfort inside the building structures in Saudi Arabia. The research aims to assess the environmental response, adaption qualities and capacities of vernacular architecture in supporting thermal comfort and meeting occupants' preferences and psychological needs. Since the research in the context of Saudi Arabia is low and does not provide adequate information, an in-depth research was required and therefore the study adopts an exploratory research design.

Thermal comfort is a result of environmental characteristics; air temperature, air velocity, relative humidity, and mean radiant temperature. The given research focuses on measuring temperature, relative humidity and dew point temperature to analyse the indoor thermal comfort of buildings.

## 3.3 Research Philosophy

A paradigm or philosophy is a matrix of beliefs and perceptions, and there are power relationships and action implications inherent in paradigms. Foucault (1977) offers an explanation of paradigms. According to his theory, for each age there are certain mindsets of the age, and they emerge through the conversations and actions of people. Moreover, these mindsets are contextual and specific to a time and place. Furthermore, mindsets are social constructs rather than individual ones and emerge out of daily interactions with others, determining how we interact with others (Kinas, 2010). In designing the research strategy, it is important to clarify the paradigms that guide the research and the methods adopted. Often, a researcher's experience, knowledge, and personal beliefs can influence the research methods chosen (Saunders, Lewis, & Thornhill, 2003).

Many dimensions are important in research, such as ontology, epistemology, methodology, and methods (Seale, 2007); research question formulation, project conceptualization, and how a study is carried out depends on each of these dimensions. Research methodology and the choice of methods used are based on ontological and epistemological positions and therefore are very important considerations in research (Blaikie, 2000; James and Vinnicombe; 2002; Flowers, 2009; Kinash, 2010).

### 3.3.1 Epistemological and Ontological Considerations

Research philosophy can be primarily divided into ontology and epistemology (Easterby-Smith et al., 2015). According to Seale (2007), ontology studies the nature of being or the process of knowing. Examples of ontological enquiry include the following: Does the world we live in follow a pattern, and is it predictable? Or is it continuously evolving through human interactions and rituals? According to Blaikie (2000) and Kinash (2010) and, ontology is the science that seeks to answer questions about the external reality or the world where we live. The ontological position of the researcher shapes the assumptions of the research impacts the selection of the topic, the shapes the formulation of research questions, and influences the strategy adoption.

Researchers using the positive paradigm explore social reality based on reasoning and evidence. Positivists adopt natural scientific methods in social sciences and holds that social situations can be studied objectively with the principle and assumptions of the science. As maintained by to Cohen et al. (2000), positivists adopt the scientific principles of natural sciences and generate new knowledge. These are empiricism, determinism, generality and, parsimony. “Determinism” principle holds that there exists a causal relationship between the events and the circumstances and this understanding of the causal connection is necessary to arrive at precise prediction and control. “Empiricism” on the other hand is focussed on the gathering of evidence that is confirmable to support denial or acceptance of theories or hypotheses. “Parsimony” offers explanation to social phenomena that are economical in nature. Lastly the principle of “generality” attempts to generalize the knowledge that is obtained through observation of the social context.

On the other hand, epistemological paradigm focuses on the nature of reality (Scotland, 2012). In comparison to ontology, epistemology primarily is concerned with the study of social reality that requires interpretation (Saunders et al., 2012). Ontology helps the researcher to understand the nature of reality while considering limitations to obtaining knowledge. This helps is determining what should be the suitable method for a given study. Ontological and epistemological standpoint of the researcher form the philosophical foundation of a research project. This philosophical underpinning has considerable effect at every step of the research process that starts from problem identification, research questions formation, and selection of research method, sampling strategies and sketching the overall design of the research. Marsh and Furlong (2002) stated that, epistemology on the other hand is the theory of knowledge. Epistemological paradigm assumes that objectivity in social research is possible. The epistemological position of the researcher reflects the process of coming to know the reality.

In contrast to the positivist paradigm, interpretivists hold that objectivity does not exist in a highly dynamic social context that is continuously evolving and undergoing numerus changes. This is in stark contrast with the positivism research philosophy that lays profound importance on objectivity and truth. Interpretivists opines that social situations are different and dynamic as it involves human beings, social institutions and organizations that are continuously changing. As per this research approach, therefore a different method to research is required in order to arrive at a better understanding of the distinctiveness of human interactions and social situations as compared to the natural scientific methods (Bryman and Bell, 2011. However, this was not found to match the need of the current study because the current study is not a social one but instead it relies on natural sciences. A positivist approach was adopted because it was found to be a suitable approach for this research since it will make it possible to gather sufficient to support the research questions.

Keeping in mind the two-broad classification of ontology and epistemology, research philosophy can be further divided into positivism, post-positivism, interpretive, and pragmatic (Saunders et al., 2012). Positivism and post-positivism both are concerned with studying social phenomena from an objective and scientific point of view (Philips

and Burbules, 2000). On the other hand, the interpretive approach is related to epistemological point of view and studies social reality by employing subjective analysis techniques (Saunders et al., 2012). Finally, the pragmatic philosophy is the basis of mixed method research (Tashakkori and Teddlie, 2010). This philosophical stance blends both numerical data and subjective interpretations that provides a more detailed understanding of the social reality. Since this study is employs both quantitative and qualitative analysis, the pragmatic philosophy is chosen. The study assessed respondents' opinion quantitatively to analyse the use of traditional and modern techniques and their impacts. Furthermore, by using a qualitative approach the researcher also carried out an interview with the respondents to assess the impact of technology in the architectonic tradition to develop a sustainable future in the Middle East.

## 3.4 Research Approach

This study adopted a mixed methodology, combining both qualitative and quantitative research methods of study (Creswell, 2009). Mixed methodological approach is another kind of method of study. It defines which instruments are used for the purpose of data collection (Creswell & Plano Clark 2007).

For the purpose of this present study both quantitative and qualitative research methodologies were found to be pertinent. To arrive at a balance of both quantitative and qualitative approach, mixed methodology has been chosen for this study. A survey questionnaire has been developed in order to analyse the respondents' opinion regarding the use of traditional and modern techniques. In addition, the respondents were also interviewed to understand their opinion on the impact of technology in the architectonic tradition and how it can build a sustainable future in the Middle East. This approach of combining the qualitative and quantitative study makes the study a mixed method research. Therefore, the research questions will be answered by applying both quantitative and qualitative methods of data collection. In every research, quantitative data plays a major part in research design (Saunders et al., 2012). Since this form of data is measurable, quantifiable, statistical analysis is best suitable (Berman Brown and Saunders, 2008). With quantitative data measuring the variables becomes possible that helps the researcher to derive analysis in terms of level of impact, extent of influence,

and the like. Quantitative analysis plays a significant part this research. Since the researcher attempted to analyse the extent to which traditional architecture with modern adaptation adjust occupants' psychological comfort and wellbeing, a quantitative analysis was found to be more suitable. The survey questionnaire was developed in order to address the question and the respondents were required to provide their responses based on a fixed category of answers. This helped the generation of large volume of quantitative data that facilitated further analysis of the research objectives.

Creswell and Plano Clark (2007), on the other hand, commented that qualitative method is suitable as it helps in the exploratory designs of the research. In this study, the data collected are primarily used to address the final research question. This question mainly explores the impact of the balance between traditional architecture within a contemporary context on occupants and on building performance. The adoption of qualitative interview techniques provided the participants with a scope to provide answers in a detailed manner. This also helped the researcher gain valuable insight into the building performance using both traditional and modern architectural forms.

### 3.4.1 Advantages of Quantitative Method

i. It helps adoption of various numerical measurement, statistical tool and quantitative analysis approaches to achieve precise findings that are measurable (Saunders, Lewis, & Thornhill, 2009). In relation to this project, the numerical measurements were primarily adopted to assess the performance of the buildings. For instance, respondents were asked questions about indoor temperature, ventilation, lighting, and energy conservation. This helped in assessing the importance of traditional environmental architecture to thermal comfort. In addition, quantitative questions were also related to the effectiveness of the combination of traditional and modern architecture and the way it can provide the occupant's psychological comfort. This helped the researcher in arriving at a definite answer to the research questions and highlight suitable design approaches that can be used to improve thermal conditions in building architecture to increase occupants' thermal comfort. Through survey method of

quantitative data collection, soliciting information from a large number of respondents was possible.

### 3.4.2 Advantages of Qualitative Method

i. It will help drawing additional inputs from the respondents and help the research to arrive at a better explanation of the research results (Creswell & Plano Clark, 2007). Since quantitative research questions were based on a fixed category of response, the researcher could not ask any probing questions or gain further clarification. This limitation of quantitative analysis was dealt with in-depth qualitative data collection with the help of interview. For instance, the respondents were asked to provide their opinion on psychological comfort, design approaches, thermal conditions, and recommendations were solicited on improving thermal conditions in building architecture. This sort of questioning helped in gaining further insights and arrive at a comprehensive answer to the research questions.

## 3.5 Research Strategy

The sample of questionnaire (used for survey) and interview guides (used for field survey), are provided in Appendix 1 and Appendix 2 of the study respectively. Measurement of climatic conditions in the physical environment and the immediate surroundings is conducted in the environmental monitoring (Zikmund, 2003). Both indoor and outdoor spaces were used to conduct the survey in Saudi Arabia. Keen attention has been given regarding selection of the study area considering the varying climatic conditions and locations of the cities. The external climatic conditions that people are likely to experience in their daily life in Saudi Arabia were obtained through survey.

## 3.6 Sources of Data Collection

Data acquired from the works of other scholars is known as secondary data. For example, the finalization a research report can include secondary information that has already been administered by another person (Creswell, 2010). Moreover, studies including statistical analysis comprise secondary data. However, this kind of data has been explained by its use instead of its natural nature. Secondary data to support the

study are gathered from an extensive literature review of the key variables of this study. Primary data are collected through a quantitative survey using the survey questionnaire as well as through interview of the research participants.

### 3.6.1 Primary Data Sources

Primary is data collected from first hand sources in the area of study. Through the process of sampling, participants were chosen who best fitted the criteria of research and an online survey was conducted with them. In addition, primary data was also collected by using a semi-structured interview with the research participants. Since the data is collected directly from the participants of the research this is known as primary data (Zikmund, 2003). Primary data precisely represents the main purpose for which data are being collected (Saunders, Lewis, & Thornhill, 2009). They serve the below mentioned functions:

i. Improves comprehending the research question (Crotty, 1998).
ii. Direct assessment of the topic can be conducted by using a questionnaire and an interview guide (Yin, 1993).

The questionnaire was designed in order to ensure the following:

i. Ensure that there is consistency in the information between respondents.
ii. Produce a high mean score that can help in assessing a large number of respondents.
iii. Allow collection of data in a structured manner as the questionnaire adopts a semi-structured format for data collection.
iv. Confidentiality and anonymity can be maintained by using questionnaire (Robson, 2004).
i. Administration costs are low in comparison to other methods.
ii. It can facilitate examination of participants' belief system, values and attitudes and motives (Blaikie, 2000).

However, there are some disadvantages as well of survey method of data collection:

i. Bryman (2004) stated that Questionnaires are expensive in as the design is critical and it is time consuming as well.

ii. The chances of response are low in case the subjects interviewed do not have interest in the topic.
iii. Misinterpretation of the questions at times creates difficulties to obtain the accurate responses.

Using questionnaires as data collection method, researchers often ask 'what' questions to the respondents. The questionnaires came in the packet of research materials which included employee questionnaires and a manager questionnaire, as suggested by Salkind (2003); this division was necessary, as it was aimed at increasing the response rate to the questionnaires. Employees are offered with full confidentiality of their comments, responses and ratings.

In addition to questionnaire, the research also used a semi-structured interview guide to gain the detailed knowledge about the respondents' opinion on the effective architectural design. While the guide helped the researcher in framing and structuring the interview to find answers to the research objectives, it also helped gaining clarification by asking additional questions. By using both the methods, the researchers were able to generate adequate data for analysis and arrive at a definitive answer to the research objectives.

### 3.6.2 Secondary Data Sources

Secondary data includes information from previous researches or the existing literature sources (Sekaran, 2003), and one conducts research in order to obtain this type of information. Secondary data is important to draw successful conclusion of a study, Researchers Often find collecting and using secondary data to be easy. However, secondary data cannot meet all the objectives of the study as per researcher's expectations (Cooper & Schindler, 2006), nor answer all research questions. The present research gathered secondary data from a number of sources listed below:

- a community library,
- prior projects conducted by former students of the academic institution of architecture and environmental studies, and
- online databases of journals, and Books.

Therefore, it should be noted that both secondary and primary source of data helped in answering the given research questions.

## 3.7 Data Collection

Survey and semi-structured interview methods were adopted as the data collection method for this study considering its suitability and cross-sectional data-collection method (Saunders, Lewis, & Thornhill, 2009), but also for its ability to cover high sample size.

The study collected data from both secondary and primary sources. Primary data, according to Cooper & Schindler, (2006) can help in the following ways:

- It helps to understand the goal of the research.
- Subjects or the participants can be directly evaluated by using interview guide and survey questionnaire.

Primarily in order to maintain consistency in responses the study employs the method of survey. Primary data can be obtained from following sources (Blaikie, 2000) and the present study uses the same sources

- journals,
- articles,
- books,
- prior projects that are conducted by former students, and
- Online data bases.

For instance, the study collected secondary data from journals like Habitat International, International Journal of Architectural Research, International Journal of Civil and Environmental Engineering, International journal of urban and regional research etc. These journals and articles provided useful information and the researcher was able to gain a better understanding of the area of research. However, they did not specifically help in analysing the research objectives adopted in this study. These sources although analyses Islamic tradition and architectural formations in the Middle East, they did not specifically analyse how technology is adopted for an effective amalgamation between traditional and modern form of architecture. This gap as

identified after critical analysis of the existing sources of data, has been addressed by this given study.

Physical measurement and subjective assessment were the central methods that are used for the purpose of data collection. In order to obtain information about the two weather conditions which are mainly hot and dry or hot and humid, the researcher founds it important to visit Madinah city once or twice. However, since the researcher stays in Riyadh, the researcher was naturally updated with the information about the weather conditions. These visits and understanding the temperature throughout the year helped me analyse the research questions in a more detailed fashion.

Along with a number of field studies related to thermal control (Wong & Khoo, 2003; Yang & Zhang, 2008), the study uses ASHRAE's (The American Society of Heating, Refrigerating and Air-Conditioning Engineers) standard questionnaire for assessing indoor thermal comfort (ASHRAE, 2010), these were to understand the scope of the questionnaire. The questionnaire was divided primarily into three sections and the participants were required to assess the below mentioned areas in the first section:

i. thermal preference,
ii. thermal acceptability, and
iii. thermal sensation.

The survey method has a crucial role in analysis of the research objectives as it helped gather data on a number of aspects including traditional architecture, building performance, and thermal comfort. The questionnaire recognizes the importance of the presence of environmental traditional architecture in the indoor environment, as well as their importance to the thermal comfort. The study combines both quantitative and qualitative approach and adopts questionnaire and interview guide as the main tools for data gathering. It aims to solicit information from a large group that supports the reliability of the study's conclusions, this study adopted the survey strategy method.

## 3.8 Data Collection Instruments

The interview schedules and self-administered questionnaires were used in order to collect primary data. This is explained in the below sub-sections.

### 3.8.1 Survey Questionnaire

There are a number of components of a well-designed questionnaire. These components comprise brand trust measurement scales, elucidating the setups used by the association and the in-pretesting procedure of the questionnaire. Chapter 2 seeks to conduct a detailed review of the secondary data that leads to the formation of the survey questionnaire. Based on secondary data analysis, an explicit questionnaire was developed. In order to ensure that questions prominent and are all answered, the questions were arranged vertically (Zikmund, 2003). In addition to this, a pilot study was also conducted to assess respondents' interpretations of the questions this also led to subsequent changes, modifications of the questionnaire to ensure that it is easy and well-understood by all. Also, it is important to divide the questions into various categories or sections and subsections in the questionnaire for better readability. The questionnaire was administered online and the respondents were given the required information about the survey including the estimated time to complete the survey. In addition, voluntary participation was sought from the respondents to avoid any ethical dilemma.

### 3.8.2 Interview Guide

A semi-structured interview guide is developed for the purpose of this study with households in different houses (traditional – transitional and modern), totalling 10 interviews. The arbitrary number of 10 participants was established for this research in order to avoid the problem of data saturation. As highlighted by Silverman (2013), it is better to stop recruiting participants once the diverse group of sample is gathered for interviewing. Theoretical saturation or data saturation occurs when the responses become similar from one respondent to the other and thus, the research generates no new data or information for analysis. Thus, in order to maintain the quality of interviewing and collection of the required data the participants were limited to 10 respondents. Regarding the data loggers' devices settlement, the researcher will use:

- Addiriyah location (indoor, outdoor and courtyard),
- Landform house location (indoor modern, indoor transitional and outdoor), and

- Al- Madinah location (traditional house indoor and outdoor).

Figures 1–4 below show the urban and architectural features of both modern and traditional homes.

First is a modern house, but with a private courtyard for cool ventilation and a view**.** The architectural design as is evident from the below image is modern. The courtyard provides a visual focus for the house and separates the public and private spaces. The open space also provides for greater ventilation and natural light.

*Figure 5: Modern house-private courtyard-open roof*

The second house was also modern, but with a semi-courtyard also for view and ventilation. As the picture depicts the courtyard is sheltered and provides a common space for the household members to gather and spend time.

*Figure 6: Modern house-semi courtyard-closed sun roof*

The third house, also modern, added a traditional element, a "tent," as a place for family gathering, because it imparts a tranquil and intimate feeling. As the picture depicts it is a greater amalgamation of traditional elements with modern designs.

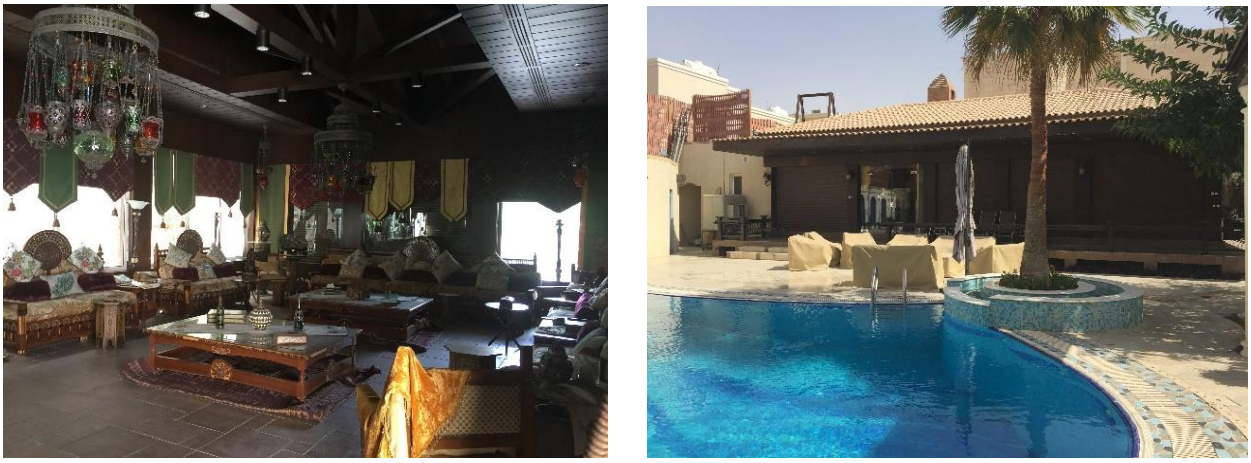

*Figure 7: Modern house with traditional elements-patio and traditional tent*

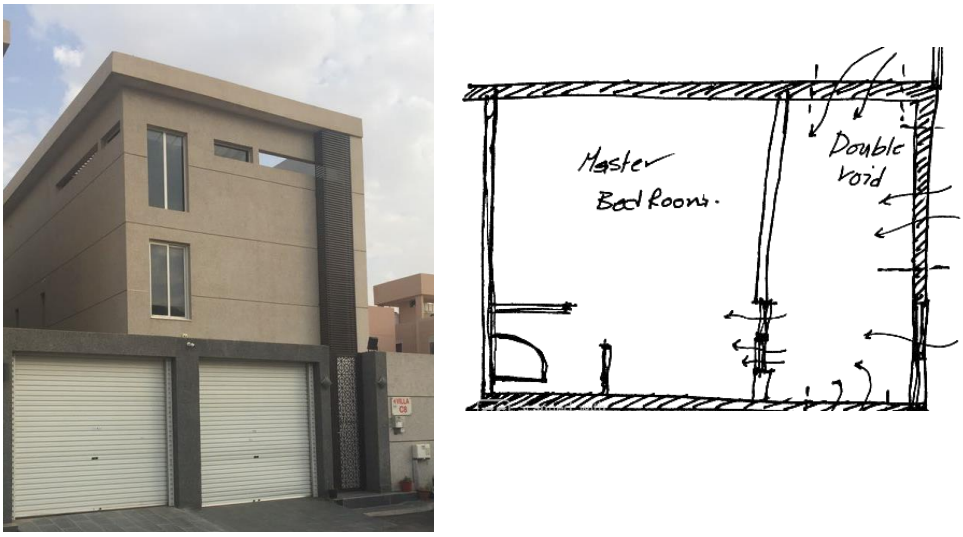


*Figure 8: Modern house-private villa*

The above house is also modern, but with the addition of a new concept, the wind tower in a double void a technique that is defined, as two or more separable spaces opened vertically on each other for cross air ventilation.

The above images depict that the architectural formations are in response to climatic conditions and religious needs (El-Shorbagy, 2010). The courtyard and mashrabiyyah were the two most distinctive features in traditional Islamic Arab houses. The contemporary modern architecture has adopted some of the traditional architectural forms, however, the focus is more on the contemporary design elements. The concepts of courtyard are still there in modern Arab houses and is upgraded with newer design and structures as depicted in the above images.

## 3.9 Data Analysis

The data obtained from the surveys will be calculated and evaluated using quantitative tools like Excel and SPSS (Statistical Package for the Social Science). To the characteristics of the participants, descriptive statistics have been used. In order to present data and provide interpretations tables and graphs were used. The use of five-point Likert scale for quantitative data collection and analysis. As stated by Creswell (2009), this helps in the analysis and measurement of internal stabilities or consistencies by the SPSS tool application. As Saunders et al. (2009) noted the Likert

scale helps in the assessment of responses in grades or degrees of opinion an also allows maintaining a neutral position.

## 3.10 Schedule

The research onion contains two categories of time horizons (i.e., completion times) in it: the cross-sectional and longitudinal. The time horizon of cross-sectional survey is termed as "snapshot" or time compilation. Here, the information is assembled at one point. Cross-sectional time horizon is best utilized when in situations where the evaluation of the data concerned primarily with just a specific idea and a particular time. On the other hand, the longitudinal time horizon is suitable where data is gathered over an extensive time period. It is also significant when a vital aspect for the study is investigating the issue over a long period of time, as a part of the current study.

## 3.11 Population of the Study

The population of the study refers to the entire universe covered under the topic of research. Since the study is based on Riyadh and Madinah, the residents in these two cities are covered under the research population.

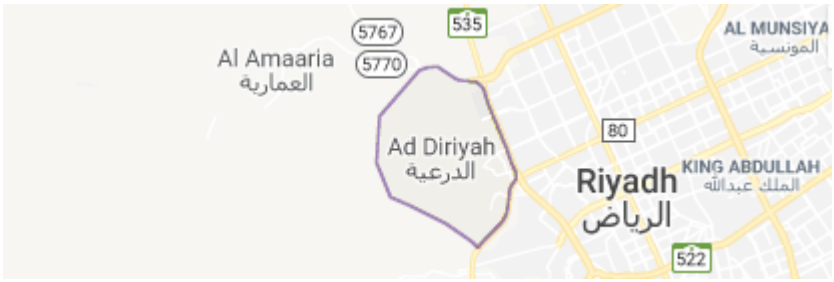


*Figure 9: Addiriyah in Riyadh*


*Figure 10: Al Madinah in Saudi Arabia*

### 3.11.1 Location

Addiriyah and Landform house has been selected as the locale of the study. Landform house bears the marks of the region's indigenous culture and heritage and depicts a traditional form of living. It has also combined contemporary architectural formats and environmental solutions. In addition, Addiriyah also depicts traditional architectural styles. Thus, these two sites were primarily chosen as the main locale of the study.

However, it is not possible to study the entire population and therefore, the process of sampling is important.

### 3.11.2 Sample

The instrument of data-collection used in this study for both qualitative and quantitative and study are were as follows:

- questionnaires, and
- An interview guide.

A preliminary letter was essential to obtain consent to gather data from the respondents as well as the institutions of research. The researcher handled the completed the questionnaires.

### 3.11.3 Sampling time-frame, sample size, and sampling location

Sampling frame is necessary for collection of data given the application of selective sampling. First data was collected from a private villa called Landmark House, the villa was designed, constructed and built by an architectural firm called "The Other Dada" (Dada, 2013). This data was obtained from the loggers in three different spaces: an indoor, modern, inhabited house, an indoor transitional-scheme tea room/ library spaces, and an outdoor space. Secondary data was collected from traditional Addiriyah site from three data loggers, covering indoor traditional living, a traditional court, and an outdoor area. The sample included both the architects and the dwellers in order to gain a comprehensive knowledge about the architectural knowledge of the builders as well as the occupants' level of comfort in the transitional or modern houses. All respondents were chosen by applying convenience sampling method, as they were

available. Qualitative data, on one hand, was collected with the help of an interview guide. While on the other hand, quantitative data was gathered from data loggers with the help of questionnaire.

## 3.12 Instruments and Software Section

De Dear (2004) argued that in order to study thermal comfort, argues that it is better if it is conducted in actual thermal environmental conditions. These studies often include real residents, usually high in number and in diverse samples. The questionnaire survey and the interview script were designed specifically to deal with thermal comfort data that are subjective in nature such as

i. demographic background,
ii. thermal preference and sensation, and
iii. thermal acceptability.

Both the architectural design and climatic model of Saudi Arabian buildings were profiled. The research used measuring instruments for temperature measurements surrounding certain building areas to be analysed through Easy Logger. Population consists of the entire universe under this area of research. Since this is not feasible, sample is chosen that represent the population characteristics adequately (Sekaran, 2003). This study has selected a target population of builders and occupants. Selecting the architects provided the researcher with an understanding of their level of knowledge in combining traditional and modern architecture and also their knowledge of traditional Islamic culture and heritage. In addition, the occupants have also been included in the research study to understand their opinion on thermal condition, building performance, and psychological comfort in living in transitional and modern buildings.

## 3.13 Administration and Data Collection

Collection and analysis of data in a pilot survey was the first step in this study. The pilot study was very important because it enabled me to predict what to expect on the official day of study, when conducting the interviews (Cooper & Schindler, 2006), it also helped me to select and prepare the methods best suited to understanding the topic of this study.

## 3.14 Pilot Study

A pilot study was conducted prior to the data-collection phase of the project. The pilot test ascertained the suitability and applicability of the scales in this study. Teijlingen Van et al. (2001) agree that a pilot study helps in the following respects:

- clarity of instructions,
- establishment of procedures and parameters,
- definition of the appropriate levels of the independent variable, and
- determination of the reliability and validity of the variables prior to main data collection.

In addition to the above, the pilot study also helped in proper wording of the questionnaire and address any ambiguity. The questions that were found to be misinterpreted or understood incorrectly were simplified to overcome the participants' language difficulty. Moreover, it was also found that adding more visual representation can provide the participants with greater clarity and thus, more pictures and illustrations were added to facilitate visual interactions. Finally, Arabic language were also translated to English in order to make it easy for the non-Arabic research participants.

A small number of operational employees, as those involved in the study's population, were conveniently sampled and used in order to pre-test these scales. Language difficulty is likely to be a factor because questions were written in Arabic to target a broader population, and photos were added to explain the meaning of traditional modern and transitional features.

## 3.15 Fieldwork and Data Collection

At first the researcher sought to obtain permission from the institution of study and the randomly selected respondents prior to main data collection. Primary data collection was approved with the issuing of a letter from the intended competent authorities. Individual participants included in the study were also asked for their permission before data could be collected from them. The questionnaires were primarily administered by the researcher and similarly conducted interviews. For this particular study, the

respondents were requested to read the questionnaire and give their views, pertaining to this study.

## 3.16 Data Analysis

Quantitative data analysis of the survey responses was carried out by displaying data in tables and graphs. IBM SPSS Statistics and Excel Worksheets (2010) assisted in quantitative data. I first coded the data prior to their entry into IBM SPSS Statistics. In order easily manipulate the information and avoid confusion coding the data becomes very important (Zikmund, 2003). While quantitative data and numeric values are presented in tables and graphs, interview data is analysed by using interpretive techniques and qualitative analysis. With respect to each of the research question, both qualitative and quantitative analysis were done in parallel.

Analysis and measurement of internal consistencies was completed with the help of IBM SPSS Statistics, thanks to the employment of Likert scales for quantitative data collection. Creswell (2009) affirms that it is possible to evaluate internal consistency and reliability as well as other important modules, given the use of Likert scales. Saunders et al. (2009) further argue that the Likert scale permits the expression over some degree of opinion or no opinion at all.

## 3.17 Limitations and Ethical Considerations

### 3.17.1 Limitations

One of the significant challenges faced was in terms of accessibility of the site of the research. Since at the initial phase of the study, the site was under construction, the researcher could not carry out the research. In addition, some of the data loggers were lost or damaged. However, the researcher was able to retrieve most of the data from the damaged loggers that led to subsequent modifications of research methodology. In addition, by digging deep into the data patterns and underlying themes were identified related to space behaviour and thermal performance that helped me in data in a more detailed fashion and provide interpretations to the research findings. Another challenge encountered was the time constraint or the period of time in which the study was required to be completed. Therefore, completing the project on the given timeline was

the most challenging nature of my daily tasks. I followed a strict timetable with explicit goals and milestones to be accomplished while carrying out the project was the only remedy that I had to prevent delays. Financial constraints acted as another major problem in the data-collection process. Another major limitation is the use of the Likert scale since it is scaled on scales thus results are expected to be based on this score.

### 3.17.2 Ethical Considerations

All the academic guidelines and ethical principles have been adhered by the researcher for successful completion of this project. To meet this objective, permission was sought from the participants through a preliminary letter to provide them with necessary information. Personal data of the respondents was collected for this study. One thing important to mention when a researcher is conducting research is to abide by reliable ethical principles. In doing this, one can guarantee the maximum objectivity and the representativeness of research results in the broader population. Samples of interview questions were submitted to the organization ahead of time. In addition to this, strict data confidentiality and privacy have been maintained throughout the research project. The data was stored in a secured manner with proper encryption to ensure mishandling of the respondents' data. Once the research project is over, the data will be destroyed and will not be used for any other purpose. Finally, anonymity also has been maintained to protect the research participants from any harm or negative consequences.

## 3.18 Summary

The present chapter provides a detailed analysis of the methodological orientation adopted for this study. It highlighted the philosophical stance, design, research approach, sampling and methods of data collection. Furthermore, it also indicated the ethical guidelines followed for carrying out the academic research and specified the limitations of the study. Based on the discussed methodological approach, the next section will highlight the major findings of the research and interpret them with the help of literature.

# CHAPTER FOUR: DATA ANALYSIS AND RESULTS

## 4.1 Introduction

The current chapter presents the research findings and results based on questionnaires and interviews. For the questionnaire, 200 respondents to the questionnaire completed it, out of the 250 questionnaires that were distributed. The questionnaire measured the uptake of architectonic tradition and the impact of innovation and technology on promoting a sustainable future in the region of the Middle East.

## 4.2 Quantitative Data

This section will discuss the findings from the survey. Each of them is discussed with suitable illustrations, graphs and charts, along with interpretation of the findings.

### 4.2.1 General Characteristics

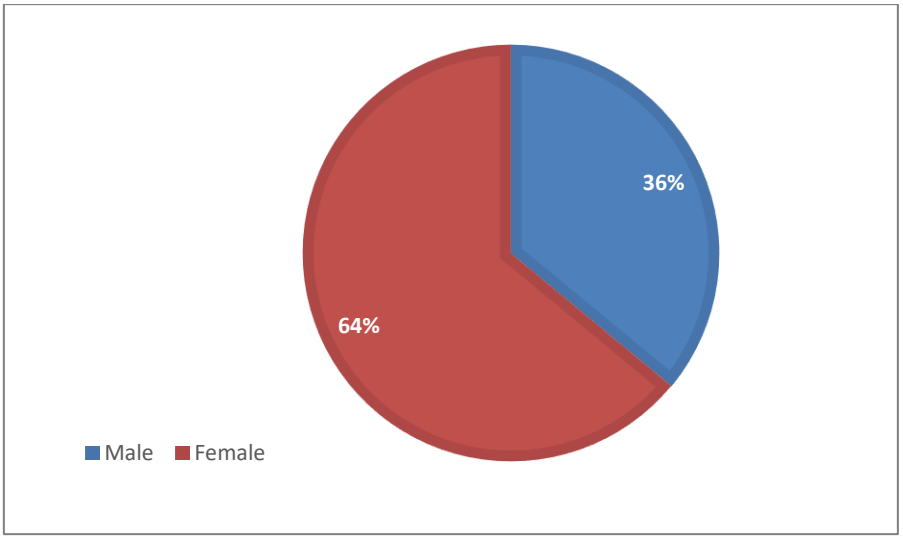


*Figure 11: What is your gender?*

The above diagram clearly shows that the gender of the participants. In the sample population women were the majority, that is 64% (or n=128 participants) while the rest 36% (n=72) were male. Since, women have more knowledge of the indoor environment; they were included more in the survey to gain knowledge of the indoor environment as well as its impact on the psychological aspect of the dwellers.

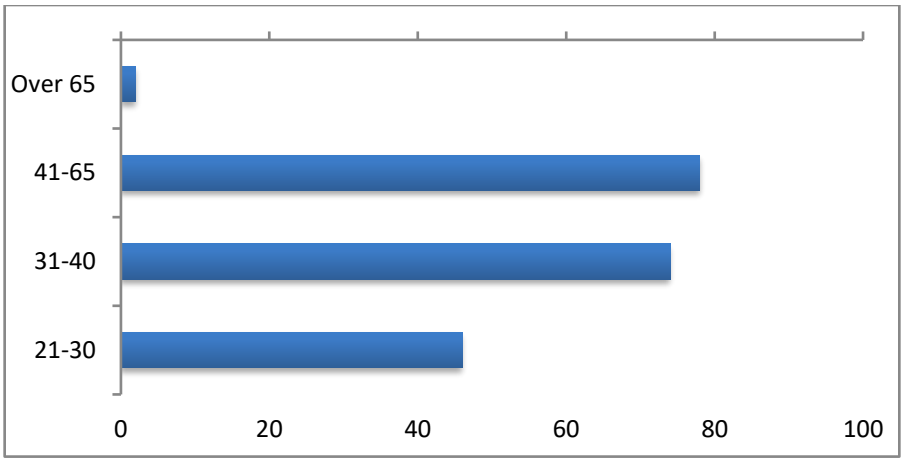


*Figure 12: What is your age?*

Figure 12 analyses the ages of participants. The oldest participants in the study were 41–65, representing 80 people. The second group of participants were aged 31–40, which represented 70 people. The third group of participants were between 21 to 30, at 50 people. The oldest age population for the study was over 65 years, with the lowest number of participants had 5 people. This distribution shows that majority of the occupants were aged between 31 and 65. The variable of age were introduced to identify if there is any difference among the different age group regarding the indoor atmosphere and comfort level and understand if the experience was similar for all the participants.

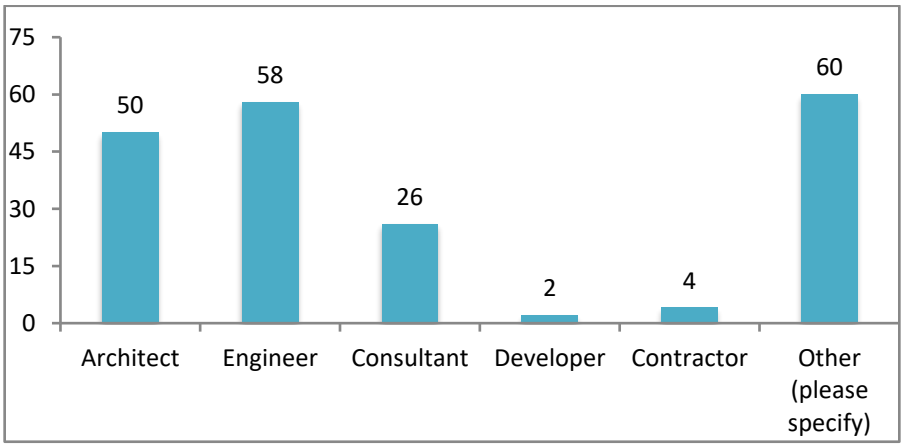


*Figure 13: What is your professional role?*

Figure 13 represents all the types of professional who participated in the study. The most prevalent participants comprised the "Others" category, at 30% ($n$ = 60). The participants in this category consisted of building surveyors, site managers, planners,

decorators, builders, and realtors. Engineers were the second-largest group of participants, at 29% (*n* = 58). Architects represented 25% (*n* = 50), followed by consultants at 13%. Contractors and developers were the least prevalent, at 2% (*n* = 4) and 1% (*n* = 2), respectively. The mix of different group of professionals was selected to gain knowledge about their level of architectural knowledge. As noted in methodology, selecting the architects provided the researcher with an understanding of their level of knowledge in combining traditional and contemporary architecture and also their knowledge of traditional Islamic culture and heritage. Since the contemporary architects can take into consideration the traditional built environment and learn from its structural patterns it was important to include them in the survey to build a sustainable environment in the Middle East.

### 4.2.2 Residential identity of the respondents

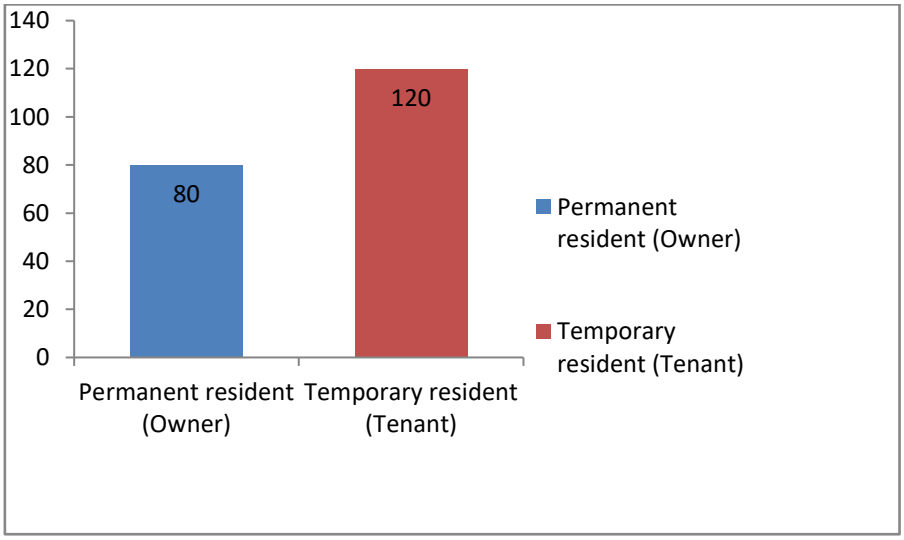


*Figure 14: Type of your place of residence?*

Figure 14 represents participant's residential difference, temporary or permanent. Temporary residents or tenants represented the highest percentage of participants, at 60% (n=120). Those with their permanent residents or owners stood at 40% (n=80). The findings evidence a good balance of occupants' representatives. Based on demographic statistics, Saudi Arabia has a high number of expatriates, and thus tenants are obviously the majority. This data was important for this research because it indicated the level of awareness about the region's culture, heritage, and history.

Although the number of permanent residents is lower than the temporary residents, the study focused on collecting data from those expats who have lived for a considerable time in the same city.

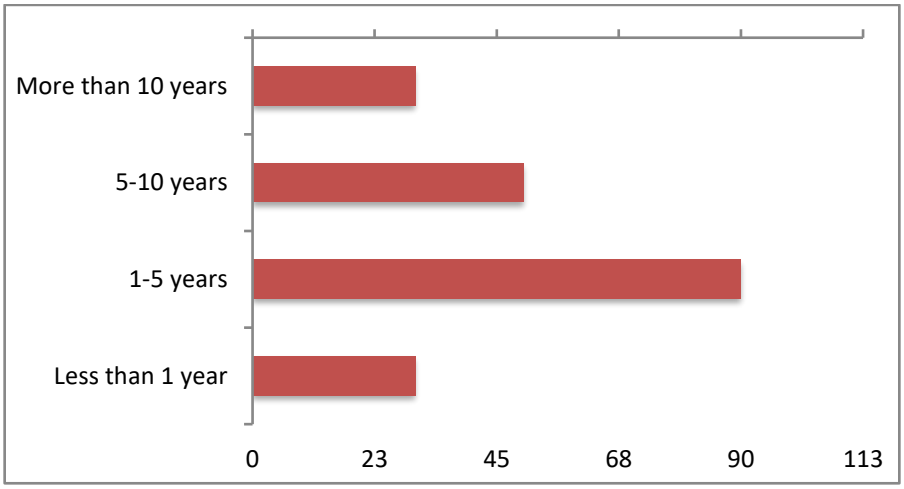


*Figure 15: How long have you been living in your place of residence?*

Figure 15 represents the duration of residence for the participant group. Those with less than a year in residence comprised 15% of the total population, with 1–5 years representing the most residents, at 45%. A range of 6-10 years represented 25%. Those with over 10 years comprised of 15%. The results show that the occupants have lived in their houses for a length that gives them sufficient knowledge of their residence. Thus, they could be expected to provide accurate feedback on the other questions.

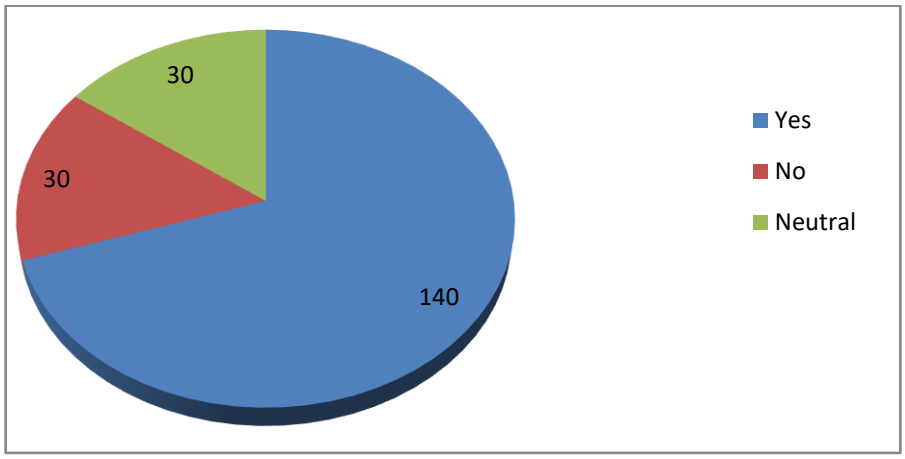


*Figure 16: Do you like your place?*

Figure 16 presents findings regarding to participants' feelings about where they live. Seventy percent agreed that they were satisfied with the places they were living currently, while 15% disagreed, and the other 15% remained neutral. This also indicated that how far the respondents are satisfied with the type of dwelling and are having a comfortable stay.

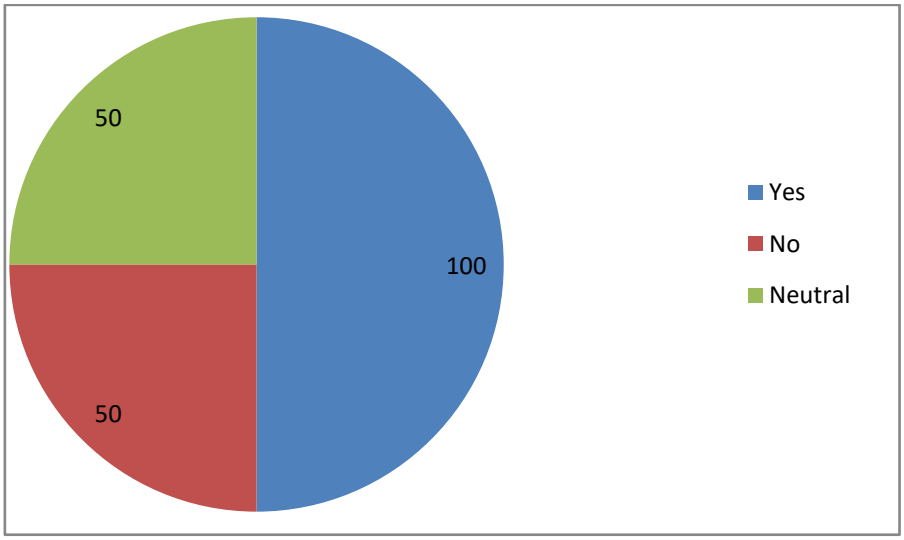


*Figure 17: Are there times that you feel poor air is circulation accompanied by bad odour in the building?*

Figure 17 presents findings on buildings' bad odours: 50% confirmed that the buildings contained some bad odour, while 25% confirmed that the building they were staying contained no bad odour, and 25% remained neutral on the whole issue. The bad odour could be due to fresh air circulation. In comparison to traditional form of building with courtyard system and wind catchers, the contemporary buildings are westernized and do not provide for adequate ventilation. In order to maintain the thermal condition air conditioners are used that do not provide for adequate air circulation. Such differences are revealed from this analysis.

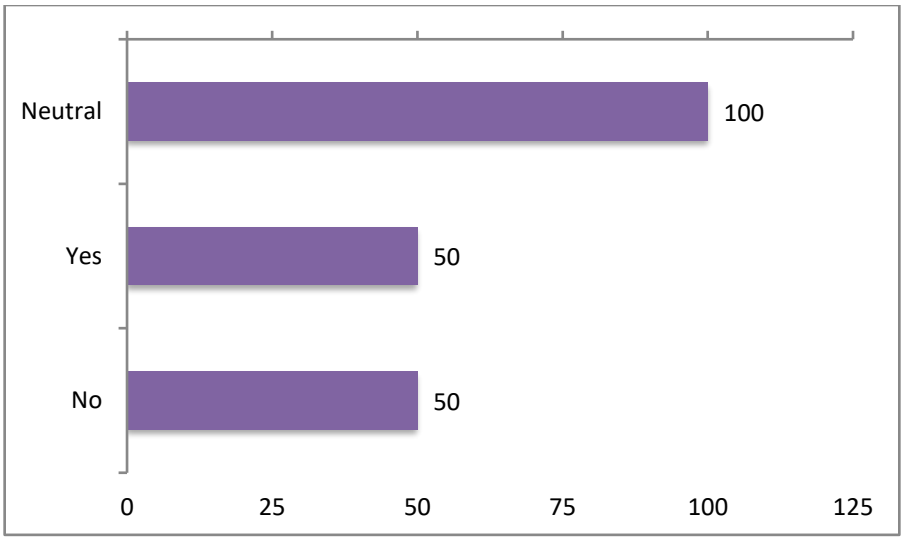


*Figure 18: Is the ventilation in the building poor?*

Figure 18 presents findings on building ventilation: 25% disagreed, 25% agreed that the buildings were staying in were well ventilated, and 50% remained neutral on the matter. This question did not adequately capture the aspect of ventilation in the houses. However, this can be related to the previous question when the respondents stated that bad odour might be because of the poor air circulation. Thus, it can be stated that the contemporary buildings in the region do not provide for adequate air circulation and ventilation.

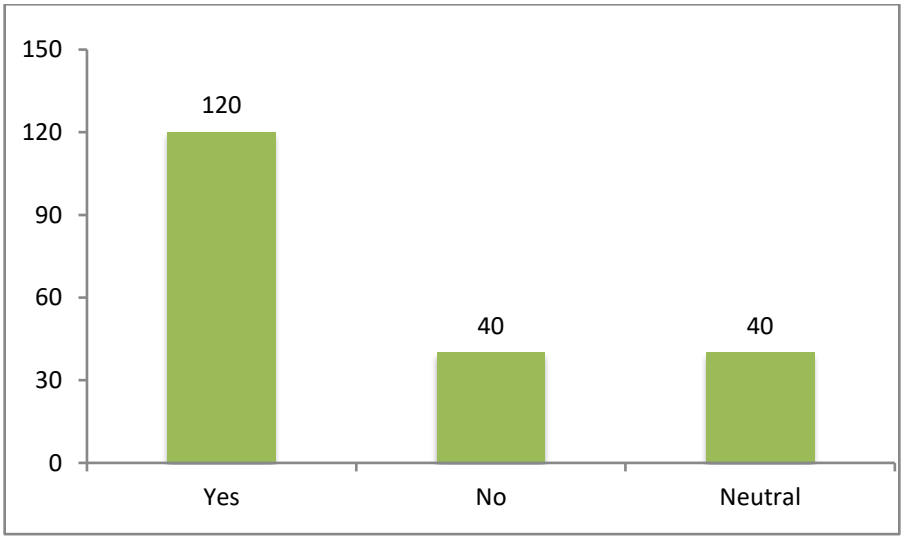


*Figure 19: Are you comfortable with the drainage system in the building?*

Figure 19 presented data on the drainage system of the buildings.60% agreed that the drainage system in the building was acceptable, while 20% remained neutral on the matter and another 20% faulted their drainage system. The drainage system also indicates the performance of the building in the current scenario. Thus, this question has been included in this research.

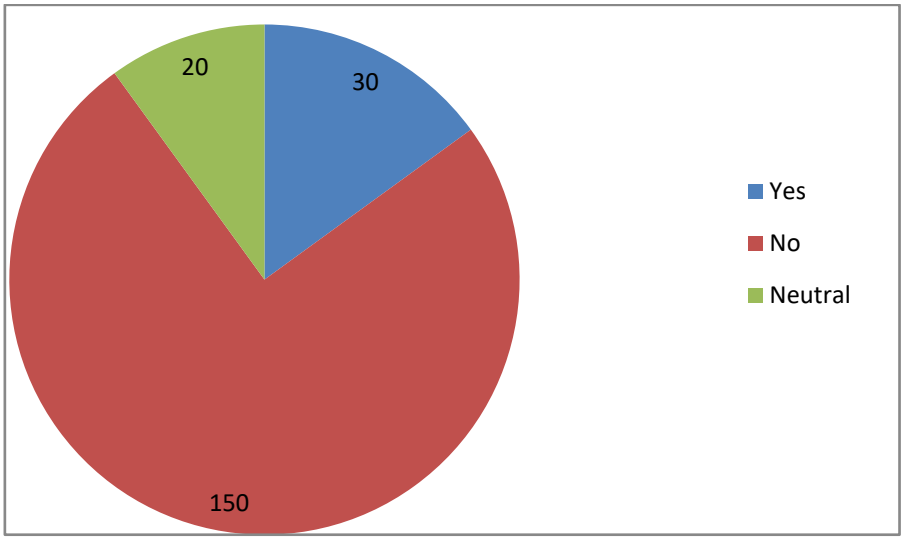


*Figure 20: Do you believe that the temperature in the building is relatively higher than normal levels?*

Figure 20 presents findings on buildings temperature level. In sum, 15% agreed that temperature level in their building was above the normal levels, and 75% indicated not. The remaining 10% chose to remain neutral. This is an important finding of this research that indicates the adequate thermal control system of the buildings. It can be because of the adoption of the principles of green buildings as highlighted by Rahman and Kojima (2018) that can effectively control the temperature of the indoor environment.

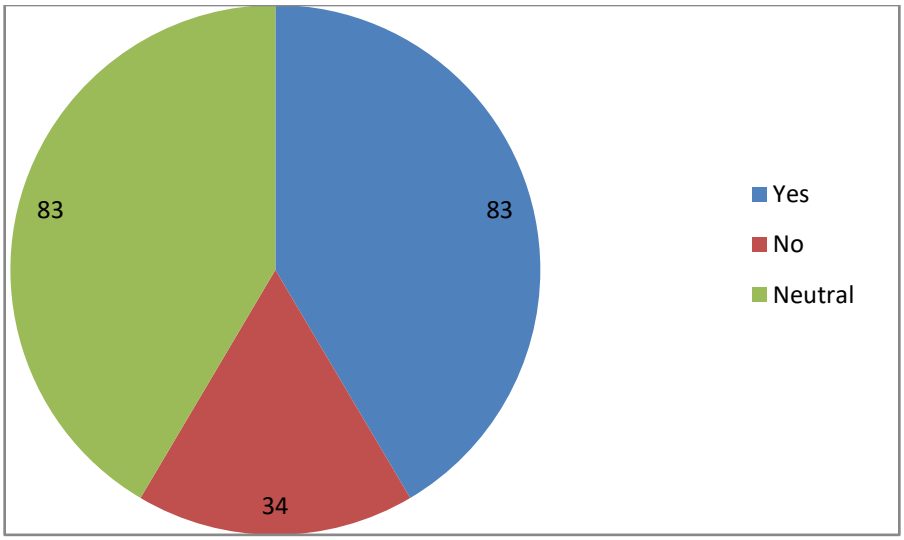


*Figure 21: Dweller' opinion on their possibility of contribution towards improving building's condition to meet their needs*

Figure 21 presents findings on residents' opinions on what they think should have done or what they could do to make their buildings more comfortable; 41.5% agreed that they could do something in order for the buildings to respond to their needs. 27% felt nothing could be done to change the situation, and 41.5% remained neutral on the matter.

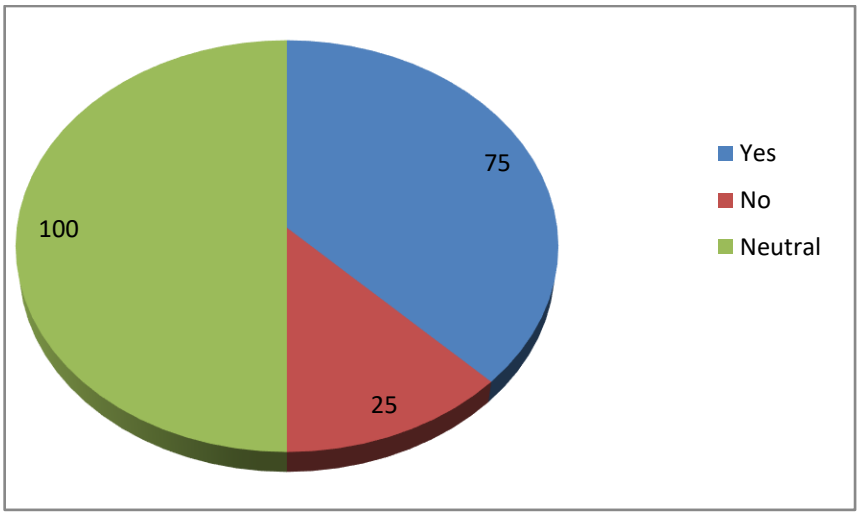


*Figure 22: Owner's opinion on their possibility of contribution towards improving building's condition to meet their needs*

Figure 22 presents data on owner's roles in the current state of the buildings. A total of 37.5% of owners agreed it was their choice for the buildings to appear in the state

they did; 12.5% felt that they were not to be blamed for the current state of the buildings; and the other 50% remained neutral on the matter.

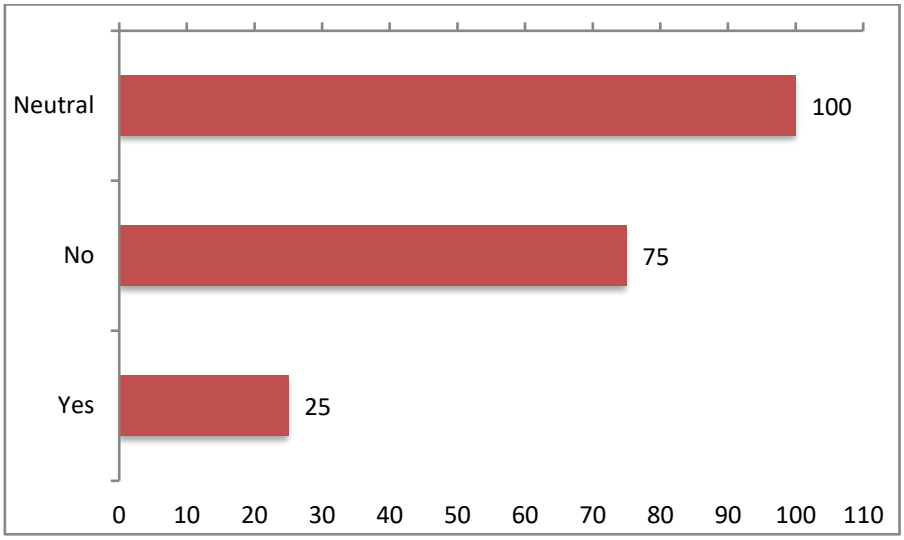


*Figure 23: Occupant's request for more traditional features*

Figure 23 presents data on client requests for extra traditional features from the owner. Of the building owners, 12.5% agreed that some clients had approached them to talk about adding extra traditional features to their buildings, and 37.5% reported receiving no information in regard to additional traditional features from their clients, while 50% of the owners chose to remain neutral on the matter. As has been highlighted in the earlier discussion, traditional features bear the symbols cultural heritage. Moreover, the traditional architectural formats had advantages like adequate ventilation, air circulation and were also sustainable. Thus, the research reveals that there is a greater need to combine contemporary architectural forms with the traditional building's features to meet the needs of the occupants.

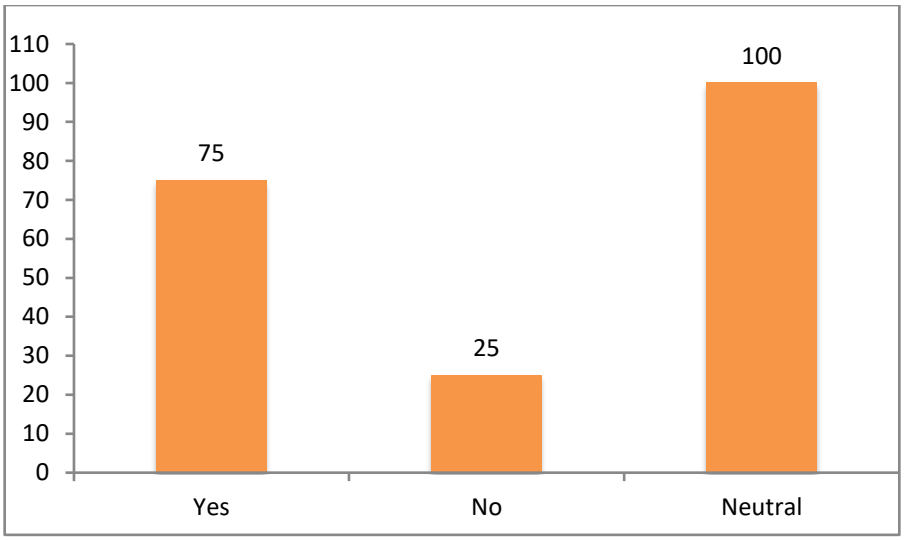


*Figure 24: Occupant's request for air conditioning as an essential feature in their house?*

Figure 24 presents data on occupants' air conditioning (AC) specifications to building owners as a must do feature before occupying the houses. 37.5 % of building owners agreed that yes indeed they had been approached by some tenants and asked to add some additional (AC) systems in their buildings prior to their occupation. 12.5 % reported receiving no claim from tenants regarding addition of extra (AC) system. 20% of the owners chose to remain neutral on the matter. In comparison to the traditional forms of building whereby wind catchers and courtyard system provided for ventilation and natural air infiltration, the contemporary westernized buildings do not have such provisions. The air circulation and ventilation are primarily dependent on the air coolers and conditioners. Moreover, it also shows that the thermal control of the buildings in the contemporary Arabian countries is not adequate. This also attests to the fact that there is a greater need for combination of traditional and contemporary feature of the buildings.

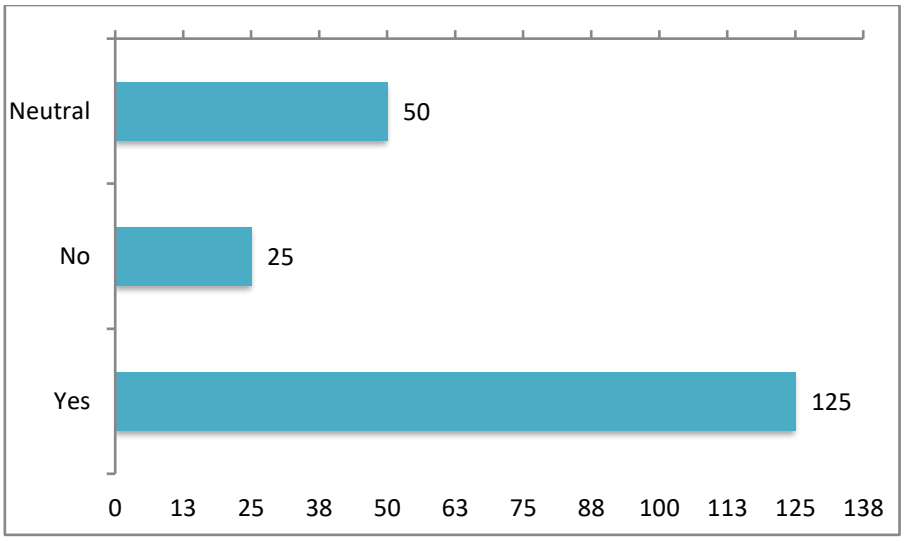


*Figure 25: Occupants' concern for energy consumption*

Figure 25 presents data on clients concern on energy consumption. Of the building owners, 62.5% agreed their clients showed concern about energy consumption, while 12.5% felt that tenants showed little concern about energy consumption, and 25% chose to remain neutral on the matter. In terms of energy consumption, thus, it can be stated that the buildings in the modern era in the chosen region has not a positive performance. Following Simpson (2002), therefore, it can be stated that the buildings do not have high-performance windows and extra insulation in ceilings, floors, and walls that were present in the traditional design. Thus, the energy consumption rate goes high in these buildings.

### 4.2.3 Perceptions related to traditional or modern architecture

This section analyses the respondents' perceptions of traditional and contemporary architecture.

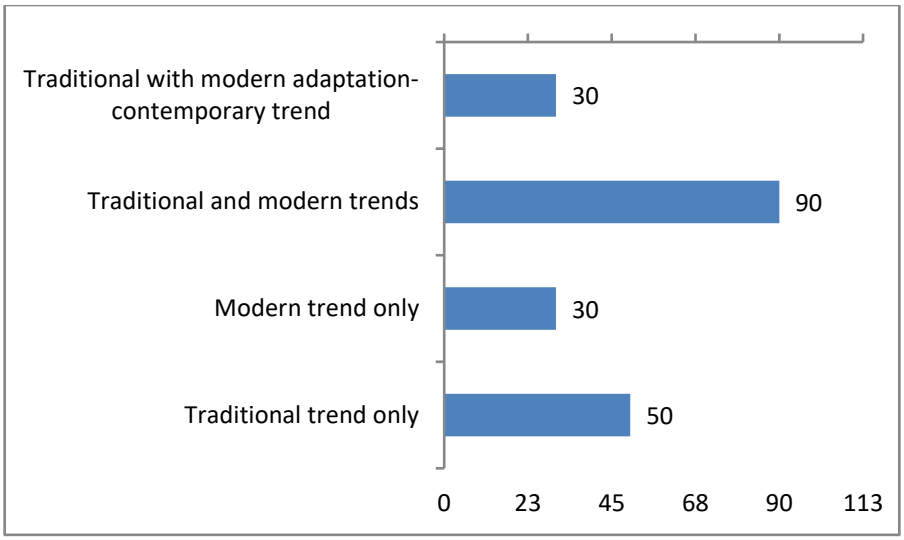


*Figure 26: Trends have you worked with or used before.*

Figure 26 above represents the different trends that participants may have worked with or used before. Traditional and modern techniques represented the largest architectural trend, at 45%. Traditional techniques came second, at 25%, closely followed by modern techniques and traditional-with-modern techniques, which occupying 15% each, respectively. The analysis reveals that the participants have limited knowledge about the combination of traditional and contemporary design. This might have resulted in the challenges in the building performances in terms of thermal control, air circulation and ventilation.

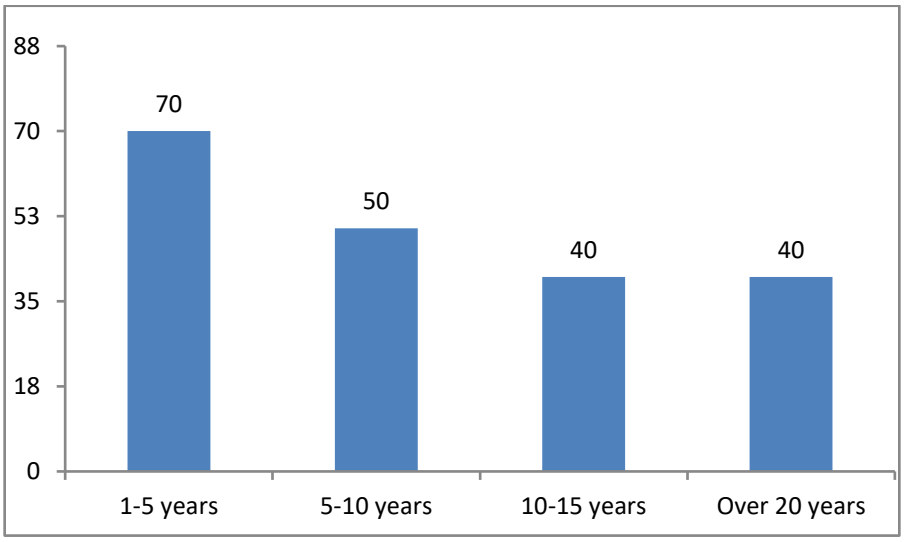


*Figure 27: Time spent in the building industry?*

Figure 27 represents total of time spent by each participant in this architectural industry. Most participants had been in the building 1–5 years at 35%, while 5–10 years represented 25%, and at 20% were participants with a duration of 10–15 years. Those with over 20 years also occupied a 20% share of the general percentage surveyed. This question was important as it revealed the experience of the builders, architects, engineers, consultants, and developers in the building industry.

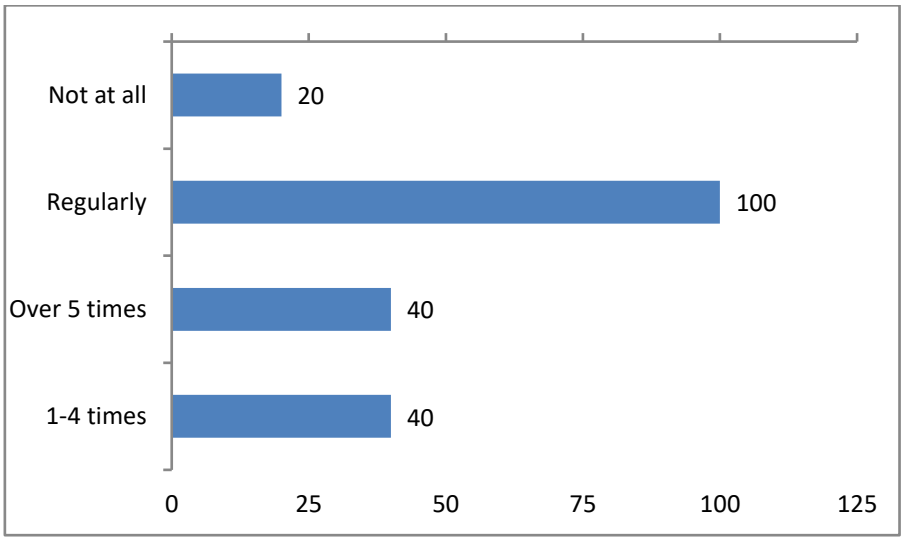


*Figure 28: Frequency of selection of the traditional elements*

Figure 28 presents information on how often the participants chose to use traditional techniques. Regular participants who chose to use traditional techniques stood at 50% and represented the highest number of all. Respondents who did not use the traditional techniques stood at 10%, while over 5 times and 1–4 times occupied a 20% portion each. The research revealed that participants do consider using traditional elements in building construction. This can improve the performance of the buildings.

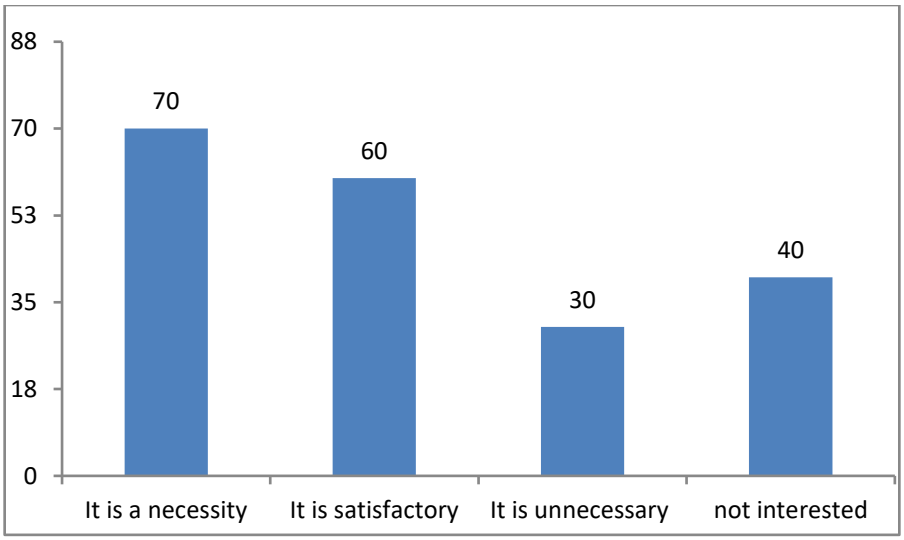


*Figure 29: General overview about using traditional features.*

Figure 29 presents general information concerning participants' use of traditional features techniques. 35% percent felt that it was a necessity to use traditional features techniques, while 30% argued that using traditional features to them was something satisfactory, and 20% of the participants felt that it was not exciting to use the traditional features techniques. Finally, 15% of these architects argued that use of traditional features techniques looked so undesirable to them. This also is one of the significant findings of the research that shows a positive inclination towards implementing traditional features in contemporary building constructions.

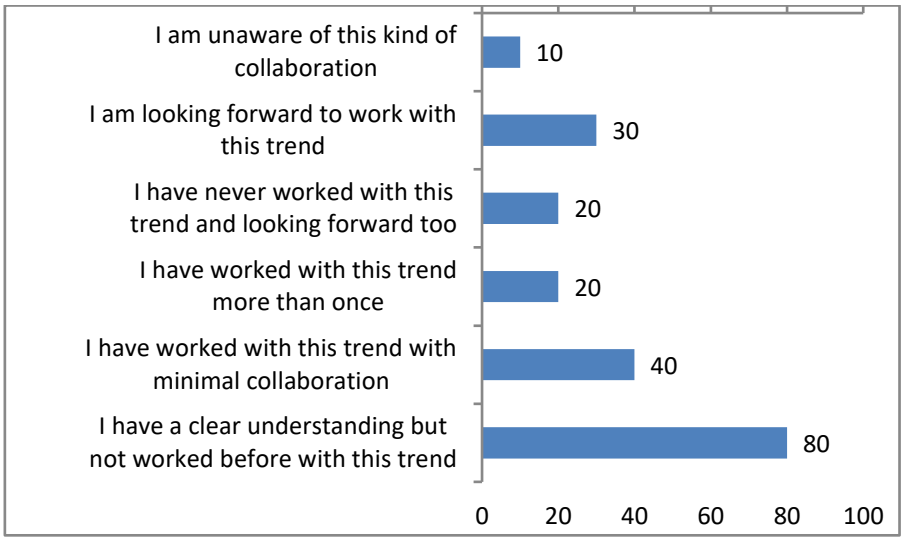


*Figure 30: Awareness of the participants regarding combination of traditional and modern features*

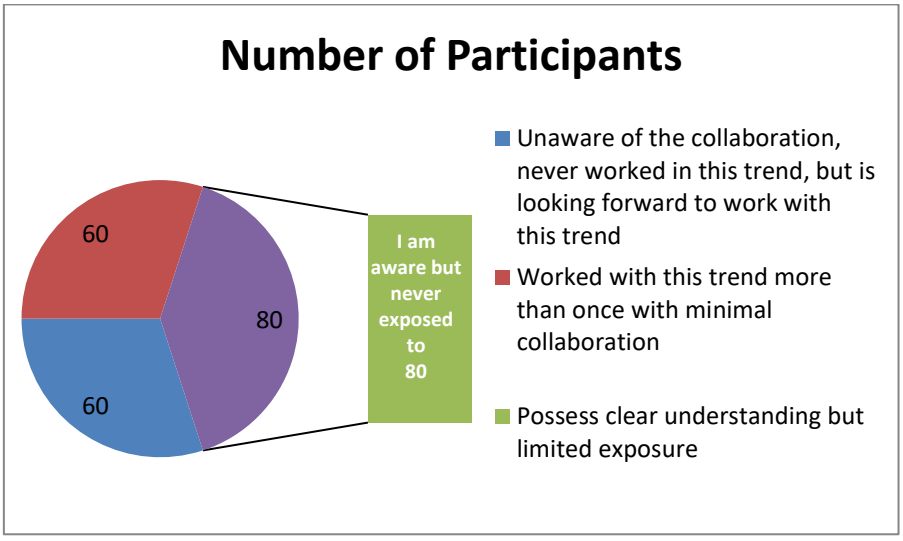


*Figure 31: understanding and exposure to traditional techniques in collaboration with contemporary context upon climate change*

Figure 30-31 provides information on participants' understanding and exposure to traditional techniques in collaboration with a contemporary context as it relates to climate change. Of these participants, 40% acknowledged that they have a clear understanding but have not had the opportunity to work before with the traditional techniques in collaboration with contemporary context as it relates to climate change.

A total of 20% agreed that they had worked with this trend, but with minimal collaboration, and 15% admitted that they were looking forward to being involved in such a trend. While 10% agreed that they have understanding of this trend at least once, 10% admitted that they have not worked the trend but are looking forward to work with it soon. A final 5% seemed unaware of such a kind of collaboration. As reflected in the above graphs, some of the respondents are unaware of using combination of modern and traditional techniques. Even if they have awareness, limited exposure is there is to explore such options and techniques of work. This has to be improved in order to improve the building performance, sustainability, and restoration of cultural heritage of the region.

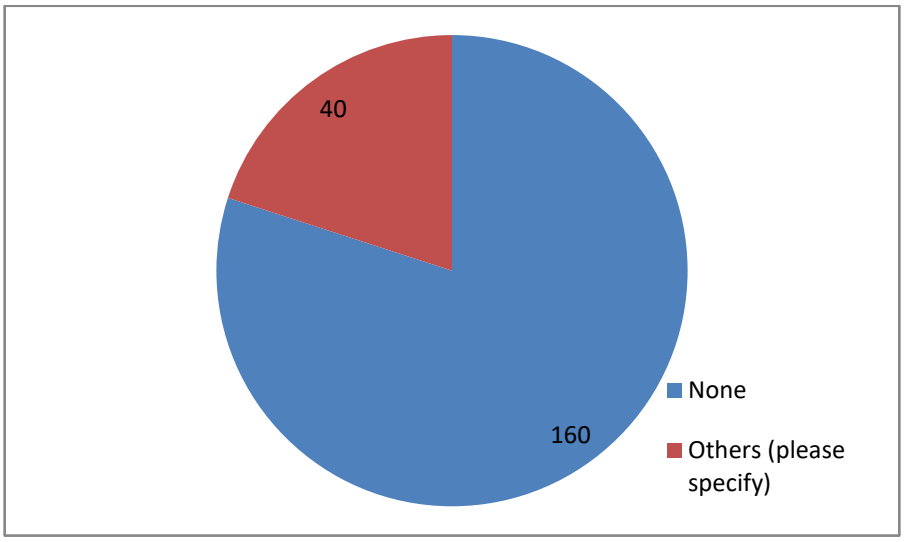


*Figure 32: Aspects liked most about traditional features in collaboration with contemporary context.*

Figure 32 presents participants awareness about the aspects of amalgamation of both traditional and contemporary features. A total of 80% of the participants failed to indicate any traditional aspects that could be applied in a contemporary context, and 20% could not even specify what traditional features interest them. Thus, it can be stated that also the respondents may have awareness of the trend they have limited exposure and knowledge about how to integrate both the aspects. This gap in the knowledge created problems in building modern houses that fail to meet the thermal comfort or ventilation requirement.

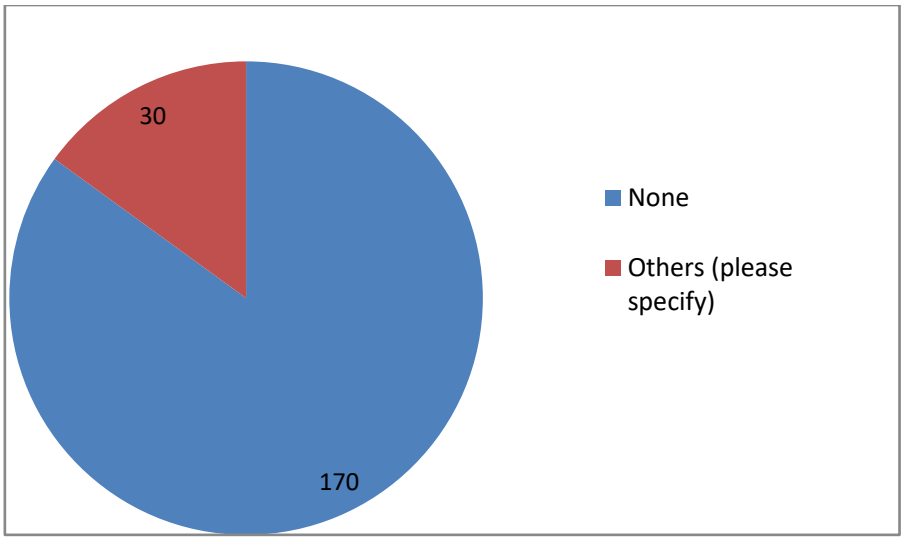


*Figure 33: Aspects disliked the most about traditional features in collaboration with contemporary context*

Figure 33 presents data on what particular aspects architects dislike most about traditional features applied a contemporary context. Of these architects, 85% stated that they disliked none, and 15% failed to specify the exact aspects they seemed to dislike. Similar to the above diagram, this also reveals that participants do not have adequate knowledge of the traditional features and the way it can be integrated with the modern buildings.

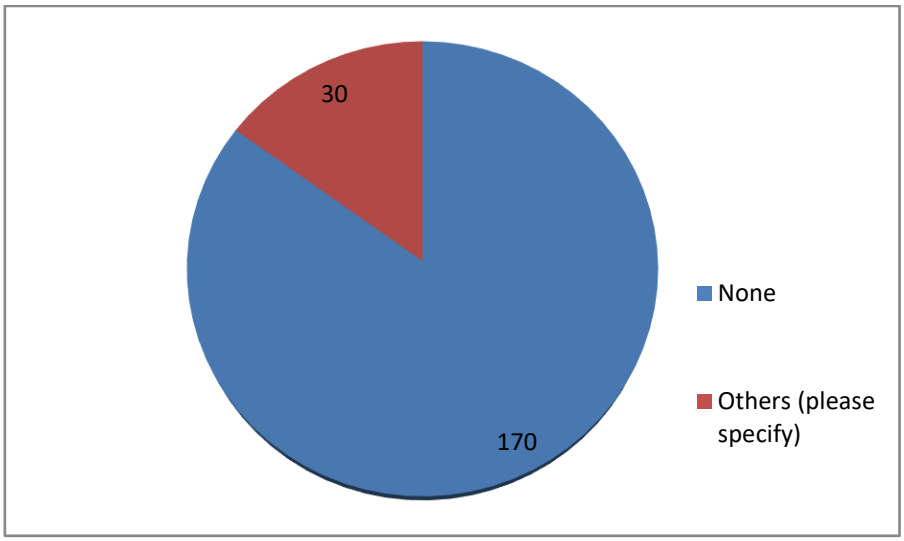


*Figure 34: Please mention your most significant building that might represent the most comfortable place with its local context and emphasis on environmental aspects.*

Figure 34 presents information on the most significant building that might represent the most comfortable place with its local context and emphasis on environmental aspects. At total of 85% of architects stated that there was no significant information pertaining to buildings with the most comfortable places fitted with local contexts and emphasizing environmental aspects, while 15% did not specify any particular information they had presented.

This section provided detailed analysis of the perceptions related to the integration of traditional and contemporary architecture. The significant finding was that the respondents possess limited knowledge as well as exposure to the techniques of combining both the traditional and modern techniques. Thus, this aspect needs improvement. The next section assesses respondents' awareness about using traditional and modern techniques.

### 4.2.4 Measuring Respondents' Awareness

This section measures the occupants' perception, satisfaction, and behaviour are regards the use of traditional and modern techniques and its impacts.

#### 4.2.4.1 Occupants' Perception

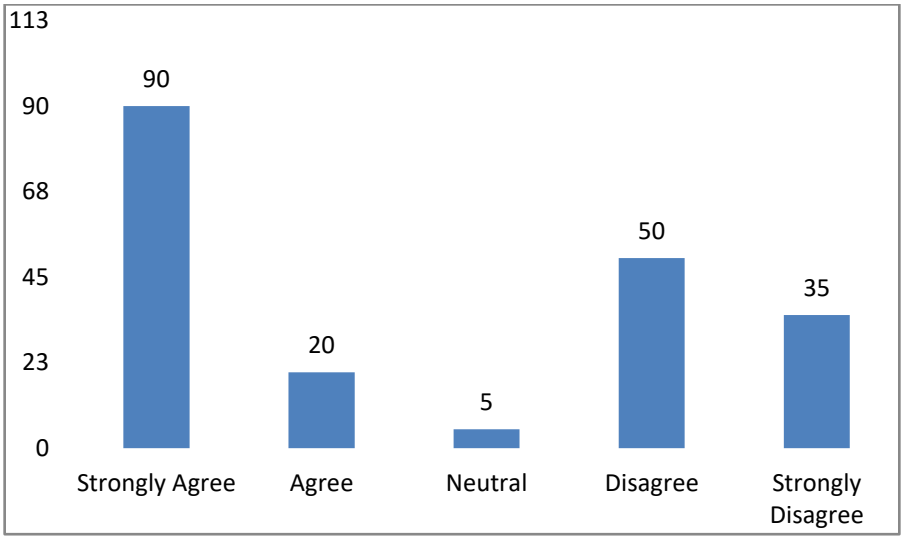


*Figure 35: The use of traditional features supports self-esteem.*

Figure 35 presents information on the use of traditional features to reflect self-esteem. Of the respondents, 45% strongly agreed that the use of traditional techniques reflects self-esteem, while 25% disagreed, and 10% agreed on the need to have traditional features added to their buildings for the main purpose of supporting their self-esteem. Of the occupants, 17.5% strongly disagreed that there is an existed need to add any traditional features, and 2.5% remained neutral. The results indicate that the use of traditional features reflects self-esteem. Since the traditional features have greater evidence of the cultural heritage, such features increase the self-esteem of the residents. This result depicts that innovation and technology have a positive influence on the promoting a sustainable future in the region of the Middle East with the uptake of architectonic traditions.

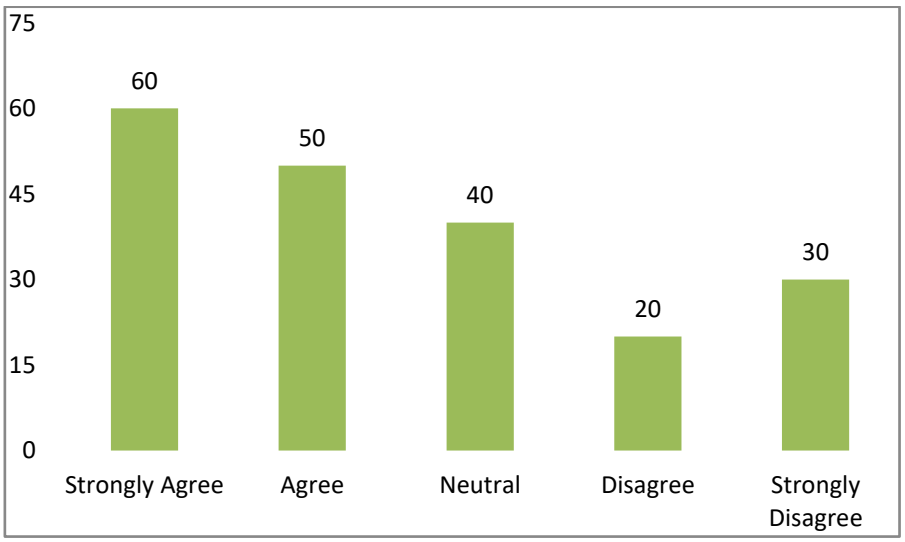


*Figure 36: Modern trends are more commonly communicated with indoor spaces.*

Figure 36 presents information on how modern trends facilitate indoor spaces. In regard to whether modern trends helped to facilitate space, 30% strongly agreed, and 25% agreed that modern trends were more often communicated within indoor spaces. 20% remained neutral while the other 15% strongly disagreed that modern trend was useful towards creation of indoor spaces. 10% of the total population disagreed to the concept that modern trends were more often communicated in indoor spaces. The research revealed that modern trends are well communicated with the indoor spaces and thus, there is little room for integration of the traditional features.

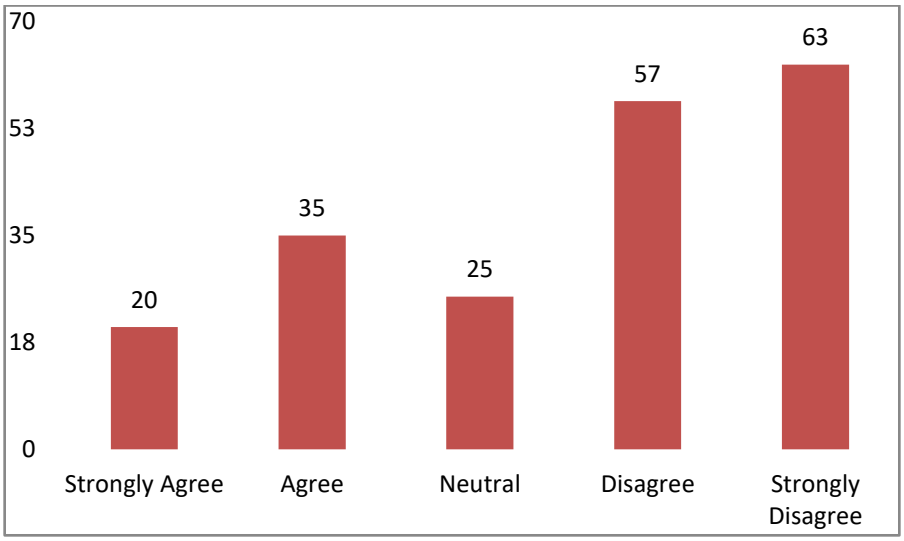


*Figure 37: The way contemporary architecture is distributed affects quality of life.*

Figure 37 presents data regarding whether modern architecture's distribution affects people's quality of life. Of the respondents, 31.5% strongly disagreed that modern architecture was to blame for poor quality of life, while 28.5% disagreed, 17.5% agreed that modern architecture's distribution affected their quality of life. Ten percent of respondents strongly agreed, and 12.5% chose to remain neutral.

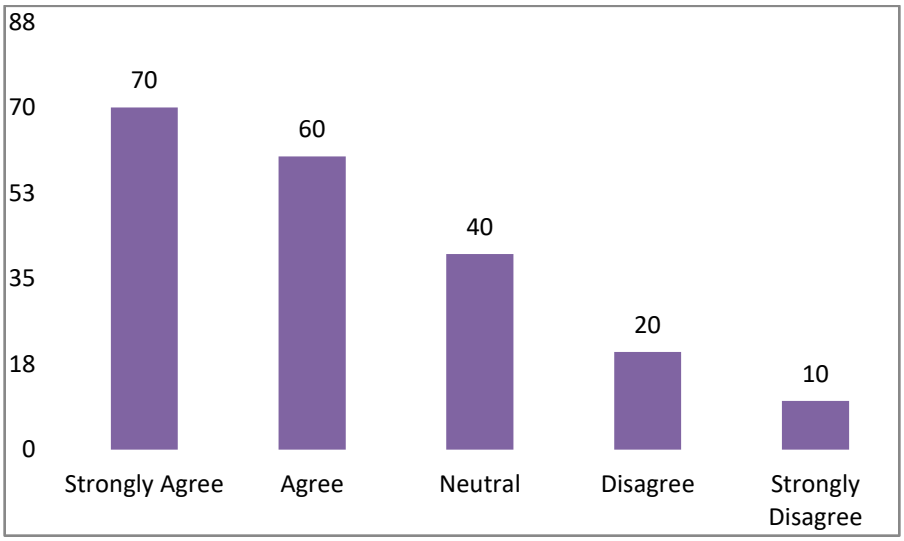


*Figure 38: To what extent do you agree with adaptation of traditional architecture to a modern context?*

Figure 38 presents data on the extent to which participants agree on the adaptation of traditional architecture to a contemporary context. Of the participants, 35% strongly agreed with the attempt to adapt traditional features into contemporary context; 30% agreed on the need to adapt a traditional context over the contemporary one; 5% strongly disagreed with any attempt to adapt a traditional context over contemporary context; 10% disagreed with any attempt to adopt any traditional features in a contemporary context; and 20% chose to remain neutral. The disagreement may be because of lack of awareness of the techniques used for combination of traditional and modern architecture. It can also be attributed to the inclination towards the implementation of green building in the contemporary housing system.

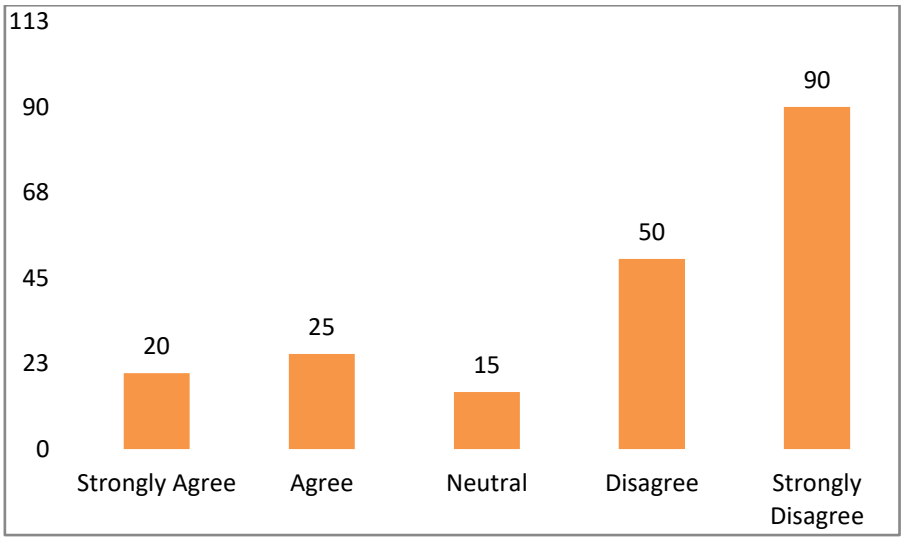


*Figure 39: Traditional architecture in context adds expenses to the project.*

Figure 39 presents information on whether traditional architecture in context added expenses to the project. Of the respondents, 45% strongly disagreed to this concept, while 25% felt that traditional architecture added no extra expenses to the project, and 12.5% participants agreed it did. 10% of these participants strongly agreed that a traditional context increases expenses for the proposed project, and 7.5% chose remain neutral. The traditional architecture makes use of sustainable low-cost material. Thus, the expense is less. These materials have now been adopted for green building projects. However, since the skill sets and knowledge in integrating the contemporary and techniques are low, acquiring such talents might become expensive. Thus, the

respondents who strongly agreed and agreed in this regard, might have considered this aspect.

#### 4.2.4.2 Occupants' satisfaction and behavior

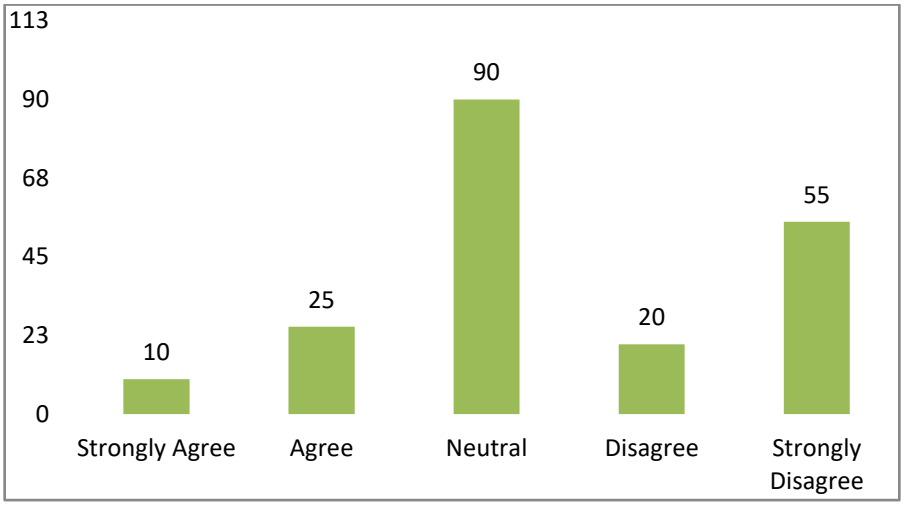


*Figure 40: The temperature in the indoor spaces is adequate.*

Figure 40 presents information regarding temperature conditions indoors. Of the participants, 45% remained neutral on the matter, while 27.5% strongly disagreed, and 12.5% agreed. The remaining 10% disagreed, while 5% agreed strongly. The results indicate that the thermal control of the buildings is not adequate. This might be because of the lack of integration of the traditional elements.

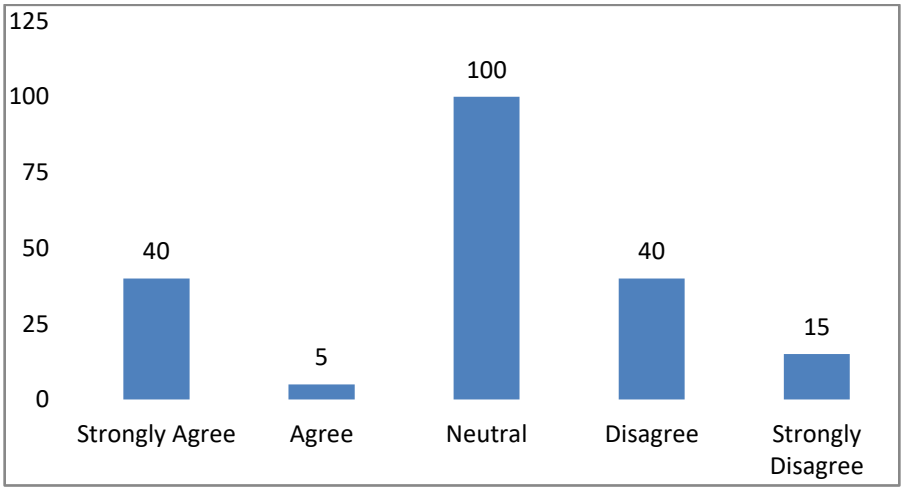


*Figure 41: The temperature in the indoor spaces is mostly cold.*

Figure 41 presents participants' data on indoor temperature conditions. Of the respondents, 50% remained neutral, 20% strongly agreed, another 20% disagreed, 2.5% agreed, while 7.5% strongly disagreed. The results indicate that the temperature inside the building is not suitable. As compared to the agreement to the given statement majority disagreed and stated that the inside temperature is not cold. Thus, the inadequate thermal control of the houses indicates a greater need to combine traditional techniques of ventilation in order to increase the comfort level of the dwellers.

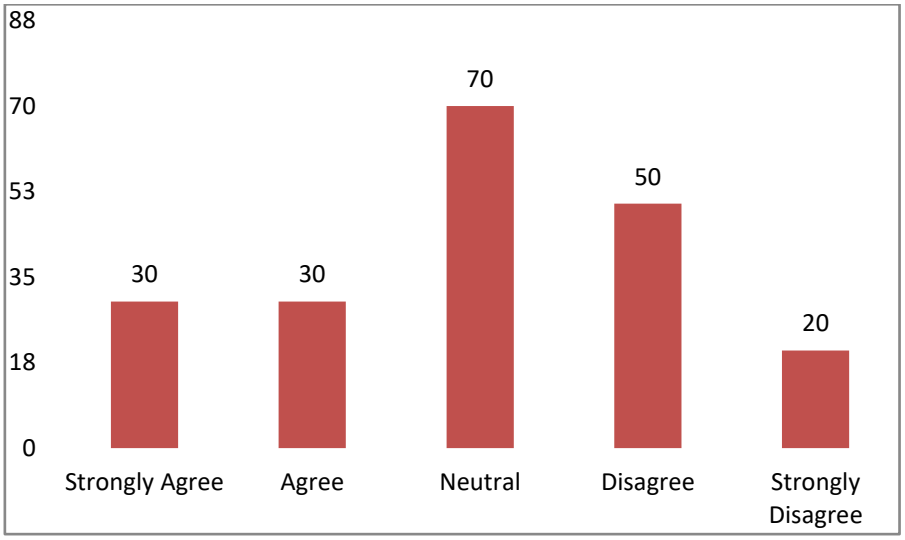


*Figure 42: The temperature in the indoor spaces is mostly hot.*

Figure 42 presents further data on indoor temperature. Of participants, 35% remained neutral on the matter, 25% disagreed, 10% strongly disagreed, 15% strongly agreed, and 15% agreed. As compared to the agreement, since the disagreement is more, it can be stated that it might be because of the installation of modern techniques of air conditioning or other combinational of traditional cooling methods, that the indoor spaces are cooler. However, since the responses are divided, the results here are inconclusive.

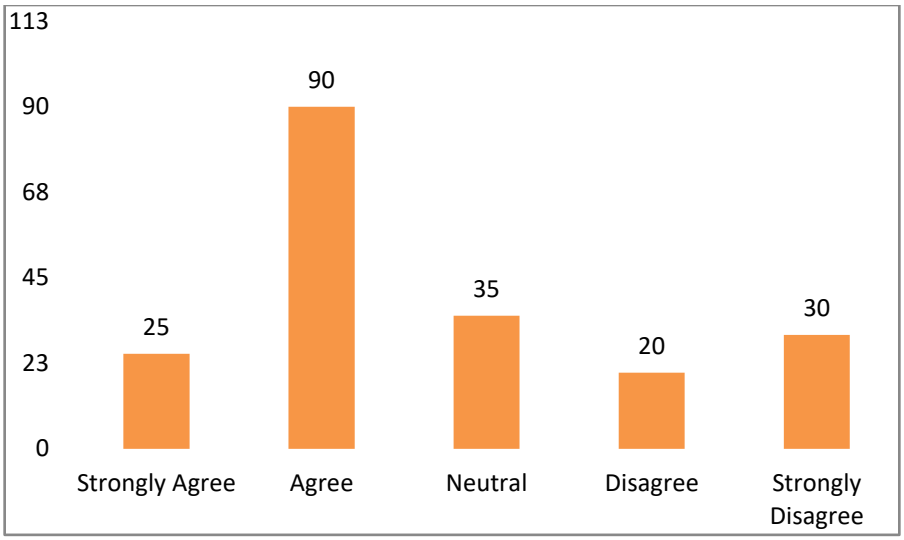


*Figure 43: Ventilation is adequate.*

Figure 43 presents participants data pertaining to ventilation. Of the participants, 45% agreed that ventilation in their buildings remained adequate, 17.5% remained neutral, 15% strongly disagreed, 12.5% strongly agreed, and 10% disagreed. The adequate ventilation for the participants who agreed might be because of the air circulation system installed within the building. However, those who disagreed in this regard, might be because of poor building performance due to lack of adequate provision for ventilation as observed in the contemporary building system.

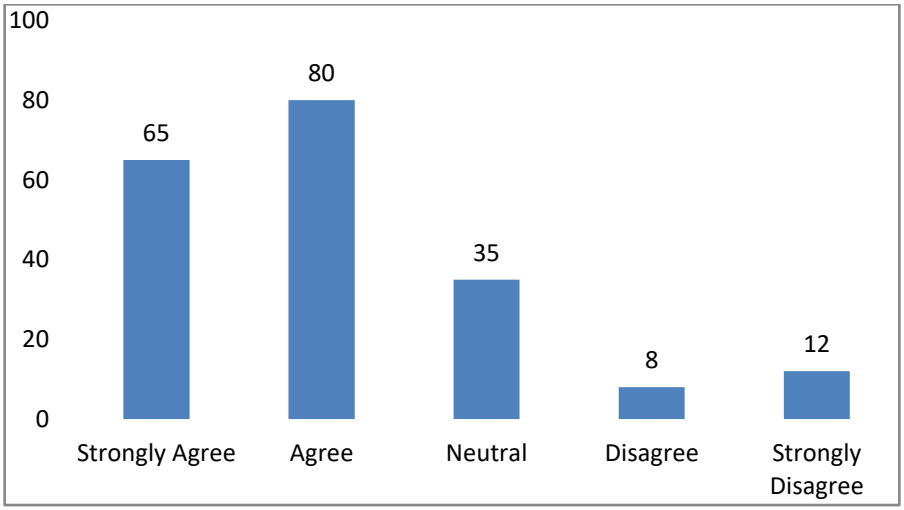


*Figure 44: Natural lighting can be better controlled.*

Figure 44 presents data on natural lighting control. Of the total population, 40% agreed that natural lighting can be better controlled, 32.5% strongly agreed, 17.5% remained neutral, 6% strongly disagreed, and 4% disagreed. The results indicate that respondents felt natural lighting can be better controlled. As noted by Simpson (2002) in traditional building design, the windows and roofs provided for natural air and light infiltration. However, in contrast, in the contemporary building system such provisions are not there. Thus, majority of the respondents stated that by incorporating some of the traditional designs and techniques, natural light can be better controlled. This finding also indicates the building performance in the region.

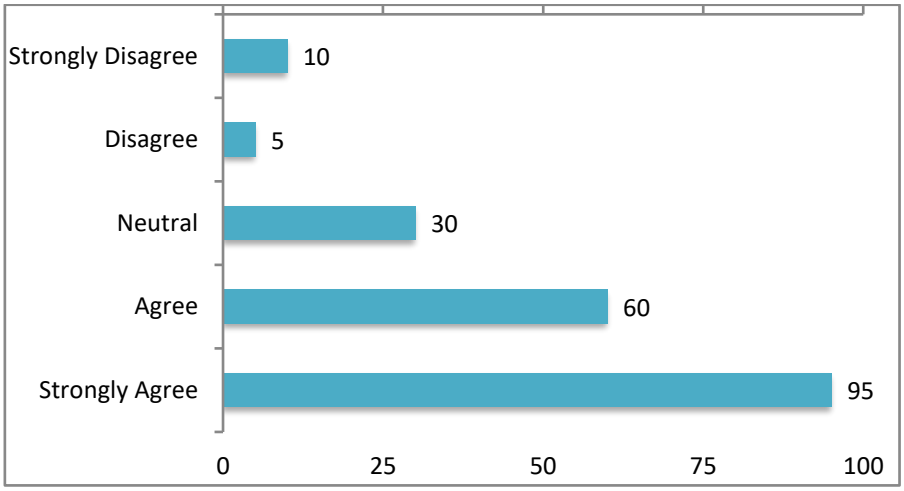


*Figure 45: Quality and quantity of indoor day lighting must improve.*

Figure 45 presents data on quality and quantity of indoor day lighting. In total, 47.5% of participants strongly agreed that quality and quantity of indoor day lighting should be improved, 30% agreed, 15% remained neutral, 5% strongly disagreed, and 2.5% disagreed. As noted in the above discussion, in the traditional building design, the infiltration of lights was facilitated by roofs and windows. However, in contemporary buildings natural light infiltration is less because of inadequate provisions. Thus, this aspect must be improved and is suggested by majority of the respondents.

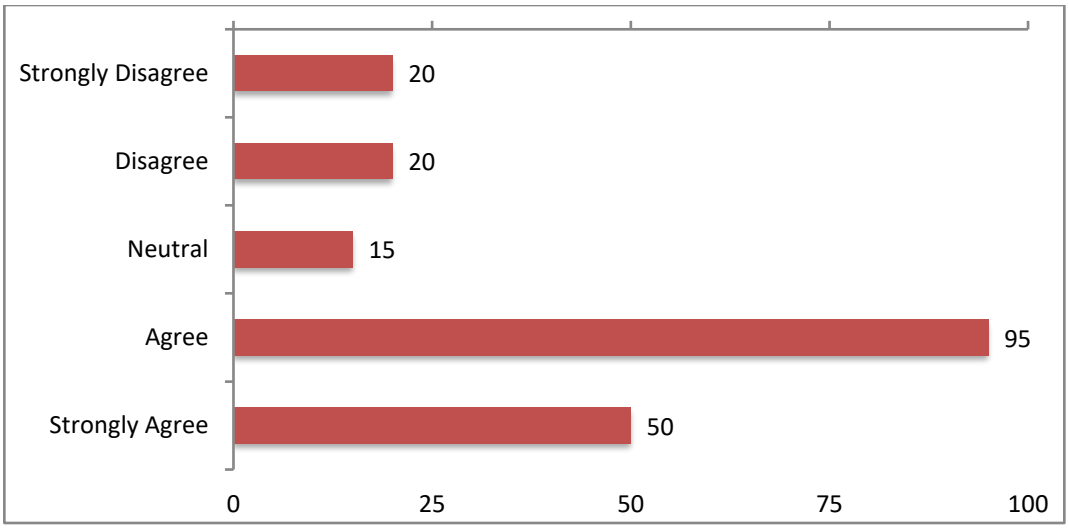


*Figure 46: The enhancement of daylight appearance*

Figure 46 presents information on the enhancement of daylight in the home. Of the participants, 47.5% agreed that exposure to daylight in the home could be improved, 25% strongly agreed, 10% disagreed, another 10% strongly disagreed, and 7.5% remained neutral. This finding is also similar to the above two discussions.

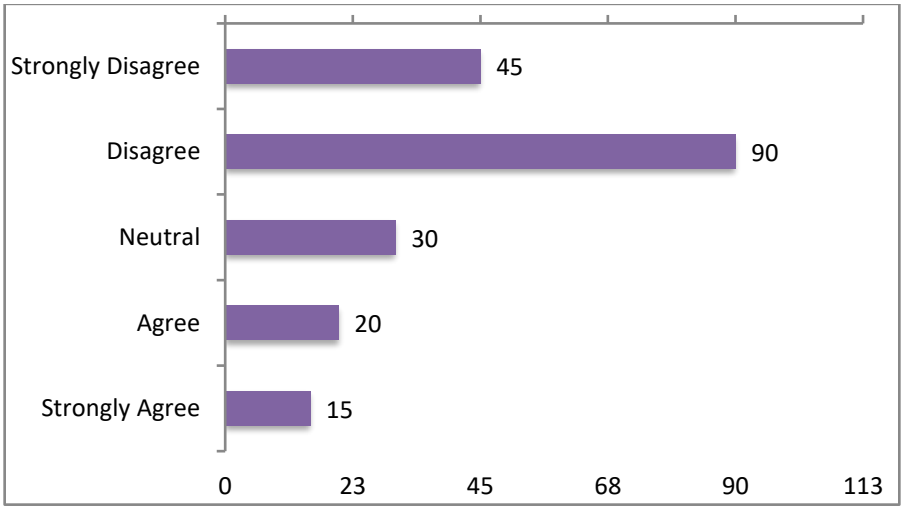


*Figure 47: The general layout and design is satisfactory.*

Figure 47 presents information on general layout and design. A total of 45% of respondents disagreed that general layout and design of the buildings appeared satisfactory, 22.5% strongly disagreed, 15% remained neutral, 10% agreed, and 7.5% strongly agreed. Most of the participants' houses are in the contemporary setting.

Unlike traditional form of courtyard house with inward-looking buildings, considering safety and privacy requirements, the modern housing designs do not meet the needs and requirements of the occupants. Thus, the results indicate the necessity of integrating buildings with local context and climatic condition.

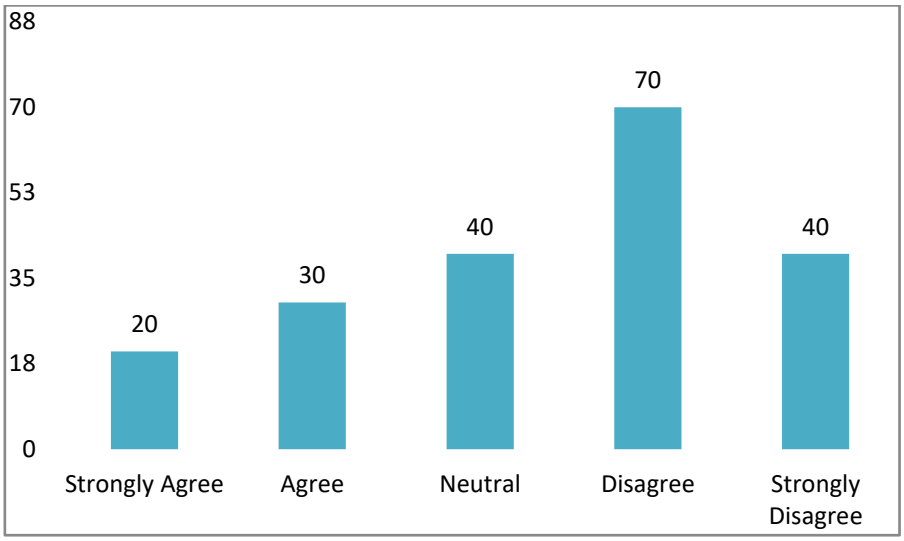


*Figure 48: The visual connection and relationship of indoor and outdoor spaces is more satisfactory than none.*

Figure 48 presents information on the visual relationship of indoor and outdoor spaces. This item prompted 35% disagreement amongst participants, while 20% strongly disagreed, another 20% remained neutral, 15% agreed, and 10% strongly agreed.

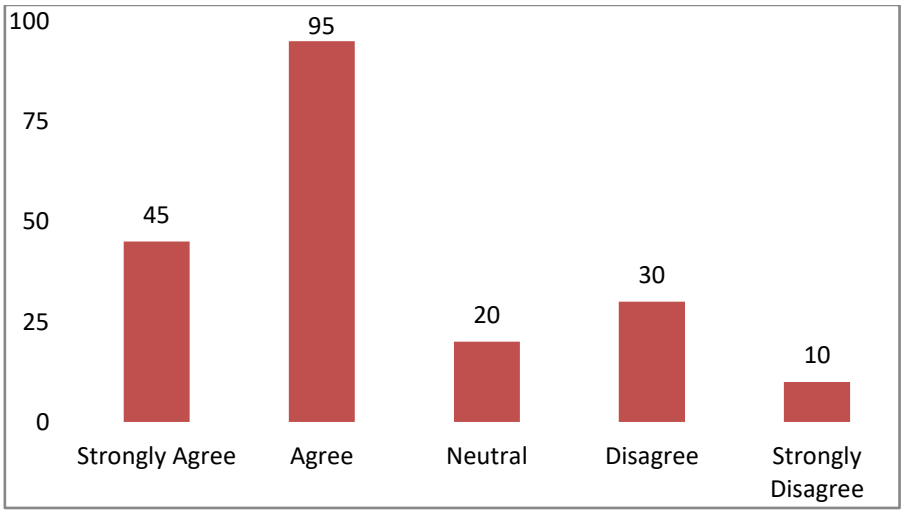


*Figure 49: Improving energy conservation within its local context.*

Figure 49 presents data on energy conservation improvement within its local context. A total of 47.5% of respondents agreed that it is necessary to improve energy conservation within the local context, 22.5% strongly agreed, 15% disagreed, 10% remained neutral, and 5% strongly disagreed. Energy conservation can be enhanced by incorporating the principles of green building in modern day. Traditional building designs facilitated energy conservation. However, in modern day the structural elements often overlook such considerations. The results indicated that this has to be enhanced.

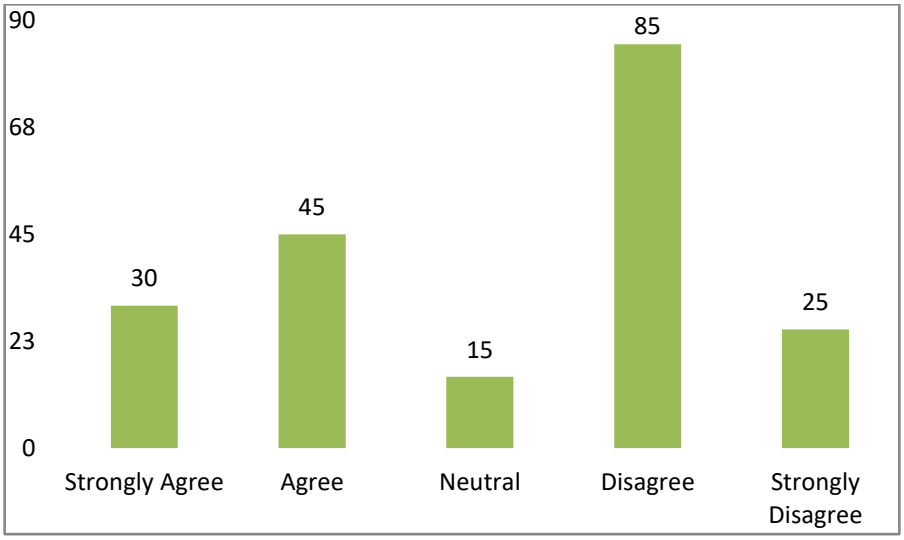


*Figure 50: The environmental aspect in relation to the local context.*

Figure 50 presents the perception of respondents on environmental aspects in relation to the local context. A total of 42.5% disagreed that more emphasis should be placed on the environment based on the local context. Of all respondents, 22.5% agreed on the need to lay emphasis on the environment, focussing on the local context, 15% strongly agreed, 12.5% strongly disagreed, and 7.5% remained neutral. The environmental concerns are often adopted as part of green buildings. In the absence of traditional building formats, the contemporary buildings must adopt this approach towards sustainability.

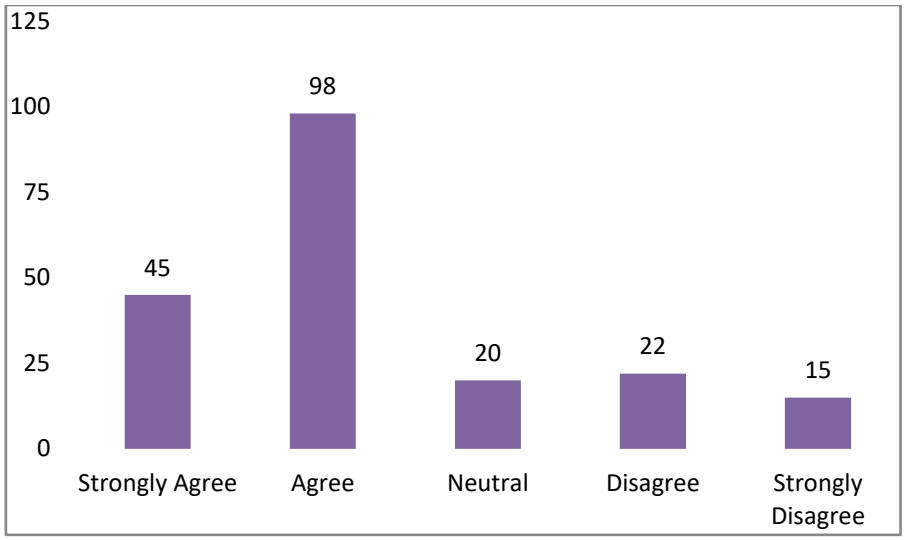


*Figure 51: Enhancing building performance and indoor quality is necessary.*

Figure 51 presents data on enhancing building performance and indoor quality. A total of 49% agreed that it is necessary to enhance building performance and indoor quality, 22.5% strongly agreed, 11% disagreed, 10% remained neutral, and 7.5% strongly disagreed. As noted in the earlier discussions, the contemporary building designs do not emphasize on indoor environment quality. Thus, this aspect must also need a special focus in today's construction projects.

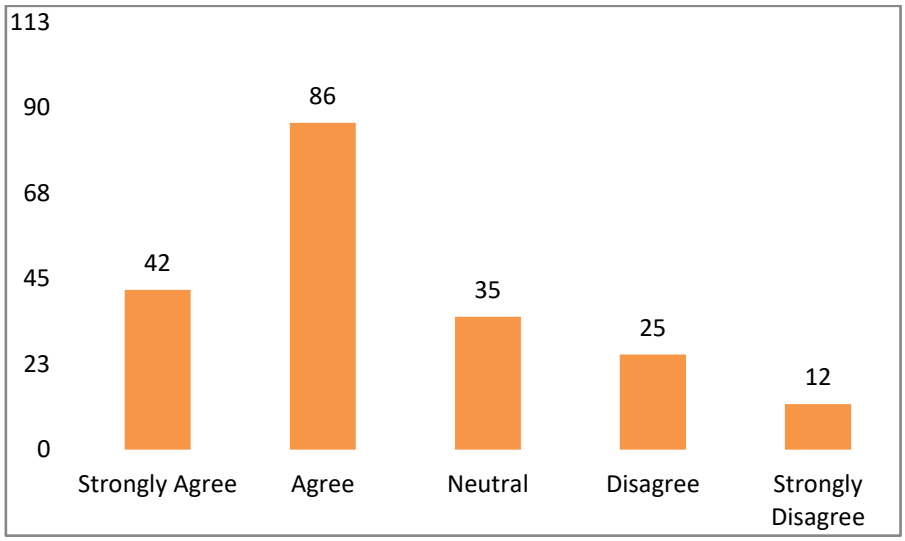


*Figure 52: Consider the integration with the local context and climate change.*

Figure 52 presents data on the local context and climate change integration. Of all participants, 43% agreed that there is a need to integrate the local context and climate change, 21% strongly agreed, 17.5% remained neutral, 12.5% disagreed, and 6% strongly disagreed.

The above section thus reveals some of the major findings of this research. It indicates that in terms of building performance and occupant's satisfaction, the contemporary building designs are not adequate. The results thus indicate a need to combine both the traditional and modern design to improve building performance as well as dwellers' comfort and satisfaction.

#### 4.2.4.3 Expert decision making

This section attempts to analyse the level of expertise and skill requirement in order to integrate traditional and modern techniques in building construction. The purpose is to the level of knowledge of the participants.

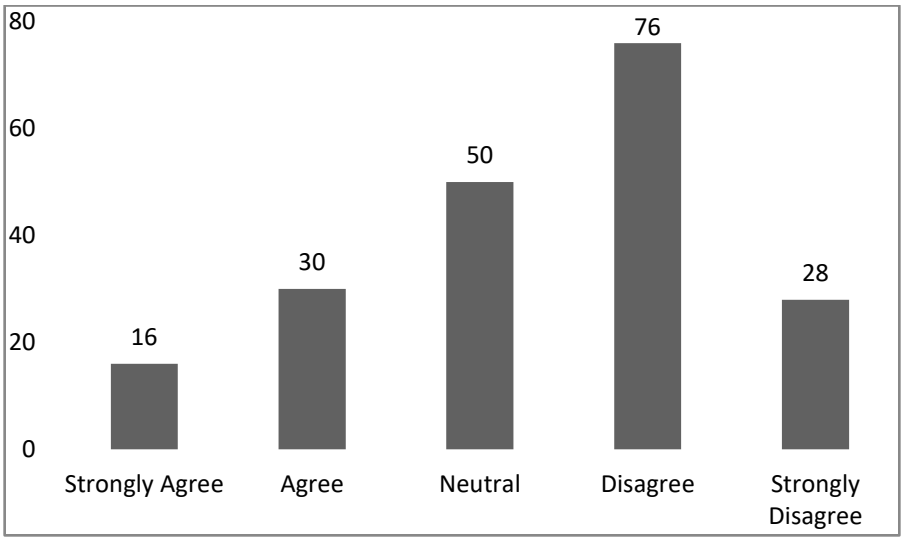


*Figure 53: The application of traditional features to technology entails a complex system for improving design efficiency.*

As Figure 53 shows, 38% of respondents disagreed that it is a complex issue to apply traditional features to new technology in a bid to improve design efficiency, 25% remained neutral, 15% agreed, 14% strongly disagreed, and 8% strongly agreed.

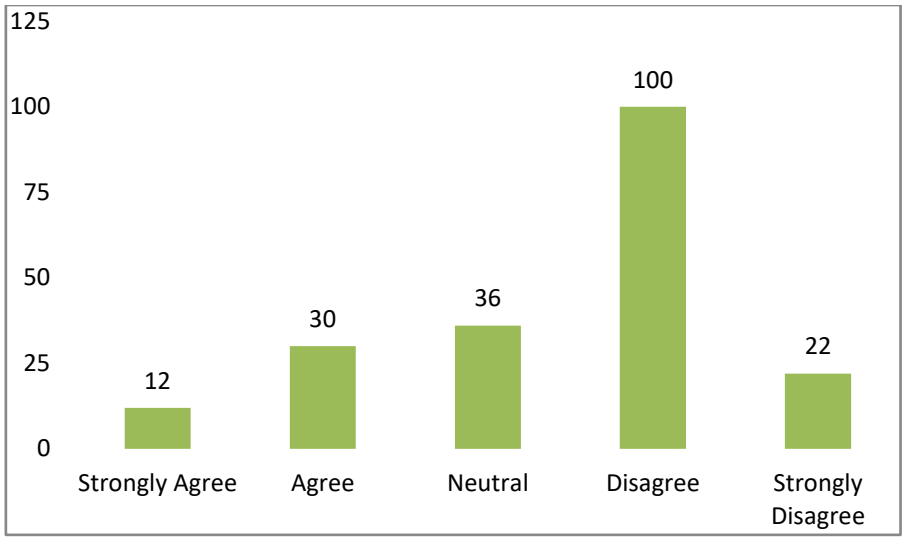


*Figure 54: Traditional techniques should be applied for refurbishment sites only.*

Figure 54 present's data on whether traditional techniques should be applied only during building refurbishment. Half of all respondents 50% disagreed, 18% remained neutral, 15% agreed, 11% strongly disagreed, and 6% strongly agreed. This is one of the significant finding of this research. Since the majority of the respondents disagreed to the given statement, it can be stated that respondents are aware of the benefits of combining traditional and modern techniques and how it can be applied to new building conditions.

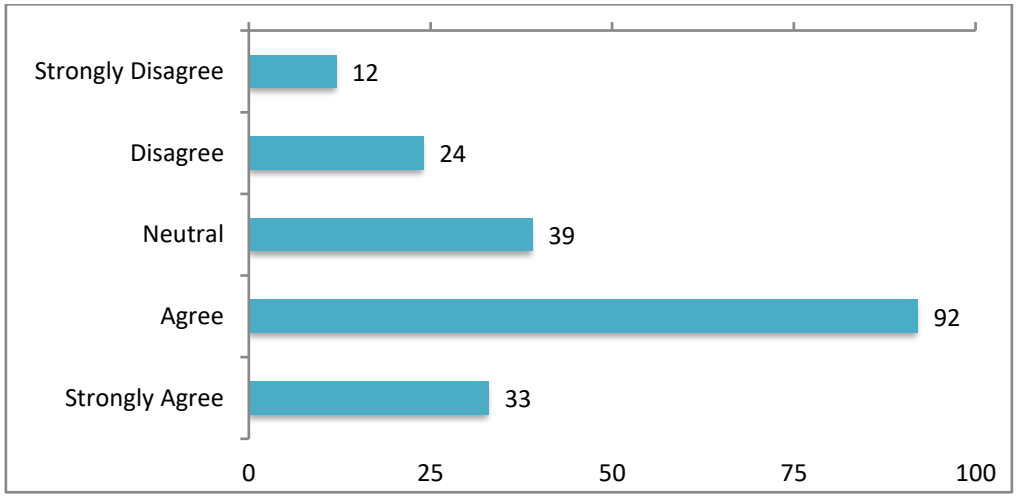


*Figure 55: The final decision for building mobilization must be made by local experts.*

Figure 55 presents data on local experts' decisions concerning building setting. Forty-six percent of respondents agreed that there is need to let local experts decide on building settings, 19.5% remained neutral, 16.5% strongly agreed, 12% disagreed, and 6% strongly disagreed.

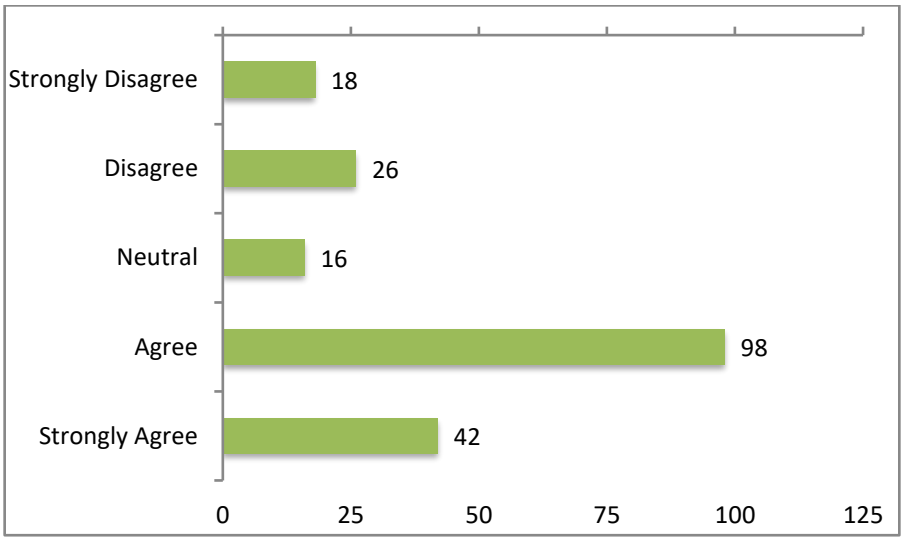


*Figure 56: Academic perspectives and methods of teaching collaboration between traditional and modern techniques need to be refined.*

Figure 56 presents data on academic attitudes towards traditional and contemporary techniques in collaboration in the service of building refinement. A total of 49% of respondents agreed that it was necessary to refine academic perspectives and methods of teaching the collaboration between traditional and modern techniques on building refinement, 21% strongly agreed, 13% disagreed, 8% remained neutral, and 9% strongly disagreed.

The quantitative analysis provided detailed account of the respondents' skills and knowledge, perceptions related to combination of traditional and modern techniques, and their residential identity. Overall the research revealed that the respondents are although aware of the trend of integration of traditional and contemporary architectural features, they are not sure about the methods and practices that are required to be adopted to reach this objective. In addition, the findings also highlighted that there is a gap in the knowledge of the research respondents in terms of techniques and tools

of amalgamation and how it can be achieved to enhance building sustainability and performance.

## 4.3 Qualitative Analysis : Interviews

This section highlights the qualitative data and interprets its findings. The researcher gathered interview data from 14 participants, coded as Interviewees 1–14 for ethical purposes. All respondents were experts in the building and environmental field. The qualitative analysis provides a detailed insight into the research and highlights some of the major findings.

**A. Background of the research participants**

- **Area of residence**

Interviewee 1 described the area in which they live in as naturally cool. Interviewee 10 said his living area was air conditioned. Additionally, Interviewees 8, 4 said it was hot while 9 said it was air conditioned and hot. Interviewee 12 specified that he experiences hot temperatures for two months in the summer. This indicates a poor level of building performance in terms of thermal control. In contrast to traditional design, these contemporary designs do not make adequate provision for ventilation and air circulation that may lead to an increase in temperature in the indoor spaces. Thus, there is further room for improvement by using both traditional and contemporary architectural techniques.

- **Surroundings of residence**

1 Interviewee 1 described the outdoor surroundings at their place as naturally cool; Interviewee 2 reported having (AC); Interviewee 1 reported that it is warm during summers, and Interviewee 7 reported heat. Interviewee 12 specified experience of a naturally cool outdoor environment in fall, winter, and spring, An air-conditioned environment in July and August, and a hot weather also in July and August.

- **Describe your residence?**

Interviewee 1 described the outdoor surroundings at their residence as traditional; Interviewee 11, as modern; and Interviewee 2, as semi-traditional.

## B. Discussion on the integration of traditional architecture with modern adaptation and its effectiveness in promoting occupants' psychological comfort and wellbeing

Ten interviewees said comfortable temperatures apply only when (AC) is on high most of the time. Interviewees 4, 6, and 9 said that psychological wellbeing is adjustable through the use of air-conditioning systems. Interviewee 13 and 14 agreed that comfortable temperatures are experienced to a moderate degree.

In regards to the lack of bad odours due to improved ventilation, seven interviewees agreed to have this experience. Interviewees 2, 7, 9 and 10 agreed that they experience improved and better ventilation due to large openings and mechanical systems. Specifically, Interviewee 11 said that to a high degree, especially when the windows are open, there is improved ventilation. Interviewee 12 said that there is a natural ventilation during the cool season (November–March) and mechanical ventilation by using air conditioners and air coolers during the hot season (April-September). Interviewee 12 also acknowledged that recently, his architecture team installed a ductless (AC) system, which made a significant impact in the hot summer months.

Additional factors that were deemed applicable included breezes, indoor lightening (natural light), good plumbing and water heating systems, more natural light with large windows, views to the outside, thermal insulation in the building envelope (walls and roof), masonry in the external walls, and minimization of the empty or solid proportion of the external walls. Specifically, the courtyard system, the wind catchers facilitated natural air circulation and thus, it was able to control the inside temperature of the houses. Such elements therefore, should be considered by the contemporary architects to provide the occupants optimum level of comfort and enhance their satisfaction.

## C. Suggestions of the thermal conditions enhancement to ensure greater thermal comfort by changing design approaches

Ten interviewees said improving ventilation in the building allows the movement of fresh air through the building, finding ways to spread the cool air non-invasively, along with the use of white outdoor blinds to reduce induction of heat. Interviewees 6 and 7 also suggested the use of operable skylights or a courtyard and passive-cooling

approach. Based on the climate, there is needed to insulate the houses. Interviewee 9 also said plenty of unwanted fresh air moves through dwellings in the winter. Interviewee 12 said that they live in an urban environment, and the house is not ideally suited for climatic factors such as a passive approach or hybrid integrated systems.

Three interviewees reported that the kitchen location could benefit from the use of strong suction pipes, possibly on the sides of the stove, before the fumes fill the air. Additionally, Interviewee 8 said that locating the kitchen on the opposite side of the dwelling from the prevailing wind direction is important to avoid undesirable smells and provide good ventilation. Interviewee 9 further said that the location should be central, using an open concept for the dining room and kitchen together. Other suggestions kitchen included location in the north and east of the building orientation.

Some interviewees (3, 5 and 6) added that long windows let in natural sunlight and aid in ventilation. Interviewee 7 said that, for public buildings, they should provide openings above the doors into the central hall that could provide air circulation and cross ventilation. Interviewee 9 also said that the use of a chimney effect, in some cases and in certain environments—such as a traditional wind tower—could work. The opinions of the participants also reflect a need to integrate traditional features with contemporary styles. While this approach can meet the need for ventilation, thermal control, can also meet the modern design choices and aspiration of the dwellers.

**D. Measures adopted by the research participants to combat the heat**

Seven interviewees indicated that improved ventilation and orientation can aid in minimizing heat. In addition, Interviewee 10 said that his place is never very hot. The same seven interviewees also said that improved space design helps to improve the conditions in the house. Interviewee 8 specifically said that the façade retreat in some locations can be adopted to improve shading. For the installation of thermal sensation models, such as fans, eight interviewees said that they help much and that, at times, these interviewees do not use air-conditioning. Interviewee 10 mentioned not depending on mechanical HVAC System at all times.

Additional comments acknowledged the use of improved installation, cantilevers, shading elements, improved district planning, improve thermal insulation of the

external walls, minimizing direct sunlight by the use of shading devices such as louvers, and improved insulation for walls and ceilings. Interviewees 10, 11, 12 and 13 added the use of roof gardens and landscape tools, using sun-shading techniques for openings, thermal control as per local codes, and sustainable HVAC systems, solar orientation, evaporative cooling systems, and good thermal insulation.

Another observation from the above-mentioned interviewees was that A blend of traditional and contemporary architecture should be considered in design. Interviewee 10 acknowledged that they recently installed new double-pane insulated windows but with the envelope not insulated, it is difficult for them to be effective. Minimizing the windows in the south and maximizing them in the north facades could also greatly improve ventilation.

### E. Participants' perception on temperature as a relevant design parameter of the Arab region influencing on wellbeing and the analysis of the extent of LEED guideline implementation

The majority of the interviewees (10 of 14) affirmed that temperature is a relevant design parameter to the study location of the Arab region; the hot, arid climate has an influence on wellbeing. They gave different reasons for the existence of efficient building regulation. Interviewee 2 reported using Leadership in Energy and Environmental Design (LEED), a green building rating system.

Interviewee 3 said that the governments impose a minimal required building regulation on commercial companies and individuals. Individuals building for commercial use tend to ignore regulations involved with hidden structures that may be beneficial to the residents. They also acknowledged the reference to Sustainable Planning Guidelines for Urban Growth in the Kingdom of Saudi Arabia a resource by which to understand building regulations.

Interviewee 4 said that temperature is a relevant design parameter but is not considered. Interviewee 5 said that this consideration is not made efficiently and that it needs to be studied by engineers. Interviewees 6 and 7 said they were not aware of temperature as a design parameter. Interviewee 9 said that temperature is important

factor in the Arab region, noting that the building codes include some measures regarding it, especially the insulation of walls and the use of double-glazed windows. Sometimes these regulations are ignored, however, the interviewee noted. Moreover, nothing in the regulations mentions building orientation, movement of fresh air, or the shading (and so on).

Interviewee 11 said that due to extreme hot weather, improved study on management and controlled design of temperature is essential. They have building codes that need enhancement and up-grading Saudi Building Code and Saudi Standards, Metrology and Quality organization (SASO/SBC) and follow international standards where applicable, including but not limited to American National Standards Institute and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ANSI/ASHRAE). Interviewee 12 said that the heat in the Arab region is due to solar gain. Traditionally, buildings were close and the streets were narrow. As understood from elders in the region, one could walk from one end of a city to the other without ever being in the sun. Another consideration is the solar island effect. With so many cars and the need for paved parking, solar gain is being absorbed into the pavement and held longer into the night.

Interviewee 13 also said that temperature is an essential factor in designing housing in Saudi Arabia. The installation of air conditioners is highly considered in all infrastructure internally or externally. It is also taken into account for individual houses, complexes, or company offices. Some examples to support this trend in building include fixing drainage pipes for air conditioners in the early stages of building and specifying certain places for the external and internal parts of the air conditioner to fit with the design of the buildings. Such combination of traditional and modern feature can provide for greater wellbeing and comfort of the occupants.

## F. Discussion on optimal outdoor or indoor thermal condition of the participants

Seven interviewees said that they prefer a naturally cooling. Interviewee 10 said that in April and May, the weather is good, so it is preferable to have naturally ventilated spaces both indoor and outdoor, while in summer, when the natural cooling space is insufficient, the AC is used. Interviewee 13 said that it is difficult to achieve ideal temperatures because whenever the temperature levels are suitable for one individual, a different person may prefer either increased cooling or heating.

## G. Participants' recommendations to improve thermal conditions in building architecture for enhancing the thermal comfort

The recommendations given were as follows:

Adoption of traditional as well as modern building techniques can be adopted for better thermal control of the buildings. Some of the recommendations are listed below.

**INDOOR**

- The use of traditional spatial organization in Arab Homes is necessary to improve internal circulation of air to cool the various spaces homogenously,
- Wind catchers should be used to promote air movement inside various spaces in the house.
- Double-glazed, e-glazed, or small windows should be used for better air circulation.
- Additional local research and development on temperature management and control should be carried out by the academicians or professionals in the field.
- Proper appropriate building design approach considering the local and international standards should be strictly implemented.
- Thermal comfort should be created through the right combination of temperature, airflow by installing more windows and doors.

- Appropriate building materials should be adopted in the design to minimize the effect of temperature and to offer sustainable design.
- Tiling the floor with marble can reduce heat inside buildings.
- Builders should pursue improved local environmental conditions and increased greenery, shrinking the concrete jungle and adopting environmentally friendly materials and design approaches.
- Conscientious orientation of the building should be established to maximize the effects of the environment on the building: solar, wind, and so forth; insulated walls and roof; high-quality windows and doors; and shading and landscaping.
- Local building approval authorities must take a serious lead role in development and enforcement of sustainable building material.
- Using suitable high-performance materials in a building's envelop and allowing cross-ventilation within the interior space, the courtyard house is one solution for this cooling technique; the central living area is another good solution.
- Shutters or electronic blinds should be used to reflect away heat rays.
- Suitable building material and sustainable guidelines like LEED ((Leadership in Energy and Environmental Design) has to be implemented to guide material selection
- Outdoor balcony or green areas should be implements.
- Windows-opening should be positioned considering the sun, and natural ventilation.
- More economical ways to reduce energy consumption should be investigated.
- Insulation should be professionally installed.
- Smart elements (sensors, smart meters, etc.) that would measure indoor parameters and improve the built environment should be used.

**OUTDOOR**

- Increase the thermal mass to use passive cooling systems.
- Traditional building features like courtyards, wind catchers can be used to improve ventilation and circulation of cool air inside building
- Given the orientation of the building, shading devices should be used.
- Sunlight should be let in through large windows, but using glass that does not heat up the house too much, in cooperation with greenery to naturally cool down the immediate surroundings.
- Natural cross-ventilation can be implemented by providing openings at opposite sides.
- An internal atrium with an operable skylight should be used for natural ventilation.
- The importance of external wall insulation and thermal mass at roof level should be emphasised to improve the thermal performance of the building.
- Shading devices such as louvers, perforated panels and screens, overhangs, and the like should be applied.
- Water surfaces should be created when applicable for cooling, including reflective pools and fountains.
- Roofs and other open space can be used to provide for air circulation and natural light infiltration.
- Shading can be implemented through external outdoor spaces by trees, tents, pergolas (extended wooden lattice work) and other devices to control the temperature inside the house.
- Solar orientation can be harnessed.

- Evaporative cooling systems can be used.

## 4.4 Data analysis from EASYLOG USB Data Loggers

### 4.4.1 Introduction

The present chapter provides an overview of the data that was obtained from EASYLOG USB Data Loggers for one year, recording data on hourly basis (the image of the machine given below). The machine measures temperature and relative humidity and by default it was measuring dew point temperature. Since the first two were the most relevant to the study case the research focused on them. The loggers were placed in three main different space building typologies that is traditional scheme, contemporary scheme, and transitional scheme. This study conducted experiments on the physical environment of traditional and contemporary architecture reflecting physical input. The experiment faced some difficulties as some of the EASYLOG devices were lost or damaged. However, the researcher was able to retrieve most of the data from the damaged loggers that lead to considerable readjustment of research methodology along with the proposed method of conducting the study. The analysis of the data from the data loggers helped me in analyzing the data in a detailed manner and to extract most common trends for space behaviour and thermal performance. The chapter sheds light on some of the major findings from the data loggers.


*Figure 57: EASYLOG USB Data Loggers*

### 4.4.2 Data Loggers' Analysis

Since the data loggers' devices were lost some of the data were lost, of temperature, relative humidity and dew point temperature graphs for different months due to different reasons. Despite displacement of data by some site managers, efforts were made to retrieve some records for one year. The missing data accounted for only a few months, with some of the data being damaged. These were thus, excluded from the analysis. The research was conducted in the two main cities of Saudi Arabia which is Riyadh and Al Madinah. In Riyadh city two locations were chosen; Addiriyah which is an important national symbol in the history of the Kingdom of Saudi Arabia as well as the capital of the new First Saudi State. Along with this a refurbished site that is planned to open for public it was still under construction also was chosen for this study. Also, the Landform house was chosen because of representing both Contemporary and transitional typology. The data logger device was put each in the indoor living area—outside—and in the courtyard, which is one of the traditional architectonic features. In general, Saudi Arabian climate depicts a typical desert climate with high temperature throughout the day and abrupt low temperature at night. The outdoor temperature starts increasing during March and continues till August in Addiriyah and from September till February the weather is cooler. Similarly, as found in this study at Al Madinah, the outdoor temperature starts increasing from March and slowly it comes down during the month of September.

Turaif Neighborhood was selected, it is considered as one of the most important landmarks in the Historic Addiriyah since it is the home of the most important archeological buildings, palaces and historical monuments. Information and permission were given by the Saudi Commission for Tourism and National Heritage as well as Addiriyah Development Authority.

Addiriyah – representing the traditional typology, one house was chosen and the spaces selected for the experiment were – indoor living – outdoor area of the location – and courtyard (which represents a traditional architectonic feature).

The second location in Riyadh City a private Villa Landform House – representing both modern and transitional typology.

Spaces chosen for the experiment were indoor living room representing the Contemporary settings – indoor tea room in the first but after the damage that affected the device/ library & office was chosen both spaces tea room and library are representing the transitional settings – and outdoor area in the house.

Al Madinah city – was chosen also to address the study way forward. Spaces chosen for the experiment were indoor – and outdoor. Location was still under construction.

For each data logger, some pictures were presented, followed by some graphs that show the maximum and minimum temperature, relative humidity, and dew point temperature (DPT) measurements for the chosen spaces. The environmental condition as distinguished in terms of air temperature, air velocity, relative humidity, mean radiation temperature measured by the data loggers have resulted in differences in temperature. The below is a sample of a pictures summarizes the same with reference to the temperature measured by the device.

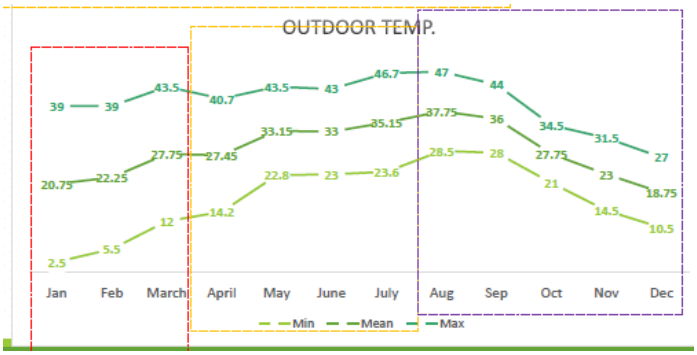


*Figure 58: Outdoor temperature at Addiriyah.*

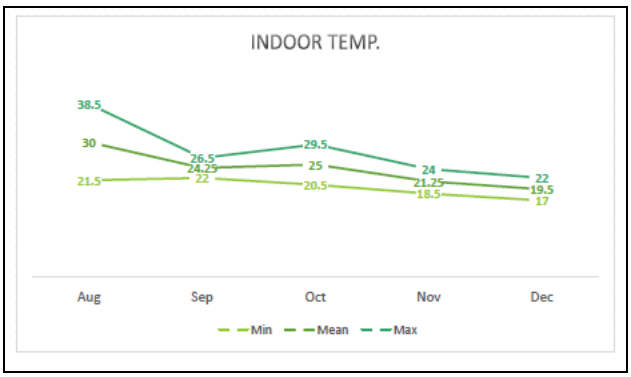


*Figure 59: Indoor temperature at Addiriyah.*

### 4.4.3 Addiriyah

Addiriyah was chosen as the site for experimentation because it represents the traditional typology, and the spaces chosen for conducting the experiment were indoor, outdoor, and courtyard. In addition, it is a traditional refurbished site in Riyadh capital city of Saudi Arabia. The houses were once owned by original Saudi families left long time ago. The surrounding neighbourhood is occupied by middle-class families. There were many districts in the area, but the study centred on the Turaif district. The area was adapted to look more modern by adding steel sheets that look like a canopy.

However, this addition raised the heat, so the intervention made a negative effect in terms of heat

Addiriyah was the capital of Saudi Arabia, all the houses where between regular houses and few palaces. The site no longer has residents, but the surrounding area is occupied by middle-class and less-privileged families. The Saudi Commission for Tourism and National Heritage started work on the area to make housing in it available for people rent for one or two days as a traditional resort. Among the many districts in Addiriyah, Turaif Neighbourhood was selected. Data was collected for around a year every hour in historical Addiriyah, and information and permission were given by the Saudi Commission for Tourism and National Heritage as well as Addiriyah Development Authority.

It is important to note that many loggers were lost in this site because there were many workers in and out of the area. The authorized people, mainly the contractor recommended selecting another space which had same orientation in terms of thermal performance and each space with the same setting and size. It was then locked so that no unauthorized people could enter. Later when the construction was completed the site was opened to try by authorized people. There was an air-conditioner inside the building, which stabilized temperature. The outside and courtyard of the new location was covered with a fabric that reduces sun radiation but not preventing the hot air ventilation, like a traditional court. This indicates that the inside temperature at the site was controlled by the installation of air conditioner. While the courtyard system facilitated the air circulation, due to the hot climate the hot air increased the temperature outside the building.

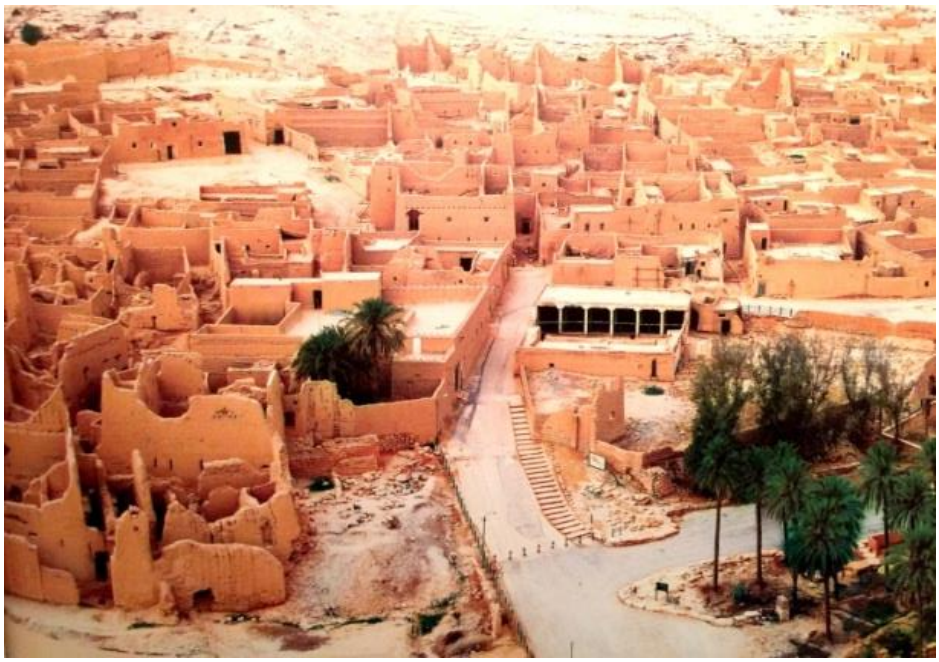

*Figure 60: Old photos of Addiriyah site, from Addiriyah brochure*

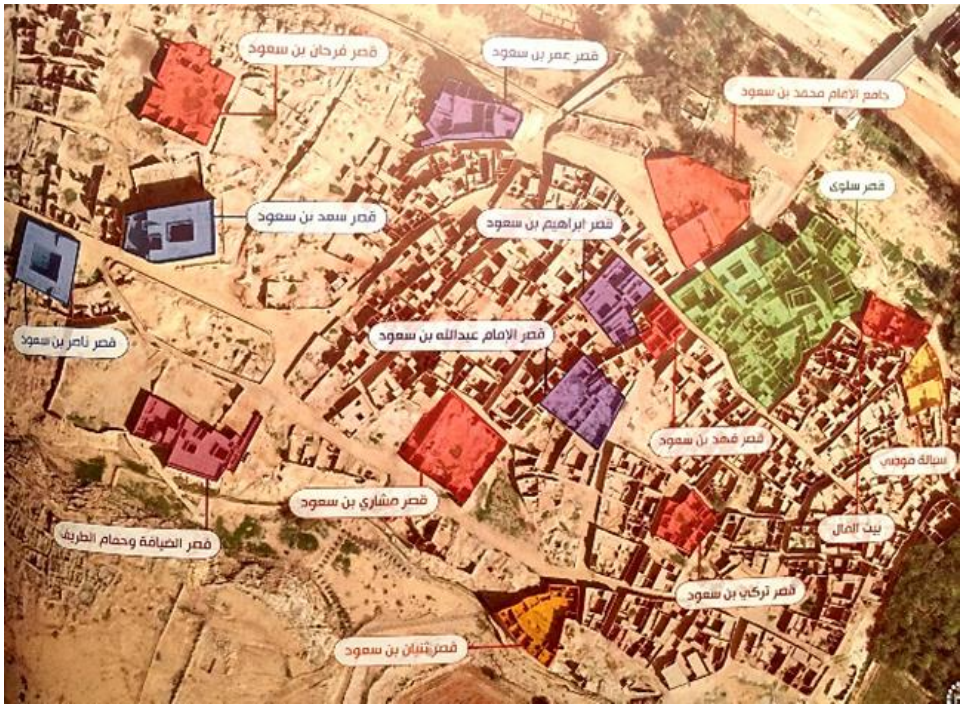


*Figure 61: Map of Addiriyah site, from Addiriyah brochure.*

Both the figure shows a map and an old photo for Addiriyah site, and another for the location site-map representing main palaces took from the authority brochures

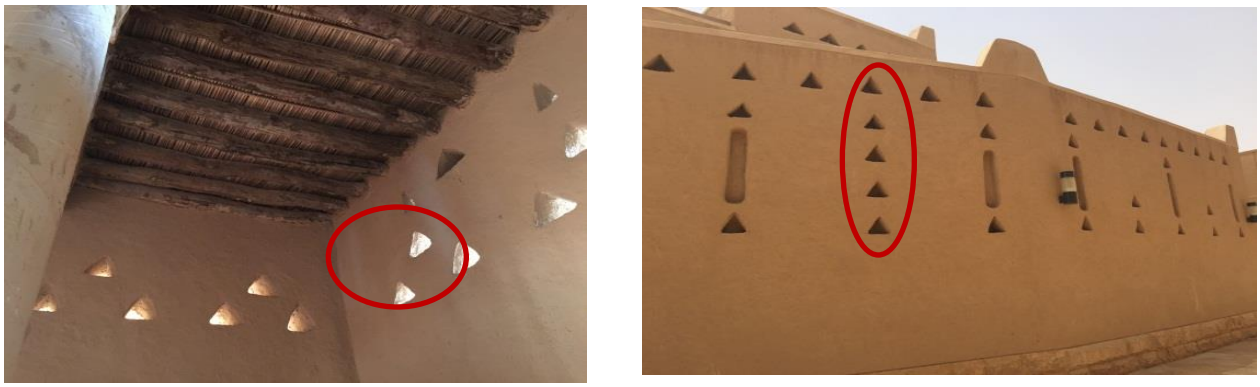

*Figure 62: A traditional architectonic feature "small openings"*

The indoor traditional space with the architectonic feature of "small openings" visible. The small openings are important for temperature regulation, as they serve the role of proper ventilation. In the traditional building architecture these provided for air circulation and ventilation that helped in thermal control inside the building.

*Figure 63: First site visit photos from January 2016, roof and courtyard*

First Site visit, when the site remained under construction and when spaces were chosen for the experiment it was on January, 2016. The courtyard on the right side is shown with the addition of a metallic sheet where the logger devices were located. As part of the refurbishing they added a metallic shed where they tried to reflect the plant motifs as a reflection of the traditional icon palm tree. The device was hanged down from the shed but it was covered with layers of cardboards to prevent heat radiation and direct heat. In the researcher's next visit in March it was found that workers removed the card boards which affected on the readings which was completely wrong to infer a PhD experiment. The loggers were also recovered later in the day from the

top to avoid extreme heat or rain, which would damage the device. Because of this, the study faced challenges during data collection. While it led to loss of some of the data it also caused damage to the devices.

*Figure 64: A courtyard with a fabric canopy.*

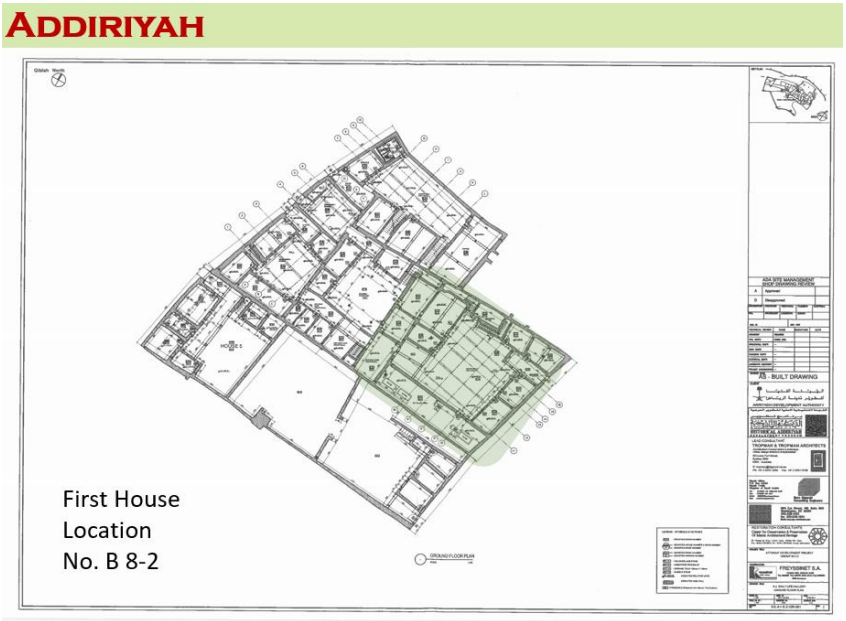


*Figure 65: Addiriyah master plan, first house location.*

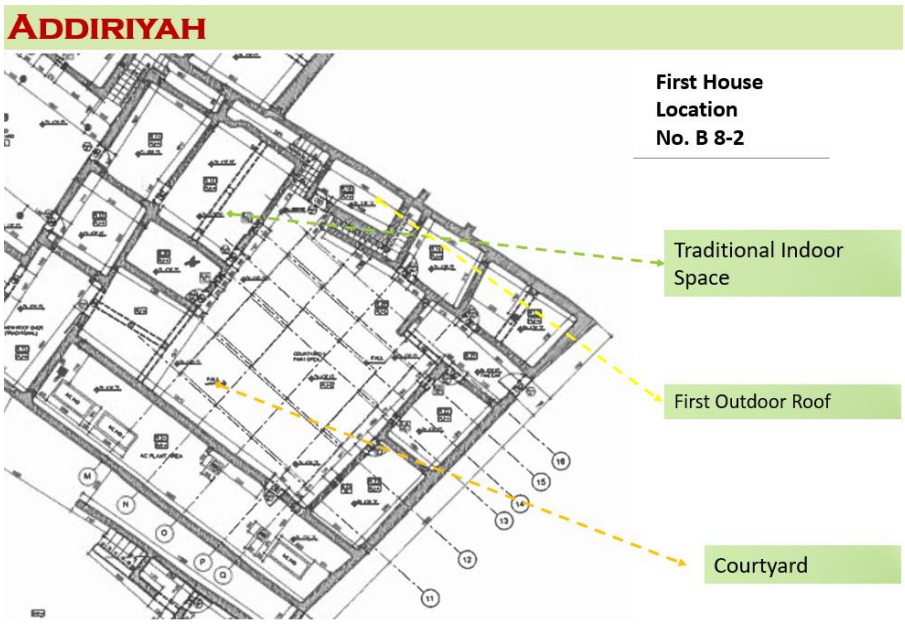


*Figure 66: Addiriyah first house location, Loggers location.*

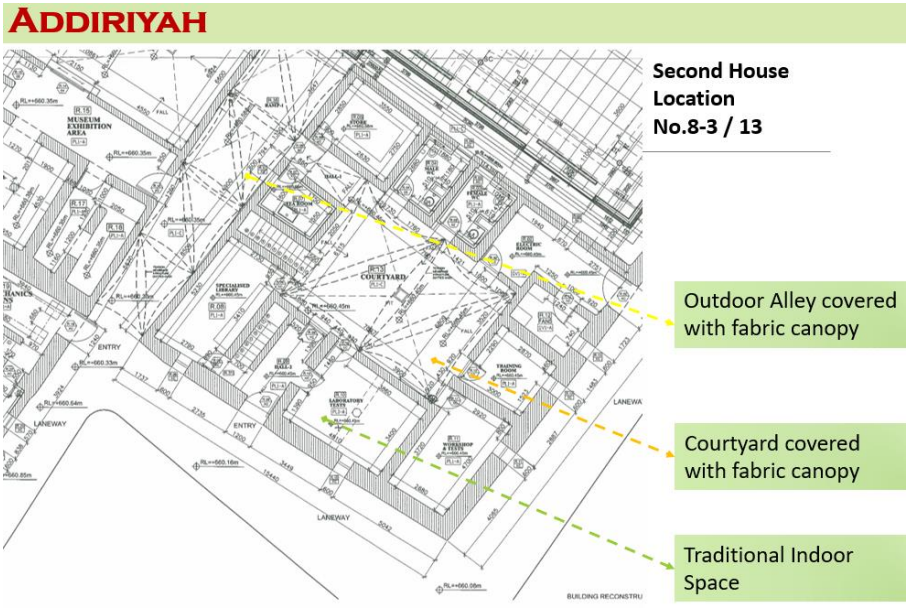


*Figure 67: Addiriyah second house location, Loggers location*


*Figure 68: Addiriyah Indoor space.*

As shown in the figure an indoor space with the development adding air-conditioning and artificial light and an indoor logger was dangled from the roof in this space. Along with the Master Plan of the chosen space for the analysis. Similar to the courtyard with a fabric canopy, such small openings also provided for air circulation. However, these formations can control the inside temperature by adequate air circulation during winter. However, during the hot summer months, infiltration of hot air can also increase the temperature. The thermal performance of such system thus varied based on the climate and weather.

#### 4.4.3.1 Traditional Typology – Indoor

*Figure 69: Addiriyah 1st Indoor space – from January till May 2016.*

*Figure 70: Addiriyah 2nd Indoor space – from July till December 2016.*

The first location (AC) was off the second (AC) was on and remain on 20 degree celisus. As can be seen from the above images, the traditional building have features like small openings, thatched roofs, and canopies. These provided for adequate thermal control.

**Temperature**

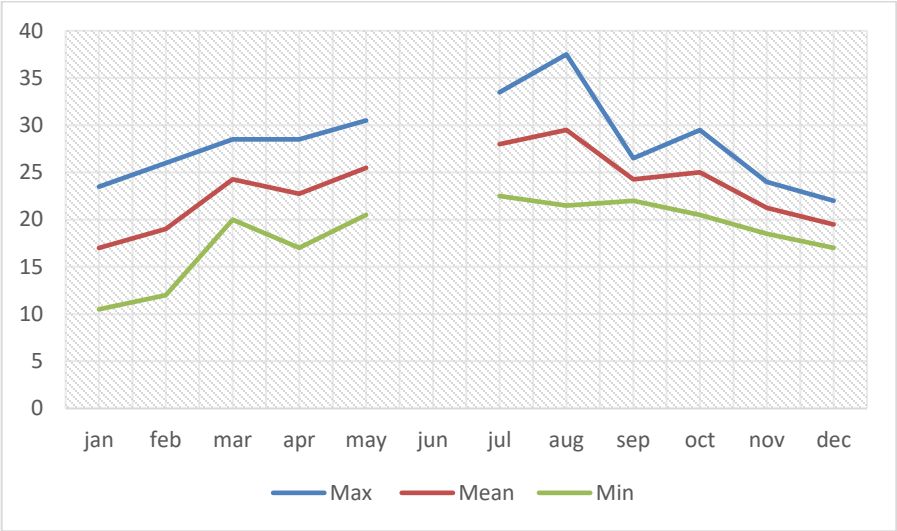


*Figure 71: Line Graph-the maximum, mean, and minimum indoor space temperature-traditional typology.*

As the chart depicts, from end of May till mid of July the data was lost and thus, no information on indoor-space temperature during that period. As evident from the above graph, the temperature started increasing during mid of July and decreased from mid of November.

**Relative Humidity**

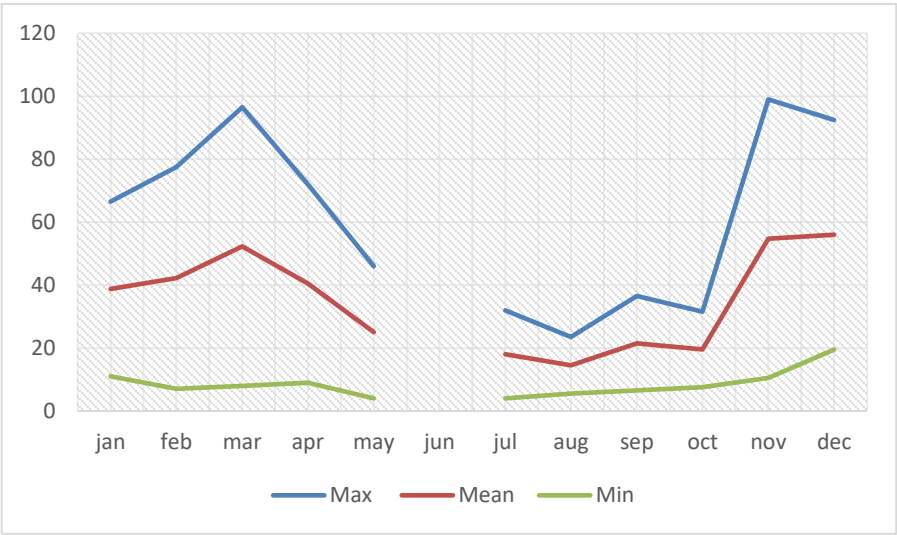


*Figure 72: Line Graph-the maximum, mean, and minimum indoor space relative humidity-traditional typology.*

The Figure above shows that the minimum relative humidity was highest in the month of December while the maximum relative humidity was highest in the month of November. The temperature dropped to zero in the month of May. From mid of May to mid of July the data was lost.

**Dew point temperature**

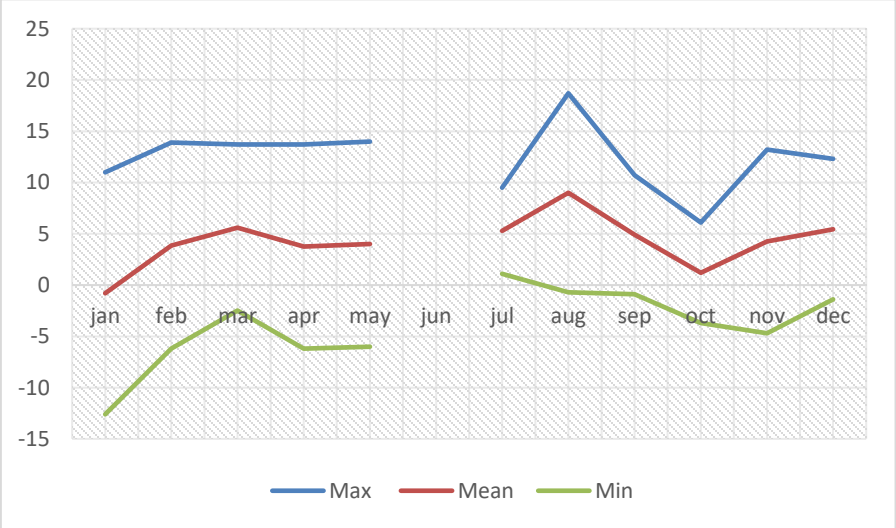


*Figure 73: Line Graph-the maximum, mean, and minimum indoor space DPT-traditional typology.*

The maximum dew point temperature (DPT) was most positive in the month of August, while the minimum (DPT) was most negative in the month of January. The temperature dropped to zero in the month of May and June due to loss of data. The indoor minimum and maximum temperature, relative humidity, and (DPT) similarly show an improvement at the end of the year when the project was completed. The outside climate and weather were the reason for variation in the (DPT) throughout the year.

The indoor temperature in the traditional building is thus, controlled by external climatic condition as well as infrastructural elements. For instance, the small openings, the courtyard, or the canopy in the roof all provided for thermal control. However, during the hot weather the temperature also increased due to hot air infiltration through the openings.

### 4.4.3.2 Traditional Typology – Architectonic Feature – Courtyard

*Figure 74: Addiriyah 1st Courtyard space – from January till February 2016 – cardboard was covering the metallic shed*

*Figure 75: Addiriyah 1st Courtyard space – from March till May 2016 – cardboard was removed by the workers*

*Figure 76: Addiriyah 2nd Courtyard space – from July till December 2016 – space is covered with fabric*

**Temperature**

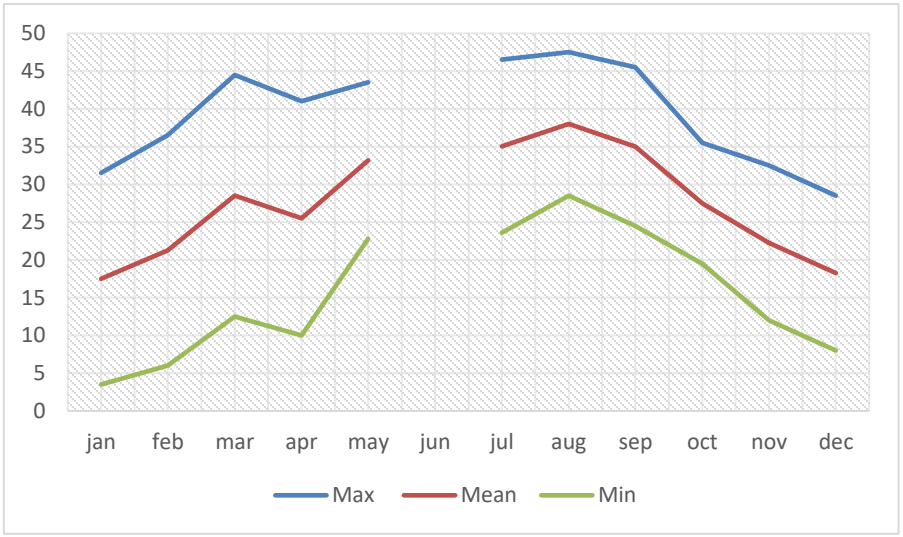


*Figure 77: Line Graph-the maximum, mean, and minimum courtyard space temperature-traditional typology.*

The traditional building has different functionalities for adequate thermal control. As depicted in the above images when the courtyard was covered with cardboard, the infiltration of the sunlight was low. But when it was removed the temperature increased due to heat and sunlight. The maximum temperature was highest in the month of August, while the minimum temperature was also highest in the same month. The

temperature was low in the month of January. Due to loss of data, from mid-May to mid-July the data could not be captured.

**Relative Humidity**

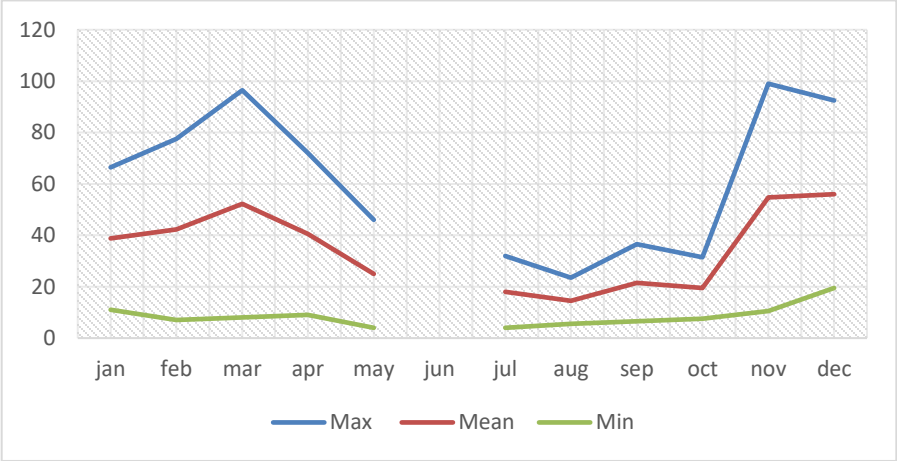


*Figure 78: Line Graph-the maximum, mean, and minimum courtyard space relative humidity-traditional typology.*

Maximum relative humidity was highest in the month of November, while the minimum temperature was in the month of May and July. Due to loss of data, the graph does not reflect the relative humidity between mid-May to mid of July. Although relative humidity depends on the pressure as well as the temperature of the system, it is also influenced by the external climatic conditions. The variation in the relative humidity thus can be attributed to the external climatic conditions.

**Dew point temperature**

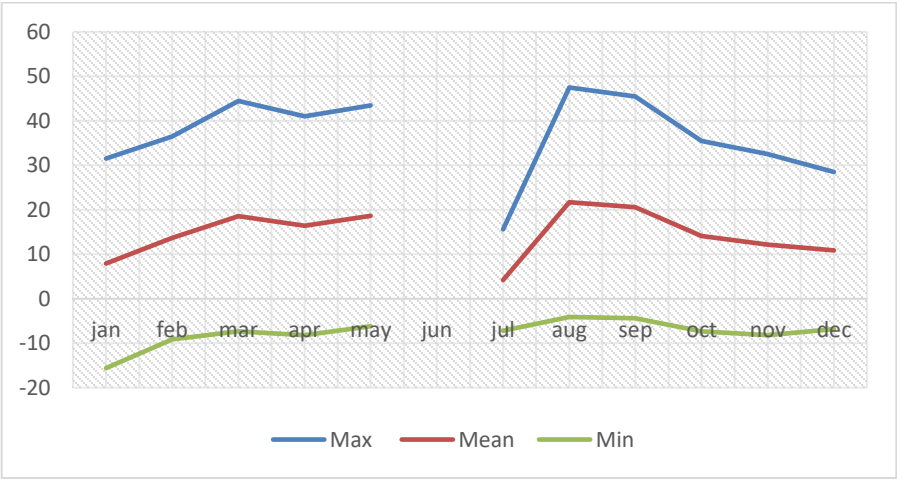


*Figure 79: Line Graph-the maximum, mean and minimum courtyard space DPT-traditional typology.*

The minimum dew point temperature was in the month of January while the maximum (DPT) was most negative in the month of August. Due to loss of data the (DPT) data for the period mid-May to mid-July could not be captured. The courtyard minimum and maximum temperatures, relative humidity and (DPT) similarly show an improvement at the end of the year when the project was completed.

#### 4.4.3.3 Traditional Site – Outdoor area

*Figure 80: Addiriyah 1st Outdoor space – from January till March 2016*

*Figure 81: Addiriyah 2nd Outdoor space – from July till December 2016 – space is covered with fabric*

The above images depict the outdoor area of the traditional buildings. As can be seen, from January till March due to cooler climatic condition, the canopies are not used. This helped in sunlight and heat to filter in the outdoor space and control the temperature. However, from July since the temperature increases the traditional buildings make use of canopies for shading purpose to protect the space from heat.

**Temperature**

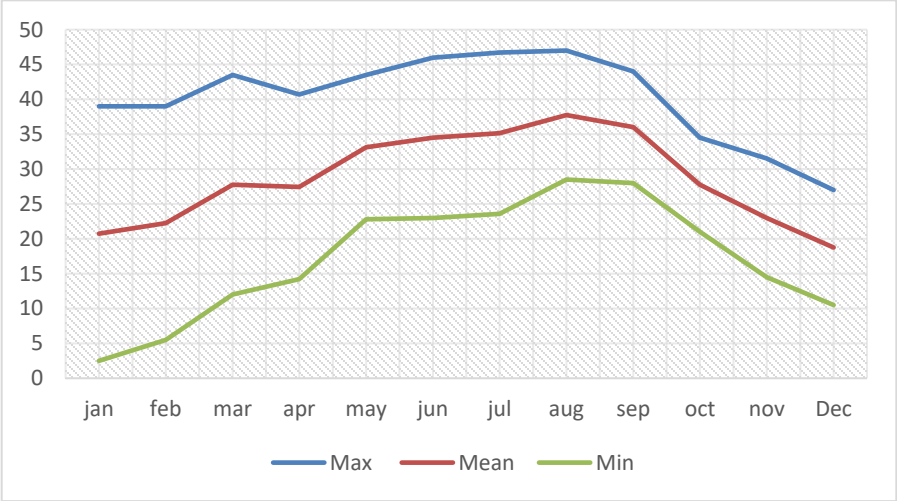


*Figure 82: Line Graph-the maximum, mean, and minimum outdoor temperature-traditional typology.*

The maximum temperature was highest in the month of August, while the minimum temperature was during January.

**Relative Humidity**

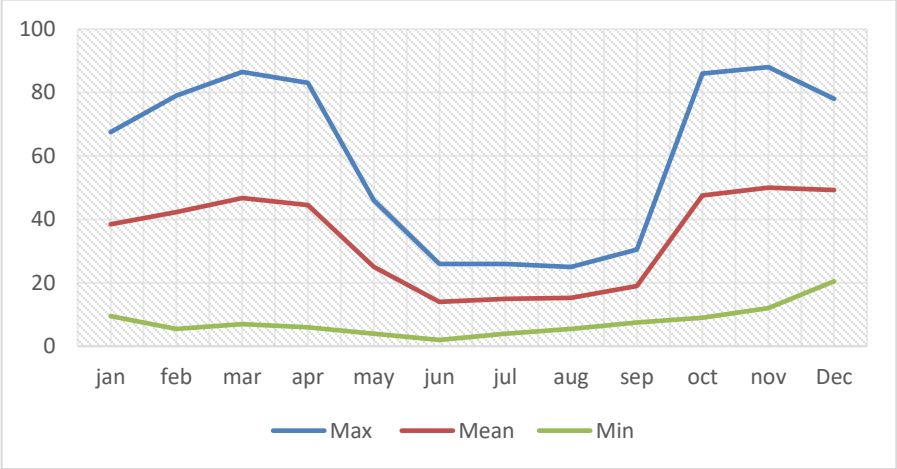


*Figure 83: Line Graph-the maximum, mean and minimum outdoor relative humidity-traditional typology*

From the figure above, the maximum relative humidity was highest in the month of November, while the minimum temperature was highest in the month of January, June and December.

**Dew point temperature**

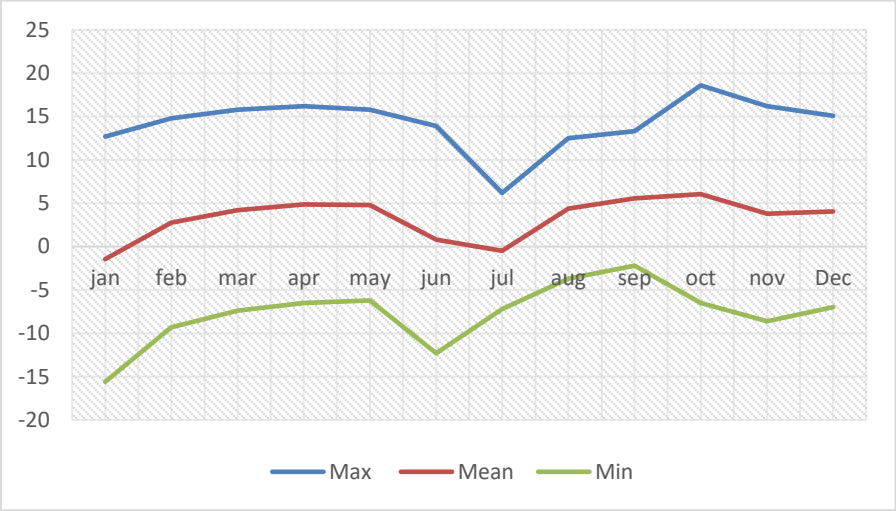


*Figure 84: Line Graph-the maximum, mean and minimum outdoor DPT-traditional typology.*

The minimum (DPT) was most positive in the month of June, while the maximum (DPT) was in the month of October.

The outdoor minimum and maximum temperature, relative humidity, and (DPT) similarly show an improvement at the end of the year, when the project was completed.

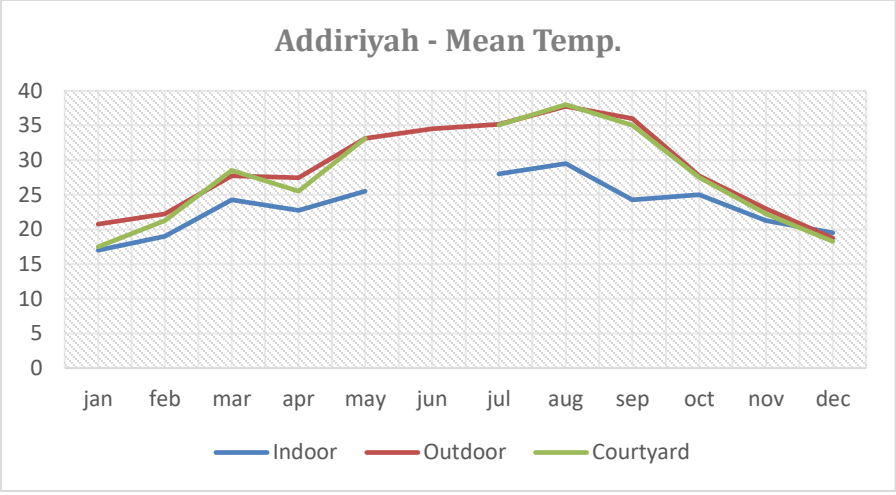


*Figure 85: Line Graph-the three spaces temp. parameters-Addiriyah mean temperature.*

Over the whole year, there is a huge difference in relative humidity, temperature, as well as dew point temperature (DPT). The extreme climatic condition of the region itself can be attributed to such variations.

Urban heat increases in cases where there is very little vegetation and can become a significant contributor of heat. In an urban landscape, the shade trees and other vegetation can create relatively cooler atmospheres which can then allow an individual to enjoy the outdoors. The efficiency of vegetation extends beyond the management of heat and to the fact that trees can act as a sunblock to the rays in walkways which can then reduce the thermal heat of the area. Finally, the presence of vegetation can also increase the quality of air.

The above-mentioned benefits of vegetation are not limited to only one small area but also extend to the wider neighbourhood area, regions and parks. Therefore, the areas which have a higher rate of trees and water bodies tend to have a cooler average of temperature. Moreover, (DPT) also has a positive effect in controlling the temperature and heat.

The selection of Addiriyah met the purpose of studying the traditional building features including indoor outdoor and courtyard. The building technology and architectonic features evidence the achievement of thermal comfort. Due to the several changes that take place between the cool air, which is dense, and the traditional space, a cooling breeze is generated which then lowers the temperature of the surrounding areas.

As has been illustrated in this study, the spaces which have shade are considerably cooler than the areas which do not have shading of any kind. This has been stipulated to be due to the prevention of direct sun exposure in shaded during high temperature months. The use of canopy and shades helped in thermal control. The courtyard system however, was found to have a dual role in the traditional building architecture. While it provided for ventilation and air circulation inside the house it also helped in thermal control. However, due to hot air circulation during the month of summer, the temperature increased within the house. Overall, the data from Addiriyah shows that a mixture of traditional and modern technology. The use of air conditioners indicates the modern features in built houses that offers the most comfortable living conditions and

the best value in terms of thermal comfort in the Middle East. In the next section analysis of Landform house also provides insight into the transitional building as well as modern architecture.

### 4.4.4 Landform House

The second site selected was a Landform house (done by a firm called Dada). The Landform house a (private villa) was built to get the BREEAM certificate (Building Research Establishment Environmental Assessment Method) a rating method for green buildings, which is similar to the LEED certificate. Both LEED and BREEAM provide the constructor and the architect guidelines about green building. I had an indoor logger device inside a modern space, another in a transitional space and outdoor area. I started in the house while it was still under construction so no one was residing there.

For the transitional space, the researcher started with a space built as a tea room with an opening in the roof. There was need to install a device custom-designed to work like the traditional-feature of a wind tower. However, a certain piece could not be found, so the roof had to be closed temporarily until the piece could be found. The space was not a transitional space typology anymore and did not provide me with the right data. So, I had to move the device to another space, a private office and a library room at the same time. The location had a traditional feature in a modern context: a court with a fountain. An indoor court and a water body at the same time similar concept of traditional architectonic feature or space, Iwan. The indoor courtyard system is one of the dominant feature of the traditional buildings. While it is aesthetically pleasing, it also can be considered as a multi-tasking space providing a number of benefits. It provides for sunlight as well as ventilation and also serves as a space for the residents' entertainment. The well-designed courtyards can stabilise the indoor temperature of the houses and provides for natural light infiltration. However, in this study it was found that during the hot summer months, due to hot air the temperature of the indoor spaces increased. In addition, Iwan has also been observed in the landform house area that provided a space for free movement from one part of the villa to the other.

#### 4.4.4.1 Landform House materials

*Figure 86: Projected outcome of the Landform house.*

The projected project outcome of the Landform house, respecting outdoor and indoor air quality, for example by using material with Low Volatile Organic Compound (VOC). VOC emission often is associated with various health issues and also damages the indoor air quality. Thus, it can be stated that low VOC emission provided for a healthy living of the residents in the landform area. Material used outdoors, such as for the façade, included stones that were locally available called "Riyadh Stone". The figure shows important green design methods such as a water feature, plants and flowers, and so on. In addition, aesthetic elements are notable, based on the floral display, fruits, aroma, and fragrance.


*Figure 87: Site visit January, 2015.*

Site visit photos from January of 2015, when the site was still under construction and spaces were selectively chosen for the experiment. Among the visible materials is "Riyadh Stone", a sustainable material used to insulate the heat inside. It is a beige limestone that is especially used in building exterior and also interior walls and floors. In addition, Riyadh stone is also used in mosaic, fountains, stairs, window sills, wall capping for design purposes. It is eco-friendly and has low VOC emission and thus, can be considered as a sustainable building material. In the image below, the house Master Plan and a selected part showing the chosen spaces for the experiment.


*Figure 88: Landform house Master Plan – showing the selected spaces.*

*Figure 89: Site visit January, 2016 – Site remain under-construction – the chosen spaces.*

Site visit photos from January of 2016, when the site was still under construction. It is observable at this stage that the glass windows were not yet installed.

*Figure 90: Site visit March, 2016.*

Site visit photos from March of 2016. At this time, the glass was installed.

*Figure 91: Site visit photos from June, 2016-collecting data.*

*Figure 92: Site visit August, 2016 – change location for the transitional typology.*

Site visit photos from August of 2016. During this period, for the transitional space, it was not possible to install the device that would work as a wind tower, so they had to shut the opening in the ceiling. For that, there was a need to change to a second space, from the tea room to the library and private office space, which has a transitional typology a traditional architectonic feature (courtyard and fountain).

*Figure 93: Site visit photos from January of 2017, where all devices collected.*


*Figure 94: Site visit collection of photos from April, 2017*

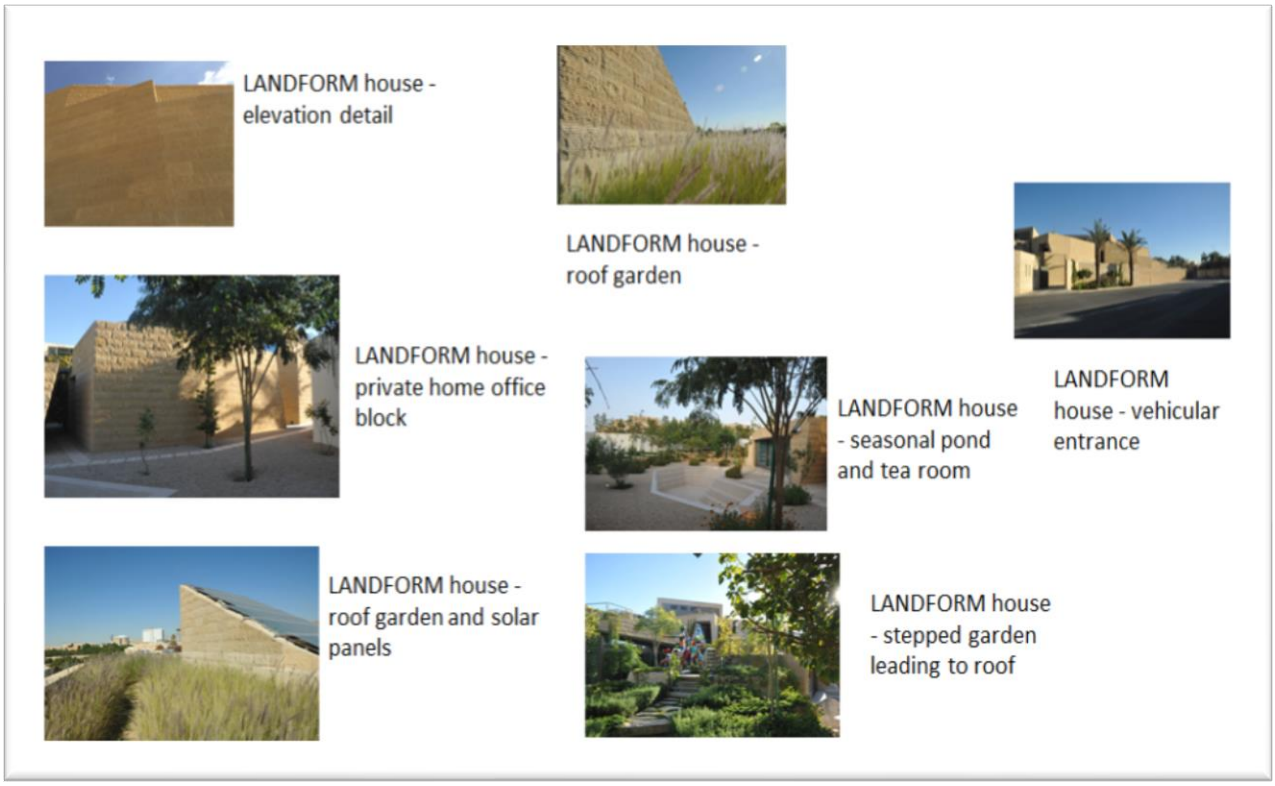


*Figure 95: Further site visit collection of photos from April, 2017*

For the Landform house, the first space was the tea room, the transitional typology with a similar concept to the wind catcher traditional feature. The second choice for the transitional typology was the private office space which had an inner court with a fountain a water body that depicted a modern way to cool the space down. This is the transitional typology with courtyard feature. The second space is the living room which had modern typology with large glass windows. The third space is the outdoor area pathway. In comparison, to Addiriyah, the architectural formations of the landform house depicted a mix of traditional and modern elements. For instance, the courtyard system was bearing the traditional features while the modern features were observed in glass windows.

#### 4.4.4.2 Modern Typology – Living room

*Figure 96: Landform House – living room, modern typology – from January till March 2016*

*Figure 97: Landform House – living room, modern typology – from April till December 2016*

Residents moved in the house in August the (AC) were installed. It can be stated that the landform buildings depict the feature of modern buildings. The structural make-up of the buildings as can be observed from the above image is similar to the modern buildings in the Middle East. The glass window provided for sunlight, however, the air circulation, as was observed in the traditional building features in the presence of courtyard, was achieved through artificial air conditioners.

**Temperature**

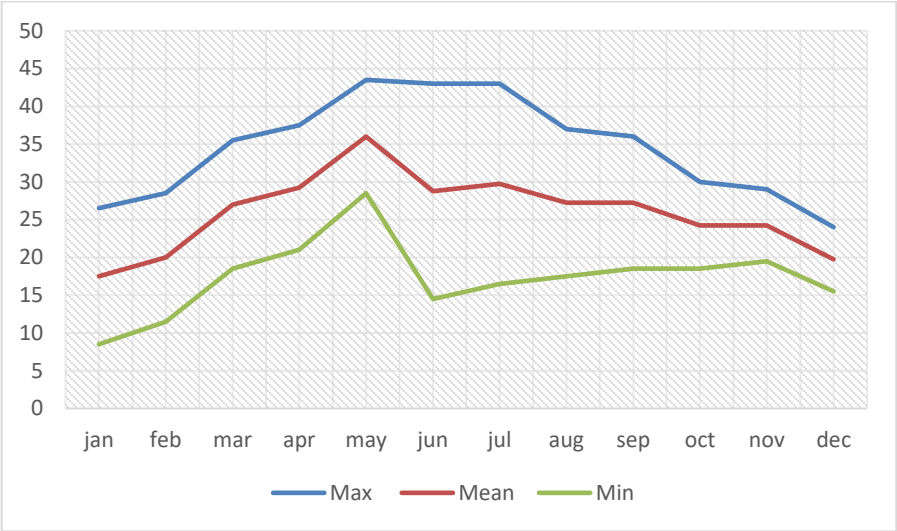


*Figure 98: Line Graph-the maximum, mean and minimum living room temperature-modern typology.*

The maximum temperature was highest in the month of May, and continued till mid of July while the minimum temperature was in the month of June.

**Relative Humidity**

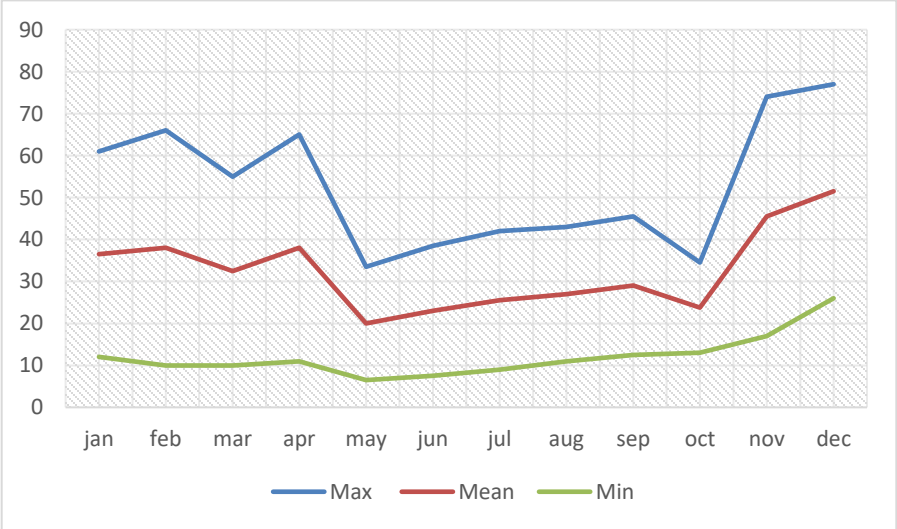


*Figure 99: Line Graph-the maximum, mean and minimum living room relative humidity-modern typology.*

The minimum relative humidity was highest in the month of December, while the maximum temperature was also highest in the same month. The minimum relative humidity was observed in the month of January.

**Dew point temperature**

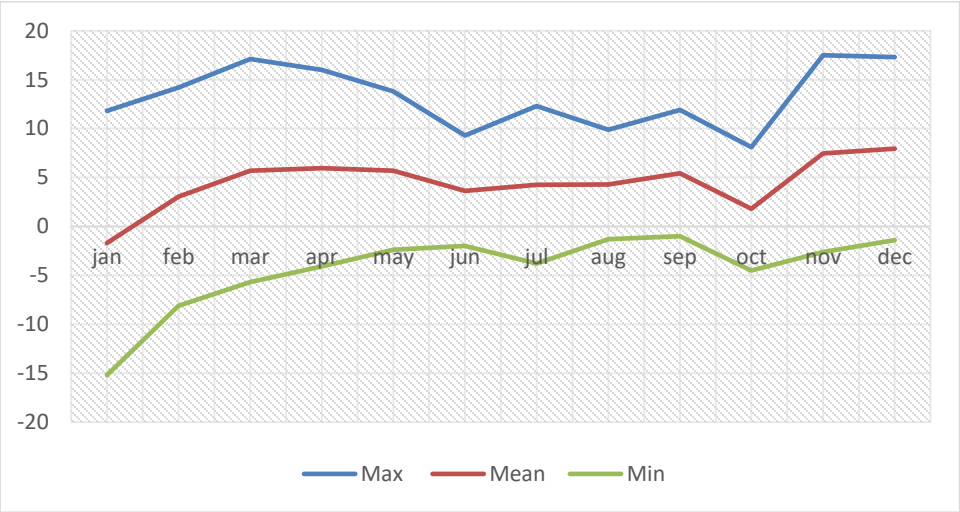


*Figure 100: Line Graph-the maximum, mean and minimum living room DPT-modern typology.*

The minimum dew point temperature (DPT) was in the month of January, while the maximum (DPT) was most positive in the months of November and December.

### 4.4.4.3 Transitional Typology – Tea room, library and private office space


*Figure 101: Landform House – 1st tea room, 2nd library and private office, transitional typologies.*

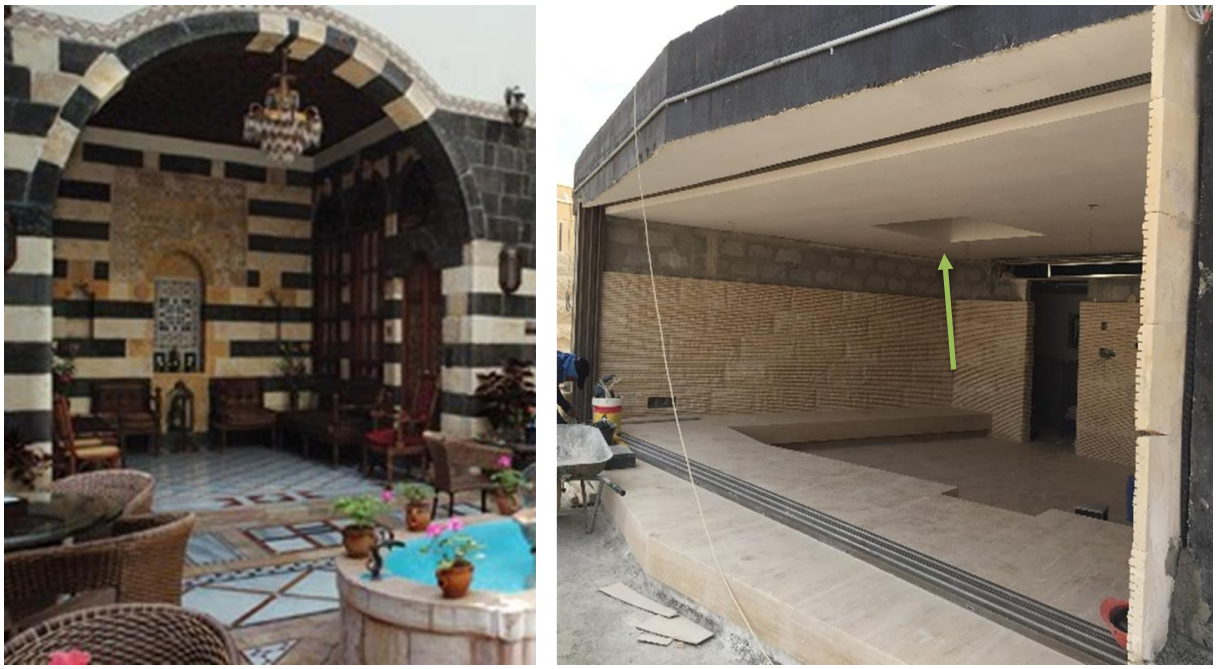

*Figure 102: Landform House – 1st tea room, transitional typology – from January till June 2016*

The space design as an interpretation to the Iwan the space from January till February was naturally ventilated from the roof and the front. By March glass window was installed but yet the roof was open, in June the roof was closed which affected the raise of the temperature.

*Figure 103: Landform House – 1st tea room, transitional typology – roof was closed / glass window.*

*Figure 104: Landform House – 2nd library & private office, transitional typology – from August till December 2016 a modern interpretation of a courtyard*

**Temperature**

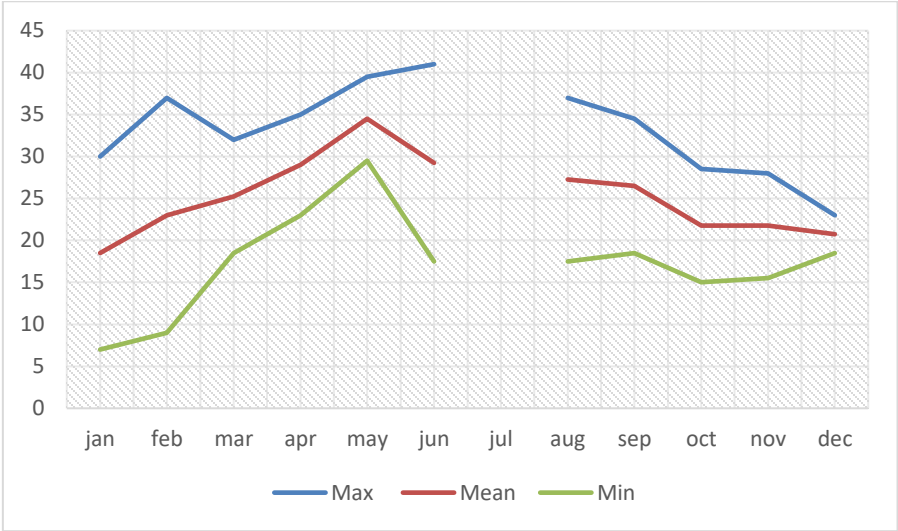


*Figure 105: Line Graph-the maximum, mean and minimum indoor spaces temperature-transitional typology.*

The maximum temperature was highest in the month of June and the minimum temperature was in the month of January. Since the device was lost, data on temperature could not be captured from mid of June till mid of August.

**Relative Humidity**

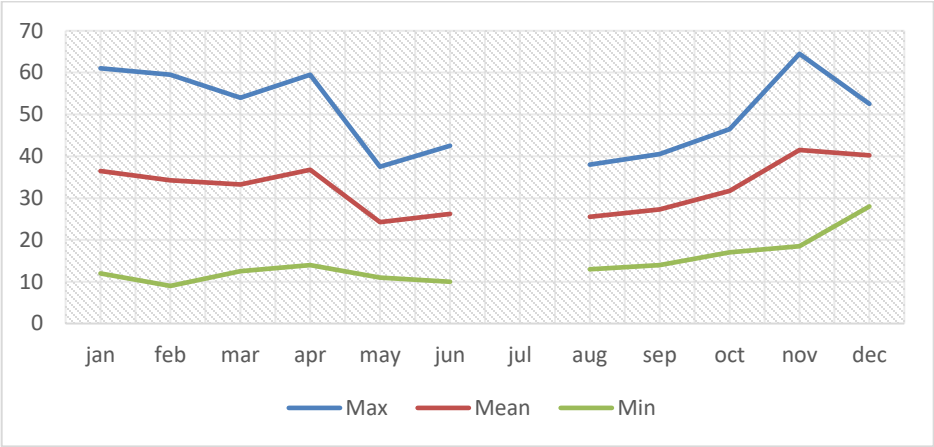


*Figure 106: Line Graph-the maximum and minimum indoor space relative humidity-transitional typology.*

The minimum relative humidity was highest in the month of December, while the maximum relative humidity was highest in the month of November. Since the device was lost, data on relative humidity could not be captured from mid of June till mid of August.

**Dew point temperature**

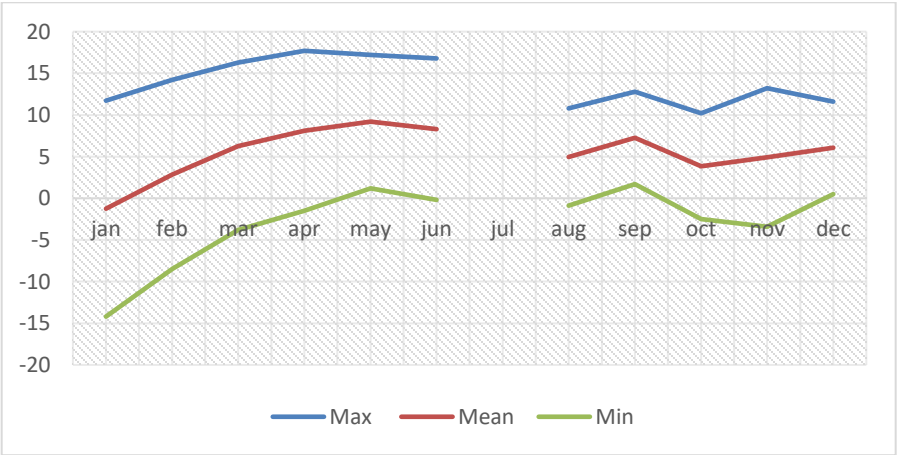


*Figure 107: Line Graph-the maximum and minimum indoor space DPT-transitional typology.*

The minimum dew point temperature (DPT) was in the month of January, while the maximum (DPT) was in the month of April. Since the device was lost, data on (DPT) could not be captured from mid of June till mid of August.

#### 4.4.4.4 Landform house – Outdoor area

*Figure 108: Landform House – outdoor area – from January till December 2016.*

**Temperature**

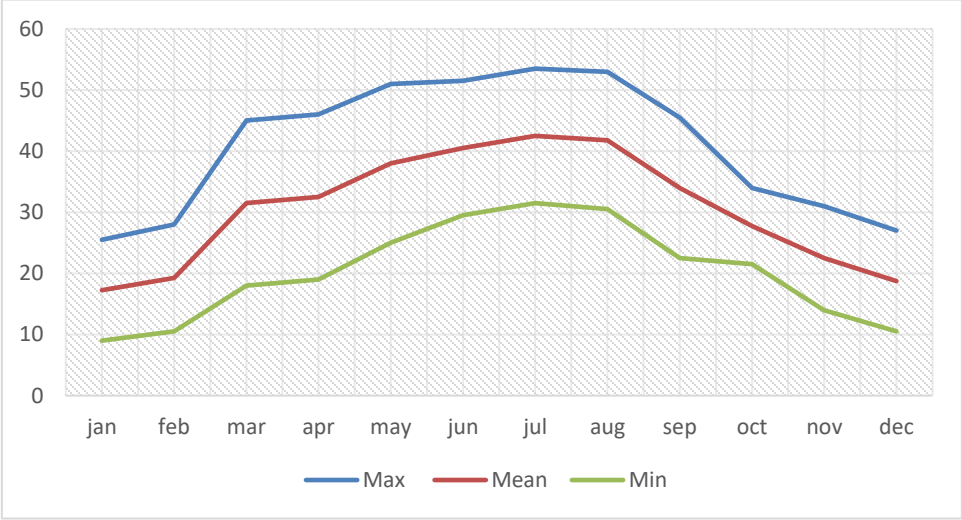


*Figure 109: Line Graph-the maximum, mean and minimum outdoor temperature.*

The maximum temperature was highest in the month of July and the minimum temperature was in the month of January.

**Relative Humidity**

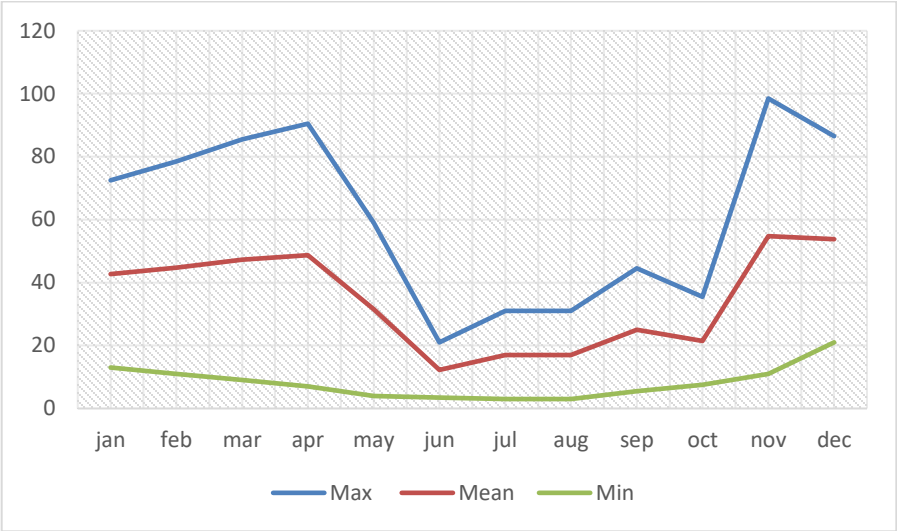


*Figure 110: Line Graph-the maximum, mean and minimum outdoor relative humidity.*

The maximum relative humidity was in the month of November while the maximum relative humidity was noted from end of June till mid of August.

**Dew point temperature**

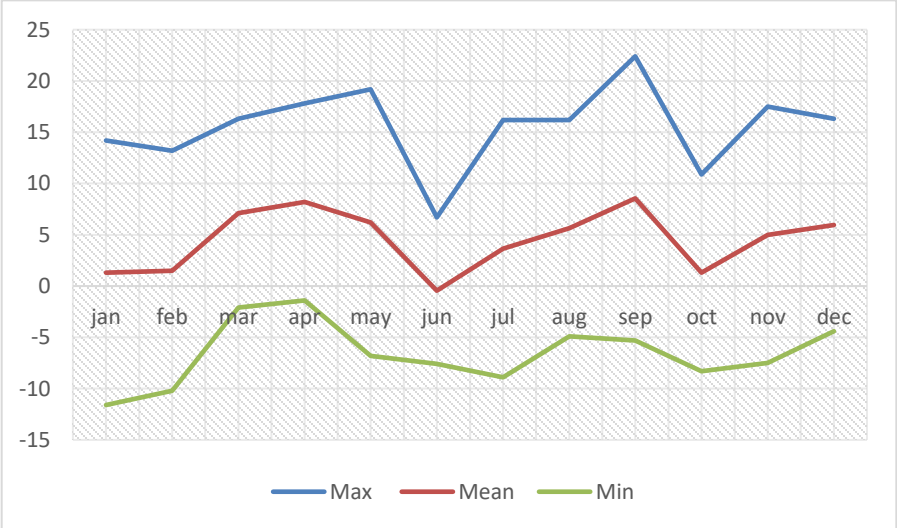


*Figure 111: Line Graph-the maximum, mean and minimum outdoor DPT.*

The minimum dew point temperature (DPT) was noted in the month of January (in negative). The (DPT) was highest in the month of September.

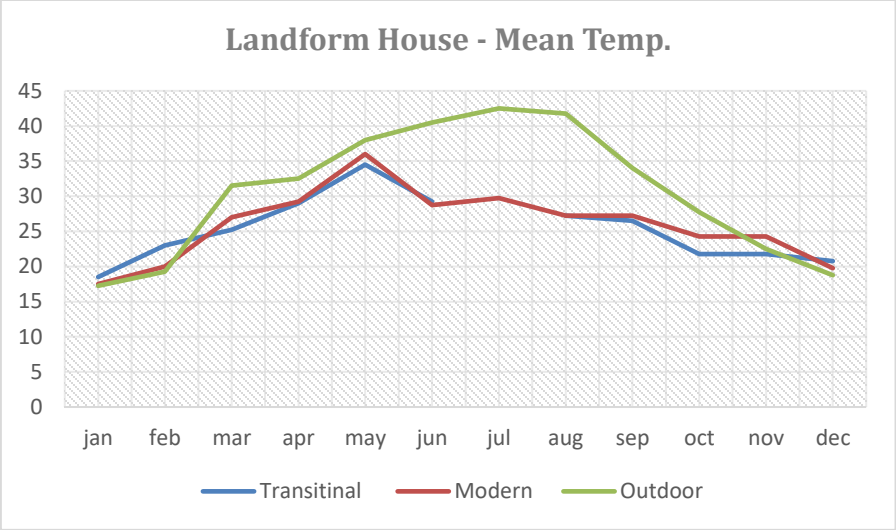


*Figure 112: Line Graph-the three spaces temp. parameters-modern, outdoor, and transitional typology.*

In comparison to the traditional building of Addiriyah, the mean temperature varies slightly in case of Landform houses. While the maximum mean temperature at Addiriyah was 37.5, in the landform houses it was 42.5. The lowest for the former 10.5, for the transitional and modern buildings of Landform houses it is 17.25.

In this section, the researcher analysed and compared the three areas together (inside, outside, and courtyard). The main aim was to show that people are in favour and comfortable with heat even if it was high and with dry weather or relative humidity, as long as the building has natural ventilation. Despite the high temperatures, the people appreciated their traditional trends. The graph lines in the figures above show that difference between inside and outside temperature was significant, and people were obliged to stay inside more or in the court. In this project, a unified strategy that is informed by traditional features design is a central element promising in the architecture of houses and cities in general.

The results showed that there was a substantial effect of shading on the overall temperature. In other words, the areas that were unshaded were on average relatively hotter than the areas that were shaded. This is true for even the most basic shading such as vines covering a wall. Because the wall is covered from direct sunlight exposure, the overall temperature of the wall is substantially cooler than in areas of lack of vine protection. The temperature varies by as much as 15 degrees Celsius.

Evapotranspiration is a process which allows the trees and vegetation to maintain cooler temperatures during high surrounding heat. This process generates relatively lower surface temperatures and hence, is responsible to ensuring that shaded areas remain cooler in comparison to the un-shaded areas. Another consideration is the wind speed which is expected to vary more on account of the vegetation. In essence, trees generally can serve as blockades to strong winds which can have an impact on the overall cooling effect of an area. Trees can block all kinds of winds whether they are cooling breezes or warmer air currents. Thus, trees need to be planted in such a way that they are adding to the air circulation and increasing the thermal comfort of the area. Since, in the modern buildings there is no courtyard, plantation or gardening becomes difficult. Thus, it is important modern architecture considers this aspect and makes provision for adequate thermal control in the modern buildings.

The use of Riyadh Stone, which is commonly used as an insulator for heat, allowed the indoor climate to maintain its thermal comfort. As the relative humidity, (DPT), and temperature of the air were measured for a year, the results strongly supported the notion that insulated areas had lower average temperatures during the day time.

This study has provided evidence which can support the strategy of importing or merging traditional features into modern architecture which will enhance the thermal comfort in the urban environment and ensure that the buildings are also benefiting from the cooling effects of the architectonic features. This is crucial as the landform houses have been found to traditional houses improved with modern houses are the most comfortable houses in which to live and perform best for maximum thermal comfort in the Middle East.

Climate change that is taking place has the most profound impact on the temperature of a space. The overall change in temperature due to global warming is supposed to increase the temperature by approximately 0.5 degrees Celsius globally by the year 2035. This is a trend towards an increasingly hotter climate across the world. This increase in temperature creates an urgency around the world to enhance the thermal comfort in indoor and outdoor atmospheres (Berry et al., 2013).

Across the world, there has been considerable amount of research that has been conducted in the context of the role of trees and other vegetation on the thermal comfort in an urban landscape. These studies have identified that the process of evapotranspiration and evaporation are the two processes which contribute substantially to reducing the thermal discomfort in a place. Furthermore, due to the greenery, the microclimate of an area is also enhanced significantly. All of this points to the fact that the planting of trees in the inner place of a building as the concept of a courtyard is crucial for the establishment of a thermally optimal living condition.

Studies such as one by Hedquist and Brazel (2014) have noted that there is a "complete vegetated portions" which represents that amount of warmth that is inactive but dispersed nonetheless. This study has depicted that the cooling effect of the trees and vegetation due to evaporation depends on the thickness of the structures as well as the degree of greenery in the urban landscape. The below section once again highlights the traditional features of the buildings at Al Madinah.

### 4.4.5 Al Madinah

Data from Al-Madinah City was also collected, and the researcher wanted to use a traditional house there to confirm that with different climate, traditional features are the most comfortable to live in and are the best in terms of thermal comfort in the Middle East. Middle Eastern space designers have long faced the challenge of managing microclimate issues for houses (e.g., Al Madinah City is one of those areas in the Saudi Arabia that has designers working tirelessly to find the most appropriate solution for this problem). Outdoor and indoor thermal comfort can best be achieved through utilization of evaporative cooling (i.e., a mist system), as proven in Al Madinah study case.

The assessment of thermal comfort was conducted on different spaces**.** Each space tested a different density: high, medium, and low showed a need to extend possible use of outdoor space in non-peak summer conditions, which supported the need to simulate the high-density area. An analysis of Medina city shows how thermal comfort is achieved in traditional architectural design.

This location was visited twice only the city but the house owners of the selected house were conservative. Thus, accessibility was restricted and it was difficult to make sure if the devices installed or hanged correctly. Therefore, the researcher had little control over the site.

Al Madinah also depicts the temperature of a desert climate. While the summers are very hot the temperature drops sharply at night. Al Medinah is located on in the west of Saudi Arabia, 600 m above sea level. It shares same altitude as Riyadh. The only difference arrives in winter, when the temperature is colder than in the capital. In January, the temperature conditions rise up to 18°C. It can even get colder during the night. In Riyadh, temperatures in winter rise between 20–30°C. Both Riyadh and Medina have a similar weather condition in summer, mostly hot and sunny. Therefore, the traditional building features require to be incorporated to provide the residents with thermal comfort.

*Figure 113: Traditional building in the Al Madinah city*

The results revealed that at Al Madinah the only appropriate solutions would be to adopt both natural and night ventilation mixed-mode systems for Madinah.

From the collected data, an in-depth knowledge was gained on how both traditional and modern houses achieve thermal comfort in Saudi Arabia. In one of the sites, the researcher chose to commence the project while it remained under construction, before even installation of the windows. As such, a large variation in readings occurred during the glass installation process. This situation led to loss of loggers in this particular site, which eventually caused much damage. This damage was largely attributed to the presence of workers moving in and out the site. In a bid to cut data losses, we shifted to another already-completed space after some careful deliberations with the relevant

authorities. Inside the new space, they decided to install air-conditioner to stabilize temperatures. The outside and the courtyard were covered with a fabric.

In the traditional site, the designer mainly tried to and compare three key areas all in one. The main objective of this experiment was to prove that people will still live in a house characterized by high heat intensity, dry weather, and relative humidity just for the sake of following western trends. The findings showed that the landform house must be accompanied by some naturally ventilated air conditioning. It has been found that many people appreciate traditional trends in spite of high temperatures but not live in. The court here is an important area of study. The designer intends to make separate analyses of both indoor and outdoor spaces.

Space was one of our key areas of research in the transitional space in Landform house. The study found it relevant to begin with space, as it was built as a tea room with an opening in the roof. This space was very important as the architects and the constructors intended to use it to install the device fitting the traditional wind-tower feature. However, inability to locate the required materials necessitated the designer to close the roof for a time, awaiting the availability of the needed materials. This decision led to rising temperatures a move that forced the architects and the constructors to further relocate the device to another room. A decision was made to settle on an office and library room which contained a traditional feature which is courtyard with a fountain located between traditional and modern transitional architectural styles.

This project ran for a whole year, with its main focus being maximum and minimum points of measurement (temperature, (DPT), and relative humidity). This focus was important in helping the study or the research ascertain annual temperature differences. The findings show that the designer had to make a decision on whether the technology is good or bad in the management of temperature. It helped in understanding traditional design concepts in temperature control. In addition, Madinah also helped in understanding the traditional architectural forms. However, after conducting the study it was understood that transitional is the best to combine best of traditional with the touch of the future. While it can provide for adequate thermal control and comfort to the residents, it also helped in maintaining a healthy indoor

environment by using sustainable building material. In addition, transitional forms also are able to meet the needs and requirements of the residents.

## 4.5 Implication of the Findings

The concept of sustainable architecture is an integration of concepts such as sustainable development, sustainability, and sustainable architecture. The examination of the concept of sustainable architecture is the first step in examining Saudi Arabia's socio-economic, cultural and design association with the housing design. Furthermore, it is also important to understand the need of shelter and comfort that human beings have in order to enhance the understanding of architecture. Thus, as noted by Al-Hassan and Dudek (2008), architecture has resulted from the need to develop sustainable, stable, and comfortable shelter for humans. Therefore, it can be said that this is one of the reasons why humans have consistently sought more and better ways to build their architecture to satisfy the socio-cultural needs.

The above phenomenon has given rise to the process of architectural development that has come to signify the civilization. Al-Hathloul & Mughal (2004) have stated that architecture is a way in which human beings appreciate the natural world and resources around them and use them to develop better and more robust shelters. Therefore, it can be said that the very tenets that define architectural design and form is the human capacity to conceptualize, coordinate and execute the development of unique forms. Furthermore, the designs and architectural forms are crucial elements which represent the cultural, social, technological, economic, and scientific aspects of the society. Thus, from the above, it can be said that there is a relationship between the environment and the human lives (Al-Hassan and Dudek, 2008).

In architecture development and technology, the notion of sustainability has created concerns about the energy and environment. According to Taleb and Sharples (2013), health issues of the residents have emerged as one of the core factors that drive sustainability initiatives to the ecological and health effects. For this reason, it is important to consider the concept of responsive development and design. This kind of practice is the cornerstone of developing housing that is energy efficient and does not

cause any harm to the environment or the ecology. For example, the location of the window in a home affects the indoor climate, ventilation, comfort and discomfort.

Considering the notion of historical development and the advent of sustainability, it needs to be outlined that human beings have been in a consistent effort to make an effort for the fauna and flora. In line with this, human beings have outlined and carried out several efforts that change the landscape such as agriculture, mining, forestry, and urbanization. However, even though these changes are beneficial for human beings, they have proven to be quite detrimental to the local fauna and microorganisms that stay in these areas. However, human beings, with the increasing technological advancements and with more area that is affected by them, have found a way to ensure that the local organisms are supported in addition to humans. The core aspect of several functions is to ensure that the natural resources are used but the natural environment is not affected.

Sharifi and Behnoud (2013) have noted that the crises that have been due to environmental causes have enhanced the adoption of the principles of sustainable development. In architectural fields, sustainability has come to mean the need to create long-lasting structures than are appropriate in the given environment as well as the population around it in order to further the socio-economic, political, and cultural developments of the society. In accordance to this, the association between the various aspects of architecture as well as a grasp on its impact on the environment through design and influences is crucial. Finally, in order to ensure that humanity’s welfare is maximized in a long-lasting manner to ensure survival, sustainable development is crucial.

## 4.6 Conclusion

The chapter provided detailed insight into the findings of the research. It analysed qualitative as well as quantitative data and analysed the data from the data loggers. After careful analysis, it has been observed that a transitional building typology is best suited in the Middle East region. While it provides for adequate thermal control by using traditional features of courtyard, mashrabiyah, iwan, and canopies, it also meets the changing needs of the residents in the region. In addition, it also makes use of

traditional sustainable materials that promotes healthy living due to low emission of VOCs. The obtained from Addiriyah, Al Madinah, and Landform Houses are compared and reveals some significant outcomes. Following the discussion in this chapter, the next chapter sheds light on the recommendations and future directions for research.

# CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

## 5.1 Conclusion

The study was based in Saudi Arabia. The research problem encompassed the fact that population growth in the Middle East continues to increase at high rates, raising demand for housing to cater to the rapidly increasing population. Some common challenges include the various impediments facing both local architects and builders, which have made it difficult to cater to the rising demand for buildings. The decline in traditional architecture can be blamed on shortages in local engineers, causing a huge decline in traditional architectural construction in the Arab regions (Eldemery, 2009; Abel, 2000). The need for traditional and sustainable architectonic buildings in the Middle East remains a drive of this study. Innovation and technological adaptation are important in meeting current building demands for the region.

The study investigated the Middle East's traditional and modern building techniques where the climate is mostly considered as hot and dry (tropical desert). Saudi Arabia served as the location of this study due to its rich history in traditional architecture and the infiltration of Western architecture in recent years. Historically, Saudi Arabia has been recognized as a rich and traditionally inclined country, given the many Arabian architectural designs surrounding most of its buildings. The need to offering a comfortable environment offering reprieve from the harsh climatic conditions influenced most of these traditional architectural designs in the entire Middle East. High solar radiation, dusty winds, high relative humidity, and extreme temperatures are some of the main factors that influenced the design and construction of most of these buildings. The need to modify and adapt to surrounding environmental factors drove the architectural design of most of these buildings.

Passively designed buildings provide thermal control while at the same time reducing the energy consumption of the entire building. Thermal comfort in this building is achieved through transfer of heat from outdoor to indoor spaces through a process designed to take place through buildings' external walls. During the high-temperature season, buildings in such areas are mostly fitted with air-conditioning systems to

provide cool conditions. Energy consumption brought about by use of electricity may account for up to 50–60% for most residential buildings. This level of energy consumption may not be sustainable any longer, considering the high urbanization rate being witnessed in most cities. Burning of fuel to run generators is now also becoming a substantive worry due to greenhouse effect brought on by CO2 gas emission.

The architectural design of buildings varies from region to region, depending on the climatic conditions present in a region. In Middle East, the area is largely considered hot and humid, with few variations. The weather conditions of a particular region, which may range from temperature, relative humidity, precipitation, sunshine, cloudiness, and winds, generally define the climatic conditions of that particular region. It may take several years and daily measurement to record the climatic conditions of a particular region. The connection between building exterior and interior can basically be referred to as the design facade. Building location and climate condition are the two critical factors that need to be considered if one is to realize high-performance facades. It also helps in providing sustainable and comfortable spaces in buildings as well as reducing entire buildings' energy consumption rates. The design of a building must always be done in strict conformity with geographical and climatic conditions. This need to respond to local conditions explains why the design of buildings varies from a region to region, depending on the climatic and geographical conditions. A sustainable building must also consider the framework of green buildings as well as the LEED or BREAM framework that promotes healthy indoor atmosphere, reduced VOC emission, and also improves air quality. Therefore, before construction of a building the architects or the constructionists must follow the hybrid building structure and combine both the traditional and modern building features to effectively control temperature, provide the dwellers with comfort, and also increase environmental sustainability.

Rapid population increase in cities is causing major problems, and many cities in the Middle East have been forced to struggle increasing energy costs and CO2 gas emissions, causing global warming as a result of fossil fuel burning to produce supply of electricity in the cities. The design of buildings in hot and humid climatic conditions regions has proven one of the most difficult tasks. This problem has largely been

attributed to high relative humidity and daytime temperatures, leading to high indoor air temperatures, beyond normal thermal levels. Most researchers believe that natural air ventilation plays a vital role in controlling indoor air temperature, reducing energy consumption and improving thermal comfort levels. The rising of high residential building with large glazed area has presented a different new challenge. The current study addresses this problem through careful evaluation of dynamic behaviours in various room orientations. Different ventilation strategies were applied to different glazed residential areas. This is necessary for the selection of minimally dependent mechanical structures as well as for enhancing indoor thermal comfort.

During the summer, the outdoor environment sometimes proves too unbearable; due to heat stress, it is important to come up with best possible solution to solve such problems. Human thermal comfort is affected by two main factors: environmental factors such as air temperature, relative humidity, air movement, and radiant temperature, and personal factors, including clothing, insulation ratio, and human body activity or metabolic heat rate. These factors play a critical role in the design of any microclimate environment. Buildings were designed to offer most comfortable surroundings to their occupants. Traditional architectural building design in the Middle East addresses the extreme environmental conditions of the region. The creation of internal environment adaptive features was driven by regions' actual environmental conditions. The use of palm tree leaves and courtyards was mostly practised in the coastal regions or in areas surrounding oases. Tents were mostly preferred among the Bedouins as homes and shelter structures. The assumptions were mainly based on primary and secondary study findings which tried to address the research questions.

## 5.2 Research Question 1 : To what extent does traditional architecture with modern adaptation adjust occupants' psychological comfort and wellbeing?

The results indicate that modern architecture intertwined with traditional aspects presents a useful physical adaptation with a positive impact on psychological wellbeing; for example, usage of building materials such as the "Riyadh Stone" were also helped in establishing an area which promises thermal comfort and is aesthetically pleasing inside and outside.

The survey findings show that traditional and modern techniques are a current architectural trend. Architectures that chose to use one of the traditional features techniques are encouraged to do so for sustainability purposes. A mixture of both modern and traditional techniques good since both are a necessity and pose numerous benefits such as the effect on quality of life. Similarly, the interview analysis presents numerous advantages from combining traditional architecture with modern adaptation, resulting in adjustments to the occupants' psychological comfort and wellbeing. These adjustments include breezes, indoor lightening (natural light), an appropriate plumbing and water heating system, more natural light with large windows, views into the outside environment, thermal insulation in the building envelope (walls and roof), masonry for the external walls, and minimizing the empty or solid proportion of the external walls.

Since the development of architecture, the aim of the shelter has been to provide a safe and thermally comfortable environment for human beings since humans cannot regulate their body temperature (Eldemery, 2009; Abel, 2000). However, in response to temperature changes, the human body does experience some changes such as shivering or sweating in response to cold or heat, small shifts in the temperature of the body, and skin vascular changes. In addition, the analysis of the logger's data can be seen to provide evidence that the modern architecture and one of the ways of enhancing the thermal comfort in a home using vegetation and trees. Increased urban heat is driven by the lack of trees and vegetation which anchors that fact that vegetation is crucial for the development of an optimal thermal environment.

The presence of trees and vegetation also helps in cooling outdoor recreational areas such as swimming pools and walking paths. This study has found that there will be a reduced heat generation in areas surrounded by trees and vegetation. The presence of trees and vegetation can lead to better air quality as well as more ventilation. The results have found that the overall average temperature is less for shaded regions in comparison to the non-shaded regions.

The overall urban atmosphere in shaded areas by trees and vegetation was considerably cooler than in un-shaded areas especially in buildings with glass ceilings

as the shade prevented direct sun exposure thereby reducing the overall heat. Therefore, planting trees in the inner space of the building or in the courtyard in a strategic manner was one of the core aspects of the ensuring that there is a cool thermal climate. The planting of trees needs to be strategic in such a way which prevents direct sunlight from hitting the surfaces of the built environment. According to Morakinyo, Balogun, and Adegun (2013), the simplest form of shading can also enhance the cooling effect in the surrounding areas. The simple shading can be as simple as vines on a wall or as a courtyard garden. For instance, in case of Addiriyah, the traditional buildings of the region used canopies for shading purposes. In some houses small openings were also found that provided for adequate ventilation and air circulation. Such features are helpful in maintaining the indoor temperature and provide the dwellers with thermal comfort. Since these types of simple shades keep the sunlight away from the wall or surface, the cooling effect is significantly enhanced.

The process that has been identified which enhances the cooling effect due to vegetation and trees is the evapotranspiration and evaporation. Areas that have more shading in peak temperatures are more thermally comfortable than areas which don't. While closed trees can reduce the air circulation by blocking air, a strategic spaced out setting can lead to an increased ventilation and higher air quality by generation of cooling breezes that can extend over larger areas**.** Courtyards also has the similar function of improving the ventilation and air circulation. Overall, for the first research question, the findings are that the adoption of modern architectural design for the improvement of the traditional architecture can enhance the comfort and well-being of the people.

## 5.3 Research Question 2 : As design parameters relevant to building design in the study location in the Arabic region, does a hot, arid climate influence occupants' wellbeing?

Temperature is vital both to comfort for humans and can be controlled by the design of an area. Temperature is affected by the design of the buildings to sustain aspects like solar radiation and wind speed. It has been understood that the variables such as wind speed and solar radiation can be manipulated and regulated by the design of the

site, to some extent. Thus, the design is a crucial element and serves as an essential regulator of thermal comfort in open spaces.

From the interview analysis, it was found that, it is crucial to have air circulation and cross ventilation. This circulation can be achieved by integrating architectonic features and the adoption of technology. To achieve both outdoor and indoor thermal comfort, it is essential to use thermal control, as per local codes, and to design sustainable HVAC systems, solar orientations, evaporative cooling systems, thermal insulations, cantilevers, shading elements, improved district planning, improved thermal insulation of the external walls, minimal direct sunlight through the use of shading devices such as louvers, and improved insulation for walls and ceiling.

From the survey and data logger analysis, the success of the indoor and outdoor space is impacted by many factors. Abdullahi (2013) has noted that the physical environment, the position of the spaces and the social environment can have significant impact. In addition, this study is only considering the impact of one design Parameter which is temperature on the wellbeing of the general population. The thermal environment of a place is considered to be the environment which can determine the thermal discomfort or comfort for the human beings. This comfort or discomfort is created due to the temperature changes between the human body and the outside environment.

Thus, the thermal environment can be said to consist of the following aspects: temperature, relative humidity in the air, heat, velocity of the wind, and sunlight exposure. Furthermore, the activity of the individual also plays a role in enhancing the thermal comfort of the individual due to the contributions of the metabolic heat which is a natural process in the human body. In conclusion, regardless of other factors, thermal comfort in the Arab region is primarily dependent on the design of the space. For instance, if the design adopts a transitory architectonic feature combining the traditional elements of courtyard, canopies, and mashrabiyah with the modern features then the temperature of the indoor spaces will be controlled. In this study, such transitory formats were found in Landform houses.

## 5.4 Research Question 3 : What design approaches can be used to improve thermal conditions in building architecture to increase occupants' thermal comfort?

Survey respondents stressed the importance of collaboration between traditional features and sustainable modern designs. Sustainability and green design models are vital in the consideration of standard approaches to environmental conditions. Modernity architecture offers sustainable architecture and adopts green designs, which has attracted many studies in the past (Abdullahi, 2013; Mohamed, 2000). The primary motive for the increase studies is a desire to create a thorough an assessment in which assessment is carried out of the building's performance.

Many academic scholars have tried to develop and understanding of the current trend towards sustainable building. Past studies such as those by Carmona (2010) and Mahgoub (2004) have noted the importance of sustainability in the energy performance and green initiatives which are altogether responsible for establishing the efficiency of the materials, buildings and the overall thermal performance which are considered essential tenets of sustainable and green design. In accordance, using performance assessments, the sustainable performance indicators also need to be considered. Furthermore, there is a need to consider the other factors which can enhance the sustainability and reduce the energy expenditure as well as the negative impacts on the environment.

Moreover, the use of green building standards and techniques has influenced the energy distribution in buildings. Modern technology has, therefore, allowed the development of an integrated connection between the efficiency of the design as well as the energy usage to allow less energy to be consumed and more attention be given to renewable sources of energy in terms of electricity, cooling, and heating. One of the primary criteria is the management of renewable energy in the examination of the sustainable design. The cultural and socio-political as well as the economic conditions need to be considered for the development of sustainable structures. Tradition and modernity need to blend together in order to ensure that there is a strong balance between the various constituents that have an influence on sustainable development of the built environment. In essence, a building should have the essential characteristics of the

economic, cultural, and social aspects. As noted by Al-Jamea (2014), if it is ecologically plausible, then the process of sustainable development can be considered to be integrative and providing a holistic quality of life.

There are several characteristics of sustainable settlements that range from the spatial arrangement to the environmental conditions as well as the values, geographical location, and the institutional ability. Thus, when considering sustainable development, the major concern of the housing is to think of the person and the houses as a collective whole representing the environment. In this respect, housing development is not meant for only the primal urges of the individual but also a deeper, more fulfilling aspect of meeting and improving the external and internal conditions of the environment. The needs of the environment can change overtime and this causes a paradigm shift in the population of the environment and hence, the environment needs to have adaptive characteristics. In essence, what this means is that the architecture must consistently meet the needs of its population. In addition, as for the usage of the house, the user of the space can be expected to behave in a manner which is sustainable, and which incorporates the social elements into the augmenting the liveability of the space and promotes the sense of security.

As noted by Burd (2008), the social and cultural sustainability considerations have found a lot of common ground so much so that there is often a great difficulty in trying to separate the two. However, even if there are many similarities, the distinction of the two is crucial. The social aspect is often relatively intangible and includes social cohesion, equity, inclusion, conflict and equality. In contrast, the cultural dimensions can include aspects such as traditional practices and art. In essence, the cultural dimensions are often tangible in nature. The use of “Riyadh Stone” was one of the primary cultural aspects that was undertaken in this study and the aspect of modernity was intermingled in the cultural and social aspect. From the perspective of the sustainable design of the house, the stone functions as the primary aspect of cultural and social preservation. These two concepts have been considered and are substantial elements which impact the environment and the notion of sustainability. The difference between the social and the cultural needs to be considered.

This variation is depended on the nature of the given society that is under consideration and is the major aspect which serves as the integrator of the primary components. Thus, there is a need to appease the cultural aspect and make sure that the solutions implemented for the housing designs are sustainable. Previous studies have noted that 21st century should usher in a new era of greener and smarter cities that are promoting sustainability at their core but this has not taken place yet (Bhaba, 2012; Grainge, 2007). One of the ways by which a much-needed representation of the sustainability of construction practices can be carried out is by first defining the role of sustainability. Blewitt (2014) stated that sustainable practices which integrate the concepts of green infrastructure are representatives of the new, innovative approach to design. Thus, the concept of the process which is needed to establish the link between uptake of sustainability processes and the socio-political and cultural aspect of society.

## 5.5 Review of Aim and Objectives Based on the Findings

The primary aim of the current study has been to understand physical (thermal heat) and psychological needs and preferences for buildings in an Arabic context through extensive focus on environmental traditional architecture in relation to a modern setting. Policy implementation on sustainability and climate should mainly be driven by the population's demands for indoor and outdoor comfort levels. Middle Eastern traditional architectural design for buildings represents unique culture that has been explored in the scope of Saudi Arabian traditional and modern architectural building. Psychological components such as space also play a vital role in determining architectural design of buildings.

The study successfully identified the critical role performed by traditional architecture in building design to guarantee thermal comfort. The results displayed that a need to combine both traditional techniques and modern technology through the creation of knowledge awareness. Any architectural design must consider its effects, from high warm temperatures to low levels of relative humidity. The integration of green features to attain sustainability represents new learning opportunity for every country in the Arab region. These countries must learn how to conserve water, control heat, and recycle scarce resources in the ecological system (Grainge, 2007). Attaining sustainable

building design in the Middle East requires efficient implementation of policies and strategies effective in generating and maintaining building standards generally. It is important to mobilize, manage, control, and organize both the personnel and resources to meet this need. Investing in more energy-friendly sources will drastically help also in reducing greenhouse gas emission, a main contributor of global warming.

The analysis has sought ways to enhance building design and the use of performance-based standards through the study of traditional environmental techniques, as well as to apply modern technology in the entire Middle East. Government, as the main driver in sustainable development, must ensure that there are relevant sustainability policies to support any upcoming development. Some of the crucial policies in overseeing effective sustainable growth include sustainable energy, waste management, management of the oceanic pollution, and ecological effects. Sometimes increased additional costs greatly surpasses technological standards, hence the importance of considering factors such as cost. However, the countries seem to be facing a greater challenge than this, brought about by the need to provide traditional sustainable architectonic building through innovation and technology. Heavy investment and adaptation are necessary to meet current building demands across the region. The region may have to struggle with high costs in providing thermal comfort if it proves to be the only solution to current existing problem.

The relevant typology essential in meeting current building demands based on exploration of traditional, hybrid, and modern spaces is considered necessary in measuring building parameters and people’s behaviours. The traditional architectural system should be incorporated together with modern architecture to cater to current sustainability needs. The study has proposed the need to invest in current technological standards to help in close loopholes in the traditional design of indoor thermal management. There is need combine both traditional and modern architectural design in responding to current outdoor thermal comfort demands. The environmental conditions in Middle East are hot and dry. Control of temperature in most public buildings seems to be quite challenging, as result of air temperature variation. According to reports released by several microclimate agencies, air temperature is the

key factor determining thermal comfort. It is believed that environmental temperatures directly affect human body temperatures; high environmental temperature can cause rapid loss of heat from the body and vice-versa.

Hot weather conditions cause high relative humidity, which helps decrease rates of evaporation. Convective and evaporative losses occur mainly as a result of change in temperature and relative humidity. According to Al-Hassan and Dudek (2008), wind is an important factor in determining both temperature and relative humidity, which is why it must be included in any thermal-comfort design process. For instance, when the air is circulated through the courtyard or the small openings, the inside temperature becomes cooler. Temperature, relative humidity, radiation, and wind speed also play an integral in controlling body heat loss, which eventually causes cooling. Wind also plays a great role in controlling heat loss in one's body. High wind speed quickly takes draws heat from the skin, which can cause rapid heat loss. Stimulation of this process can help people tolerate high temperatures. Mean radiant temperatures responsible for determining thermal outdoor sensation in sunny conditions greatly affect the balance of energy in the human body.

In such situations, a normal person experiences a great sense of balance, comfort, or pleasantness caused by thermal aspects neutrality. In such a position, one can easily maintain steady body temperatures at 37°C comfortably without experiencing any much struggle. Vascular constriction or dilation, even sweating, happens comfortably. Change in temperature, even a slight difference, can prompt different behaviours and comfort level in a given person. This factor is largely attributed to temperature sensations that bring about rapid temperature adjustment. A person's response to colder temperatures occurs more quickly than does change in hot temperatures. It is important to note that a person's level activity is sometimes not responsible for change in temperature of a person for warm and cold conditions but rather the air temperature. Discomfort caused by warm air results into a person's sweating.

Thermal stress occurs when the net loss of thermal energy from a person does not match the body's loss of heat through metabolism (Epstein and Moran, 2006). In order to relieve the body from this stress, one must be able to obtain a perfect balance. The

body recovers rapid loss of heat in cold temperatures through activation of several bodily systems, as coldness causes the body to lose what it had initially gained. Vascular constriction of blood flow to the skin automatically causes a drop skin temperature. The body can stimulate shivering voluntary or involuntary to increase heat production. The same person experiences reverse conditions in warm weather, however, as the body gains more heat and actually tries disposing some of the heat. Vascular dilation of the skin occurs as result of increase in temperature. Activation of sweating mechanisms proceeds afterward, in case vascular dilation proves insufficient. In case the rate of sweating exceeds the capacity of the environment to evaporate the moisture, that person automatically begins getting to sweat. Environmental factors play a critical role during this time, as they help one to determine the source of heat, which can be either internal or external.

## 5.6 Final suggestions

In order to attain sustainability across the Saudi Arabian region, the study finds it is integral that the important role performed by every stakeholder, from government, to local government, architectural firms, engineers, contractors, and building owners, be aligned towards sustainability. Working together of all the relevant stakeholders is essential in ensuring the success of this initiative. Some of the solutions that need to be carefully considered include passive ventilation, which may require cross ventilation, suspended timber floors, and insulation to mitigate the rate of air humidity. The public should also be involved in these sustainability efforts, through the creation of public awareness programs. Involving the public in the conservation of natural resources is necessary if the region is to achieve sustainable environmental design. The public should thus be educated on the relevance of sustainable construction, particularly the importance of cultural heritage.

Resource allocation is necessary in making this initiative a reality; the authorities bears the greatest responsibility burden in this regard. Control of most cities by municipalities also means that it is upon these authorities to ensure sustainability measures are strictly adhered to. To further enhance and augment energy conservation, there is need to adopt the latest effective technological standards and to provide necessary skilled labour through adequate training of personnel: in this case, training of architects. The

study’s main intention has been to provide a strong foundation for future researchers to build upon. It intends to provide useful information for sustainability decision makers, specifically, and a better understanding for all the relevant stakeholders.

Architects’ understanding of the combination of modern and traditional elements is necessary in controlling the three aspects. Careful selection of trees and planting can provide maximum shade during the day. Planting of trees and other vegetation cover should be highly encouraged to serve this purpose especially in the courtyard area. In areas where space is limited, one may replace trees with shade structures, as trees tend to occupy much space. The importance of trees in controlling infra-red radiation must also be clearly noted. They shield one from infrared radiation that is emitted through roads and walls in the summer. They also help in to mitigate the loss of infrared radiation via the relatively cold surface in the winter season. During the winter, wind chill factors play an integral role as a result of trees. Planting of vegetation and arrangement of structures can also help reduce heat loss during high winds in winter. Most public buildings seem to be very uncomfortable in the winter season, as compared to summer season, all as a result of poor sustainability planning. To attain sustainability standards, it is important for all the relevant stakeholders to observe all the required measures.

A tremendous increase in urban population is creating immense pressure on the environment hence the need to adopt building design centred on modern thermal outdoor comfort. Comfortable building design is an emerging issue for most urban planners and designers. Rapid change in weather patterns as a result of global warming needs also to be amicably addressed through investment in the latest technological designs in collaboration with traditional systems. Thermal outdoor comfort requires more input, not in terms technological invention as seen in indoor thermal comfort, but through ingenious alternatives. Thermal sensation can be used to create outdoor models in solving the problems pf outdoor thermal conditions. This technology predicts accurate conditions for outdoor comfort through its highly specialized mechanisms. Providing these conditions in many public buildings continues to be a great challenge, however, since current technological invention requires heating to work efficiently, for

instance. However, through planting of trees and shade structures, this situation can be efficiently remedied.

The current authorities of Saudi Arabia have to come to terms with the need for designs that provide thermal comfort and address the needs of the increasing global temperatures. This can be achieved through incorporation of international frameworks like LEED and BREAM to enhance the buildings' sustainable feature. Since the rapid economic growth of the country has been vastly depended on industrial and oil & gas development which emit carbon dioxide, the country faces a bug challenge in terms of enhancing thermal comfort. Several efforts which include allowing daylight to flow through in order to augment the thermal insulation have been proven to be unhelpful. Instead, the focus should be on using glass that does not conduct heat in sustainable design initiatives to allow the light to flow through.

If the design that is implemented is climate-responsive, then the architecture of the new houses can enhance the energy performance of the buildings as well. In addition, the public and the authorities need to develop a steady transition which leads to sustainable energy that is adapted by the retrofits of the current buildings. Internal relative humidity can be reduced by applying cross ventilation instead of passive ventilation or natural ventilation by using natural forces like wind. In addition, the designers should make use of timber floors for promoting ventilation. Furthermore, the insulation system can also be helpful in mitigating relative humidity. The country of Saudi Arabia needs to ensure that there is vast public awareness in an effort to develop the values of conserving the natural resources. One of the most effective ways of promoting this is to participate in energy conservation actively. The government of the country should segregate and allocate resources that allow the creation of awareness related to sustainable architecture in the minds of the general public, engineers, and the architects.

The Saudi Arabian Authorities must undertake unique and innovative measures which enhance the adoption of the sustainable design and energy savings. By implementing the latest green codes and having a highly talented and skilled team will be one of the ways in which it can promote the energy conservation concept and the preservation of

rich traditional designs, despite the adaptation of the modern architecture. In addition, the young generation can be harnessed with the aim of tapping their interests and focussing on sustainability. This process can begin in a school setting where they can be taught from an early age to be engineers who not only respect traditional designs but also improve them in the Middle Eastern community.

The findings further recommend that indoor spaces may integrate the use of traditional spatial organization in Arab Homes to improve internal circulation of air to cool the various spaces homogenously. In addition, it is crucial to adopt wind catchers and use courtyard spaces to promote circulation and ventilation. Some of modern building designs for indoor spaces aim at temperature management and control through double-glazed windows, e-glazing, and small windows. The appropriate bodies should ensure adherence to building-design plans considering the locality of the building. In order to achieve standard thermal comfort, it is important to combine the right airflow, temperature, and relative humidity. A variety of sustainable materials exist, such as increased greenery, insulated walls and roofs, tiling the floor with marble, and so on, which can be adopted for improved sustainability.

In an outdoor setting, shading is a crucial thermal control that ought to be considered in orienting a building. For outdoor spaces such as the courtyard, ventilation and air circulation are also crucial; for instance, in swimming-pool areas, modifications can be made to improve ventilation and circulation of cool air outside building. Additionally, implementing the use of shading devices such as louvers, perforated panels and screens, overhangs, and the like are beneficial. Further, vegetation can be used in coordination with greenery to naturally cool down the immediate surroundings, (e.g. near windows). External wall insulation is crucial for achieving thermal comfort and optimal thermal performance in the building, especially at the roof level. This study is providing a strong base for future research and will be crucial for the decision makers as well as enhance the understanding of the human needs of housing conditions in a country. Future studies can also expand this research to cover the entire GCC region.

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# APPENDICES

## Appendix A: Survey questionnaire form

The research questionnaire targeted the general public and experts.

Brief
This questionnaire form is part of PhD research that requires gathering data on your perception on the collaboration between traditional architectural features and modern technology for human comfort and well-being.

The findings of the research will benefit both academic and professional users. On the academic side, the research will offer an exploration and understanding of traditional features with modern adaptation. Professionally, findings might have practical implications for sustainable practices. This questionnaire in its quantitative and qualitative approach will measure the impact of traditional architecture with technology and innovation upon indoor environmental quality that could contribute to a sustainable future in the Middle East.

The collected data are exclusively for academic research purposes, and they may be used for academic publication. Please kindly respond to the questions based on your opinion.

Thank you for your co-operation. Your contribution will be a significant addition to this research.

Regards,

Israa
Email:
PhD Research Student
Date: _____

**General characteristics**

Kindly respond to the following questions.

| ID | A. Please fill and tick the appropriate response | | | |
|---|---|---|---|---|
| General Data | | | | |
| 1 | Name (optional) | | | |
| 2 | Nationality | | | |
| 3 | Occupational Status | | | |
| 4 | Your organization name (optional) | | | |
| 5 | Age | 21-30<br>31-40 | 41-65<br>Over 65 | |
| 6 | Gender | Male | Female | |
| 7 | Your Professional Role | Architect | Consultant | Contractor |
| | | Engineer | Developer | Others, please specify_____ |
| 8 | Email Address | | | |

**Personal Characteristics**

| | | | | |
|---|---|---|---|---|
| ID | B. Please fill and tick the appropriate response | | | |
| Data Related to participant residency | | | | |
| 1 | Type of your place of residence: | Permanent Resident (Owner) | | Temporary Resident (Tenant) |
| 2 | House location | | | |
| 3 | How long have you been living in your place of residence? | | | |
| | Less than 1 year | 1-5 years | 5-10 years | More than 10 years |
| 4 | Do you Like your place? | Yes | No | Neutral |

| | |
|---|---|
| 5 | Are there times that you feel there is a bad odour in the building? |
| 6 | Is the ventilation in the building poor? |
| 7 | Are you comfortable with the drainage system in the building? |
| 8 | Do you believe that the temperature level in the building is relatively higher? |
| 9 | Tenant, what could you have done or add to it to make it a more comfortable dwelling that responds to your needs? |
| 10 | Owner, was it your choice for the current state? What you would like to add to make it suitable or respond more to your needs? |
| 11 | Owner, does your client request more traditional features? |
| 12 | Owner, does your client specify air conditioning as a must in their house? |
| 13 | Owner, does your client show concern about energy consumption? |

**Knowledge and Skills**

| ID | C. Please fill and tick the appropriate response | | | |
|---|---|---|---|---|
| Your perception about traditional and modern architecture | | | | |
| 1 | Indicate which of the following trends have you worked with and/or used before | | | |
| | Traditional technique | Modern technique | Traditional & modern techniques | Traditional with modern adaptation |
| | Others, please specify | | | |
| 2 | Indicate for how long you have been in the building industry | | | |
| | 1-5 years | 5-10 years | 10-15 years | Over 20 years |
| | Others, please specify | | | |
| 3 | How often do you choose to use one of the traditional features techniques | | | |
| | 1-4 times | Over 5 times | Regularly | Not at all |
| | Please indicate the used features | | | |
| 4 | Identify your general overview about using traditional features techniques | | | |
| | It is a necessity | It is satisfactory | It is undesirable | I am not excited |
| | Others, please specify | | | |
| 5 | What is your understanding and your exposure to traditional techniques collaboration with modern context upon climate change? | | | |
| | I have a clear understanding but not worked before with this trend.<br>I have worked with this trend with minimal collaboration.<br>I have worked with this trend more than once.<br>I have never worked with this trend and looking forward too.<br>I am looking forward to work with this trend.<br>I am unaware of this kind of collaboration. | | | |

| | |
|---|---|
| 6 | Please indicate the aspects you do like most, about traditional features collaboration within the modern context? |
| | |
| 7 | Please indicate the aspects you dislike most about traditional features collaboration within the modern context. If none, write NONE. |
| | |
| 8 | Please mention your most significant building that might represent the most comfortable<br>Place, with its local context and emphasis on environmental<br>aspects |
| | |

**Measuring respondents' awareness**

Please rate the following statement, which represents your opinion on the use of traditional and modern techniques and their impacts.

| ID | D. Please mark the appropriate response |
|---|---|

| | | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|---|
| | Occupants' Perception | | | | | |
| 1 | The use of traditional features reflects a self-esteem | | | | | |
| 2 | Modern trends are more often communicated with indoor spaces. | | | | | |
| 3 | The way modern architecture is distributed affects quality of life. | | | | | |
| 4 | To what extent do you agree with adaptation of traditional architecture to a modern context. | | | | | |
| 5 | Traditional architecture in a modern context adds expenses to the project. | | | | | |
| | Occupants' satisfaction and behaviour in regard to the use of traditional techniques | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6 | The temperature in the indoor spaces is Adequate. | | | | | |
| 7 | The temperature in the indoor spaces is mostly cold. | | | | | |
| 8 | The temperature in the indoor spaces is mostly hot. | | | | | |
| 9 | Ventilation is more adequate. | | | | | |
| 10 | Natural lighting can be better controlled. | | | | | |
| 11 | Improve the quality and quantity of indoor day lighting. | | | | | |
| 12 | Enhance daylight appearance | | | | | |
| 13 | The general layout and design is more satisfactory | | | | | |
| 14 | The visual relationship of indoor and outdoor spaces are more satisfactory. | | | | | |
| 15 | Improve energy conservation within its | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | local context | | | | | |
| 16 | Emphasis on environmental aspects in relation to the local context | | | | | |
| 17 | Enhance building performance and indoor quality | | | | | |
| 18 | Well integrated with the local context and climate change | | | | | |
| | Expertise Decision | | | | | |
| 19 | The application of traditional features to technology entails a complex system for improving design efficiency. | | | | | |
| 20 | Traditional techniques should be distributed through refurbishment sites only. | | | | | |
| 21 | The final decision for setting a building must be made by local experts. | | | | | |
| 22 | Academic perspectives and methods of teaching | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | the collaboration between traditional and modern techniques need to be refined. | | | | | |

If you would like to make any additional comments related to the survey content, please add them here.

_____

_____

_____

_____

Your answers will be kept rigorously confidential.

## Appendix B: Interview script

You are invited to take part in an interview and provide views regarding the Impact of Technology and innovation the adaptation of the architectonic tradition for a sustainable future in the Middle East.

Please note: All survey responses will remain confidential. Participants will remain anonymous and will be identified only by an assigned ID code. *a*

A. Give a brief background about yourself and your residence based on the following statements:

A1. Describe area in which you live? [Tick all that apply]

| Cool | Humid | Air conditioned | Hot |
|---|---|---|---|
| | | | |

A2. Describe the outdoor surroundings your place? [Tick all that apply]

| Cool | Humid | Air conditioned | Hot |
|---|---|---|---|
| | | | |

A3. Describe your residence (traditional/modern)? [Tick all that apply]

| Traditional | Modern |
|---|---|
| | |

B. In your opinion, to what extent does traditional architecture with modern adaptation adjust occupants' psychological comfort or wellbeing'? Comment based on the following:

| | |
|---|---|
| Comfortable temperatures | |
| Good odour due to improved ventilation | |
| Comment on additional factors you feel are applicable? | |

C. In your opinion, what design approaches can be used in improving thermal conditions in order to increase thermal comfort? Comment based on the following:

| | |
|---|---|
| Improving ventilation in the building to allow the movement of fresh air through the building | |
| Designing kitchen space (a lot of cooking using the electrical gases that result in heating of the houses) | |
| Comment on additional factors you feel are applicable? | |

D. If you feel it is too hot in this place, what measures do you prefer to take in response?

| | |
|---|---|
| Improved ventilation | |
| Improved space design | |
| Installation of thermal sensation models such as fans | |
| Comment on additional factors you feel are applicable? | |

E. Do you believe temperature as a relevant design parameter to the study location of the Arab region, a hot, arid climate, has an influence on wellbeing? If YES, is there an efficient building regulation to follow? And is it taken into account even at the individual construction level, or should it be ignored?

F. What ideal outdoor or indoor thermal condition would you prefer at this moment? Comment based on the following:

| | |
|---|---|
| Relatively higher relative humidity level | |
| Temperature levels are suitable | |

G. What would you recommend improving thermal conditions in building architecture in order to increase thermal comfort?

## Appendix C: Example filled survey questionnaire manuscript

You are invited to take part in an interview and provide views regarding the impact of technology and innovation on adaptation of architectonic tradition for a sustainable future in the Middle East.

Please note: All survey responses will remain confidential. Participants will remain anonymous and will be identified by an assigned ID code. *a*

A. Give a brief background about yourself and your residence based on the following statements:

A1. Describe area in which you live? [Tick all that apply]

| Cool | Humid | Air conditioned | Hot |
|---|---|---|---|
| | | | |

A2. Describe the outdoor surroundings your place? [Tick all that apply]

| Cool | Humid | Air conditioned | Hot |
|---|---|---|---|
| | | | |

A3. Describe your residence (traditional/modern)? [Tick all that apply]

| Traditional | Modern |
|---|---|
| | |

B. In your opinion, to what extent does traditional architecture with modern adaptation adjust occupants' psychological comfort or wellbeing? Comment based on the following:

| | |
|---|---|
| Comfortable temperatures | |
| Good odour due to improved ventilation | |
| Comment on additional factors you feel are applicable? | |

C. In your opinion, what design approaches can be used in improving thermal conditions in order to increase thermal comfort? Comment based on the following:

| | |
|---|---|
| Improving ventilation in the building to allow the movement of fresh air through the building | |
| Designing kitchen space (a lot of cooking using the electrical gases that result in heating of the houses) | |
| Comment on additional factors you feel are applicable? | |

D. If you feel it is too hot in this place, what measures do you prefer to take in response?

| | |
|---|---|
| Improved ventilation | |
| Improved space design | |
| Installation of thermal sensation models such as fans | |
| Comment on additional factors you feel are applicable? | |

E. Do you believe temperature as a relevant design parameter to the study location of the Arab region, a hot, arid climate, has an influence on wellbeing? If YES, is there an efficient building regulation to follow? And is it taken into account even at the individual construction level, or ignored?

F. What ideal outdoor or indoor thermal condition would you prefer at this moment? Comment based on the following:

| | |
|---|---|
| Relatively higher relative humidity level | |
| Temperature levels are suitable | |

G. What would you recommend to improve thermal conditions in building architecture in order to increase thermal comfort?

Improved ventilation

## Appendix D: Example filled interview manuscript

### Example 1

You are invited to take part in an interview and provide views regarding the impact of technology and innovation on adaptation of architectonic tradition for a sustainable future in the Middle East.

Difference between traditional, modern and semi-traditional (transitional) houses

Semi traditional

Traditional

Modern

Please note: All survey responses will remain confidential. Participants will remain anonymous and will only be identified by an assigned ID code.

A. Give a brief background about yourself and your residence based on the following statements:

A1. Describe area in which you live? [Tick all that apply]

| Naturally cool | Air conditioned | Hot |
|---|---|---|
| | x | |

A2. Describe the outdoor surroundings your place? [Tick all that apply]

| Naturally cool | Air conditioned | Hot |
|---|---|---|
| | | X |

A3. Describe your residence (traditional/modern)? [Tick all that apply]

| Traditional | Modern |
|---|---|
| | x |

B. In your opinion, to what extent does traditional architecture with modern adaptation adjust occupants' psychological comfort/wellbeing? Comment based on the following:

| | |
|---|---|
| Comfortable temperatures | 20 |
| Good odour due to improved ventilation | Natural ventilation during cool season (November- March) and mechanical (HVAC) during the hot season (April-September) |
| Comment on additional factors you feel are applicable? | - Thermal insulation in the building envelope (walls and roof)<br>- Masonry external walls<br>- Minimizing the void or solid proportion of the external walls. |

C. In your opinion, what design approaches can be used to improve thermal conditions in order to increase thermal comfort? Comment based on the following:

| | |
|---|---|
| Improving ventilation in the building to allow the movement of fresh air through the building | Passive approach and hybrid integrated systems |
| Kitchen location | North |
| Comment on additional factors you feel are applicable? | Minimizing the windows in the south and maximizing them in the north facades. |

D. If you feel it is too hot in this place, and what measures do you prefer to take in response?

| | |
|---|---|
| Improved ventilation | |
| Improved space design | |
| Installation of thermal sensation models such as fans | X |
| Comment on additional factors you feel are applicable? | Depend on mechanical HVAC System |

E. Do you believe temperature as a relevant design parameter to the study location of the Arab region, hot arid climate has an influence on wellbeing? If YES, is there an efficient building regulation to follow too? And is it taken into account even at individual construction level or ignored?

Sure, the hot arid climate influences the wellbeing, many people suffer from respiratory diseases.

F. What ideal outdoor/indoor thermal condition would you prefer at this moment? Comment based on the following:

| | |
|---|---|
| Naturally cool | X |
| Temperature levels are suitable | |

G. What would you recommend to improve thermal conditions in building architecture in order to increase thermal comfort?

Using suitable high-performance materials in the building envelop and allowing cross ventilation within the interior space, the courtyard house, is one solution; the central living area is another good solution.

Example 2

You are invited to take part in an interview and provide views regarding the impact of technology and innovation on adaptation of architectonic tradition for a sustainable future in the Middle East

Difference between traditional, modern and semi-traditional (transitional) houses

Semi traditional

Traditional

Modern

Please note: All survey responses will remain confidential. Participants will remain anonymous and will only be identified only by an assigned ID code.

A. Give a brief background about yourself and your residence based on the following statements: Professor of architecture King Abdul Aziz University

A1. Describe area in which you live? [Tick all that apply]

| Naturally cool | Air conditioned | Hot |
|---|---|---|
| | X | |

A2. Describe the outdoor surroundings your place? [Tick all that apply]

| Naturally cool | Air conditioned | Warm during summers |
|---|---|---|
| | | X |

A3. Describe your residence (traditional/modern)? [Tick all that apply]

| Traditional | Modern | Semi traditionally |
|---|---|---|
| | | X |

B. In opinion, to what extent does traditional architecture with modern adaptation adjust occupants' psychological comfort/wellbeing? Comment based on the following:

| | |
|---|---|
| Comfortable temperatures | X |
| Good odour due to improved ventilation | |
| Comment on additional factors you feel are applicable? | |

C. In your opinion, what design approaches can be used to improve thermal conditions in order to increase thermal comfort? Comment based on the following:

| | |
|---|---|
| Improving ventilation in the building to allow the movement of fresh air through the building | X |
| Kitchen location | |
| Comment on additional factors you feel are applicable? | |

D. If you feel it is too hot in this place, what measures do you prefer to take in response?

| | |
|---|---|
| Improved ventilation | X |
| Improved space design | |
| Installation of thermal sensation models such as fans | |
| Comment on additional factors you feel are applicable? | |

E. Do you believe temperature as a relevant design parameter to the study location of the Arab region, a hot, arid climate, has an influence on wellbeing? If YES, is there an efficient building regulation to follow too? And is it considered even at individual construction level or ignored? Yes

F. What ideal outdoor or indoor thermal condition would you prefer at this moment? Comment based on the following:

| | |
|---|---|
| Naturally cool | |
| Temperature levels are suitable | X |

G. What would you recommend to improve thermal conditions in building architecture in order to increase thermal comfort?

-Use of traditional spatial organization in Arab Homes to improve internal circulation of air to cool the various spaces homogenously

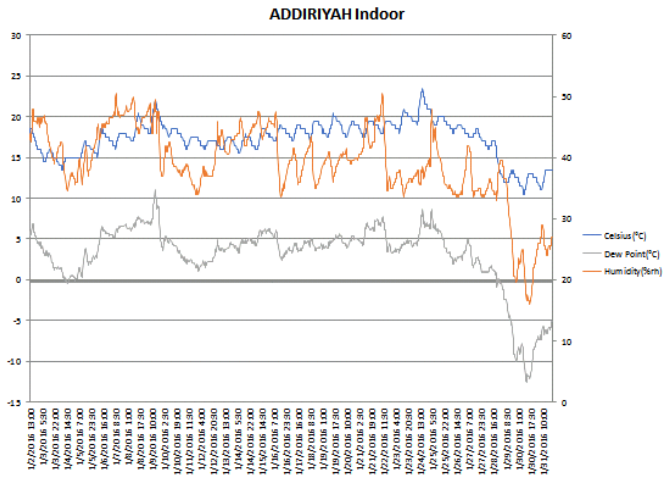
-Use of internal and external courtyards to improve ventilation and circulation of cool air inside and outside building

-Use of wind catchers to promote air movement inside various spaces in the house

# Appendix E: Example screen shots of Addiriyah data loggers

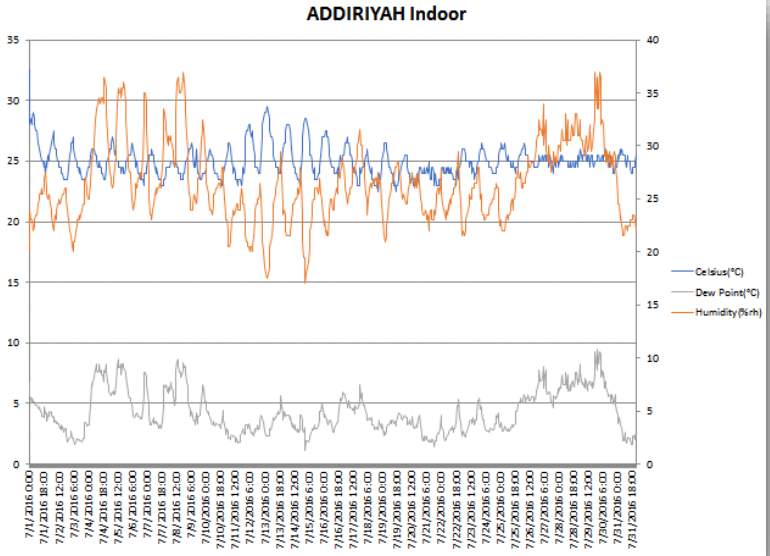
• January

| January | | | |
|---|---|---|---|
| Item | Temp | Humidity | Dew point |
| Maximum | 23.5 | 50.5 | 11.0 |
| Mean | 17.3 | 39.0 | 3.0 |
| Minimum | 10.5 | 16.0 | -12.6 |



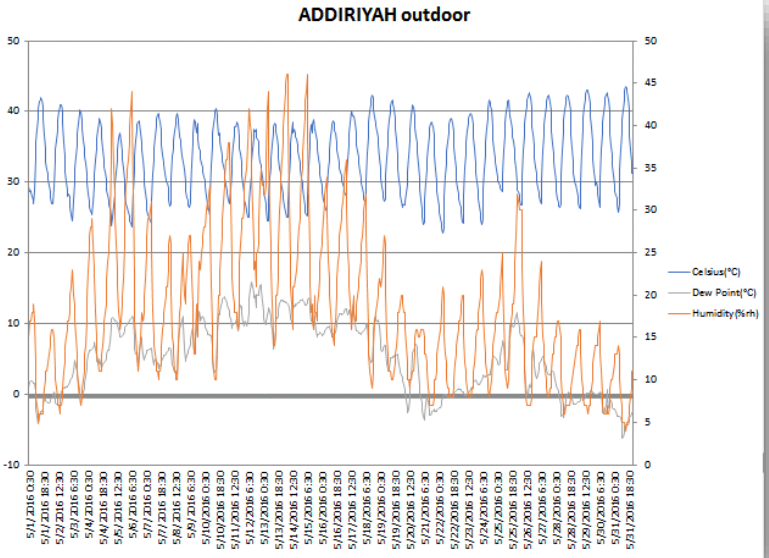

• July

| July | | | |
|---|---|---|---|
| Item | Temp | Humidity | Dew point |
| Maximum | 32.5 | 37.0 | 9.5 |
| Mean | 25.0 | 26.4 | 4.3 |
| Minimum | 22.5 | 17.0 | 1.1 |

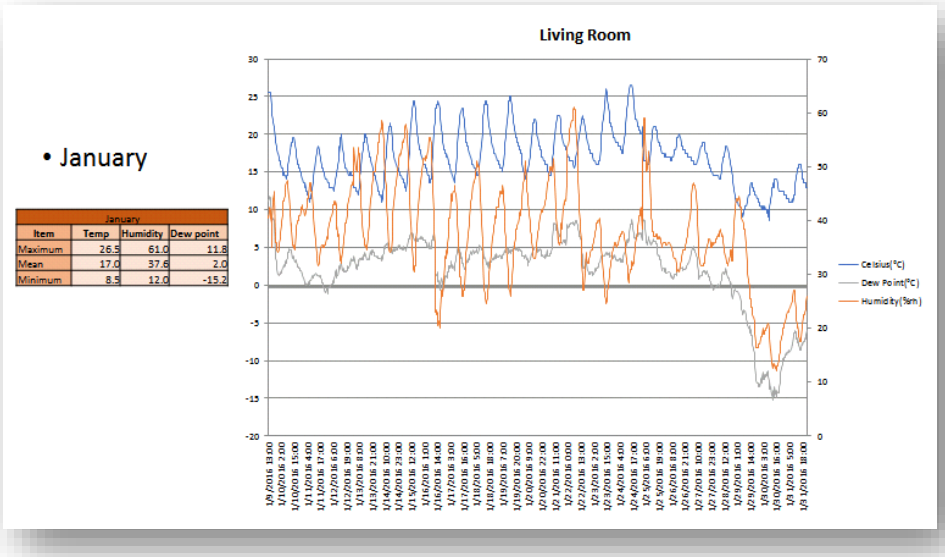


- May

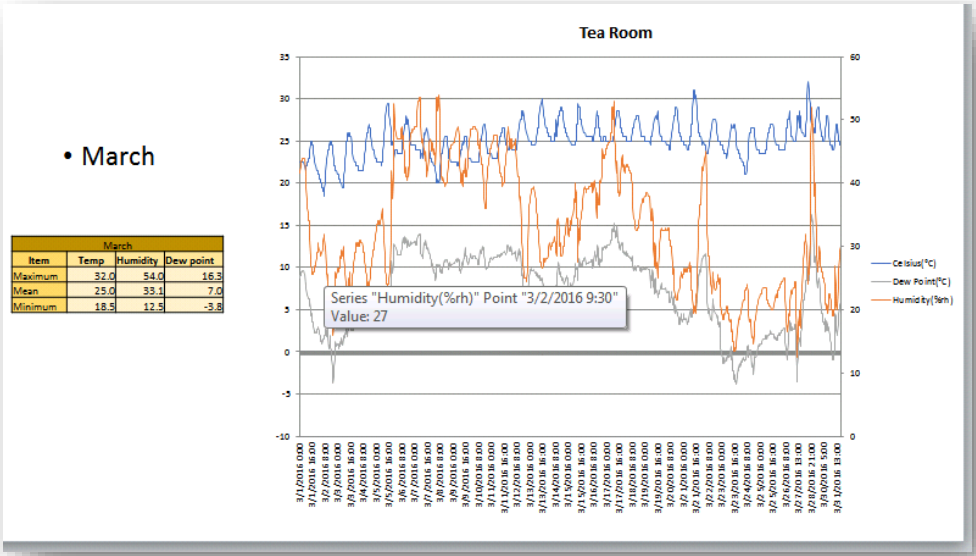
| May | | | |
|---|---|---|---|
| Item | Temp | Humidity | Dew point |
| Maximum | 43.5 | 46.0 | 15.8 |
| Mean | 33.3 | 18.4 | 5.1 |
| Minimum | 22.8 | 4.0 | -6.2 |



# Appendix F: Example screen shots of Landform house data loggers



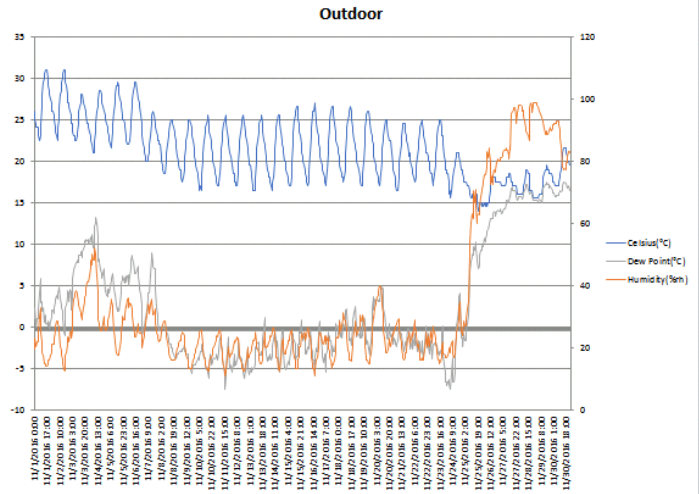

| January | | | |
|---|---|---|---|
| Item | Temp | Humidity | Dew point |
| Maximum | 26.5 | 61.0 | 11.8 |
| Mean | 17.0 | 37.6 | 2.0 |
| Minimum | 8.5 | 12.0 | -15.2 |




| March | | | |
|---|---|---|---|
| Item | Temp | Humidity | Dew point |
| Maximum | 32.0 | 54.0 | 16.3 |
| Mean | 25.0 | 33.1 | 7.0 |
| Minimum | 18.5 | 12.5 | -3.8 |

- Nov

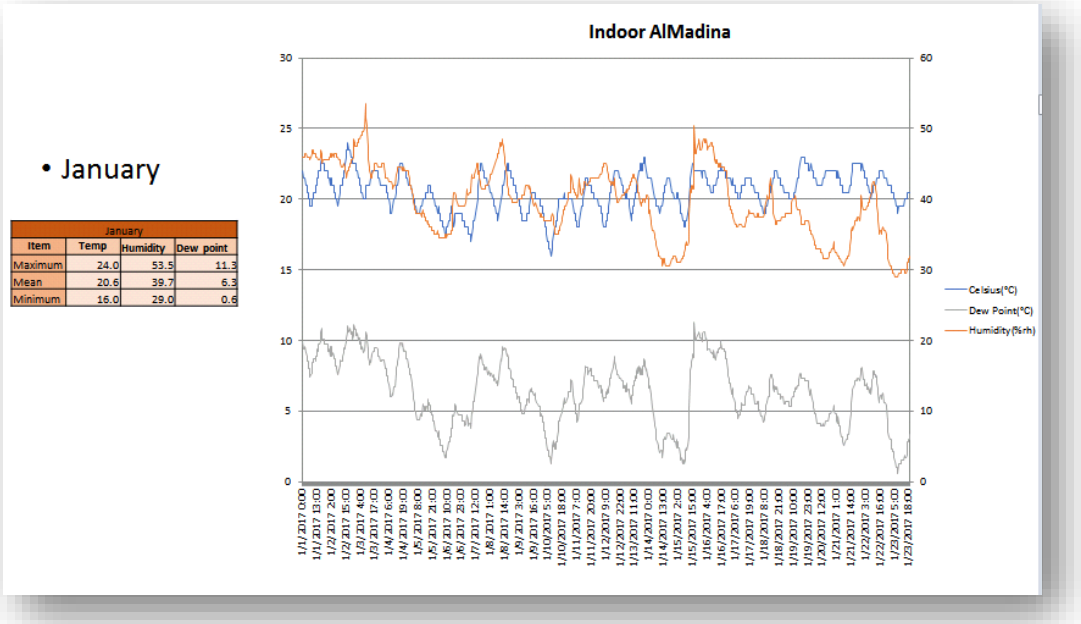
| November | | | |
|---|---|---|---|
| Item | Temp | Humidity | Dew point |
| Maximum | 31.0 | 98.5 | 17.5 |
| Mean | 21.4 | 34.8 | 2.6 |
| Minimum | 14.0 | 11.0 | -7.5 |



# Appendix G: Example screen shots of Al Madinah data loggers

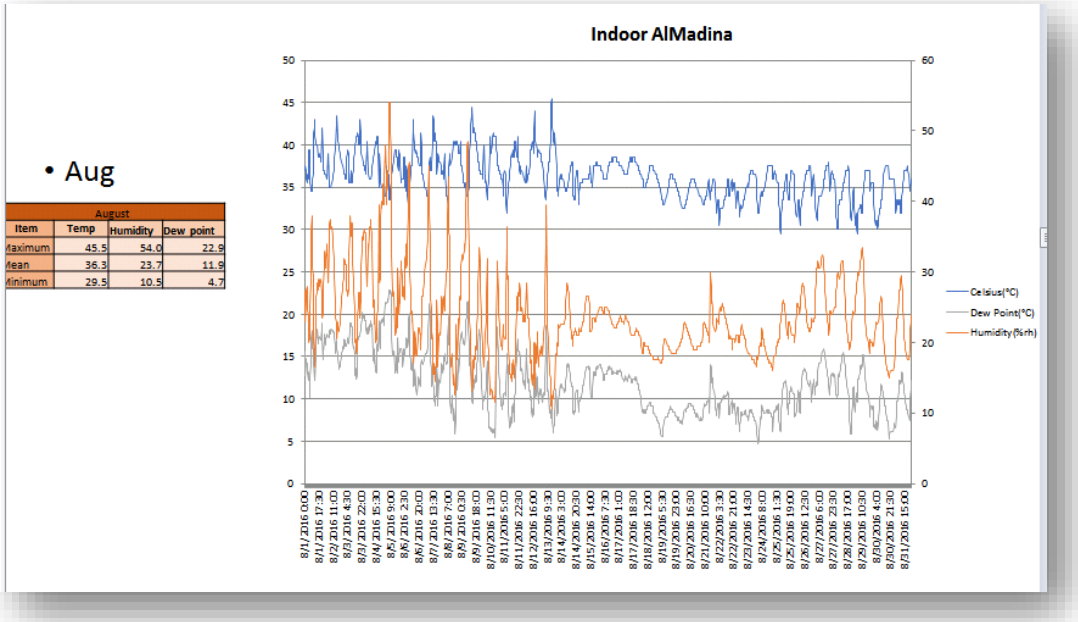
Al Madinah city

Data was collected around a year every hour in Traditional private house in Al Madinah city in Saudi Arabia
All the previous locations were in Riyadh




- January

| January | | | |
|---|---|---|---|
| Item | Temp | Humidity | Dew point |
| Maximum | 24.0 | 53.5 | 11.3 |
| Mean | 20.6 | 39.7 | 6.3 |
| Minimum | 16.0 | 29.0 | 0.6 |




- Aug

| August | | | |
|---|---|---|---|
| Item | Temp | Humidity | Dew point |
| Maximum | 45.5 | 54.0 | 22.9 |
| Mean | 36.3 | 23.7 | 11.9 |
| Minimum | 29.5 | 10.5 | 4.7 |

## Appendix H: Tabulated results of survey questionnaire

5.2 General characteristics

5.2.1 What is your age?

General characteristics

5.2.1 What is your age?

| | |
|---|---|
| 21–30 | 46 |
| 31–40 | 74 |
| 41–65 | 78 |
| Over 65 | 2 |

5.2.2 What is your professional occupation?

| | |
|---|---|
| Architect | 50 |
| Engineer | 58 |
| Consultant | 26 |
| Developer | 2 |
| Contractor | 4 |
| Other (please specify) | 60 |

5.3 Personal characteristics

5.3.1 Type of your place of residence?

| | |
|---|---|
| Permanent resident (Owner) | 80 |
| Temporary resident (Tenant) | 120 |

5.3.2 How long have you been living in your place of residence?

| | |
|---|---|
| Less than 1 year | 30 |

| | |
|---|---|
| 1–5 years | 90 |
| 5–10 years | 50 |
| More than 10 years | 30 |

5.3.3 Do you like your place?

| | |
|---|---|
| Yes | 140 |
| No | 30 |
| Neutral | 30 |

5.3.4 Are there times that you feel bad odour in the building?

| | |
|---|---|
| Yes | 100 |
| No | 50 |
| Neutral | 50 |

5.3.5 Is the ventilation in the building poor?

| | |
|---|---|
| Yes | 40 |
| No | 50 |
| Neutral | 100 |

5.3.6 Are you comfortable with the drainage system in the building?

| | |
|---|---|
| Yes | 120 |
| No | 40 |
| Neutral | 40 |

5.3.7 Do you believe that the temperature level in the building is relatively higher?

| | |
|---|---|
| Yes | 30 |
| No | 150 |
| Neutral | 20 |

5.3.8 Tenant, what could you have done or add to it to make it more comfortable dwelling that responds to your needs?

| | |
|---|---|
| Yes | 50 |
| No | 20 |
| Neutral | 50 |

5.3.9 Owner, was it your choice for the current state? What you would like to add to make it suitable or respond more to your needs?

| | |
|---|---|
| Yes | 30 |
| No | 10 |
| Neutral | 40 |

5.3.10 Owner, does your client request more traditional features?

| | |
|---|---|
| Yes | 10 |
| No | 30 |
| Neutral | 40 |

5.3.11 Owner, does your client specify air conditioning as a must in their house?

| | |
|---|---|
| Yes | 30 |
| No | 10 |

| | |
|---|---|
| Neutral | 40 |

5.3.12 Owner, does your client show concern about energy consumption?

| | |
|---|---|
| Yes | 50 |
| No | 10 |
| Neutral | 20 |

5.4 Knowledge and skills

This section analyses the respondents' perceptions of traditional and modern architecture.

5.4.1 Indicate which of the following trends have you worked with or used before.

| | |
|---|---|
| Traditional technique | 50 |
| Modern technique | 30 |
| Traditional and modern techniques | 90 |
| Traditional with modern adaptation | 30 |
| Others (please specify) | 0 |

5.4.2 Indicate for how long you have been in the building industry.

| | |
|---|---|
| 1–5 years | 70 |
| 5–10 years | 50 |
| 10–15 years | 40 |
| Over 20 years | 40 |

5.4.3 How often do you choose to use one of the traditional features techniques?

| | |
|---|---|
| 1–4 times | 40 |

| | |
|---|---|
| Over 5 times | 40 |
| regularly | 100 |
| Not at all | 20 |

5.4.4 Identify your general overview about using traditional features techniques

| | |
|---|---|
| It is a necessity. | 70 |
| It is satisfactory. | 60 |
| It is undesirable. | 30 |
| I am not excited. | 40 |

5.4.5 What is your understanding and your exposure to traditional techniques collaboration with modern context upon climate change?

| | |
|---|---|
| I have a clear understanding but not worked before with this trend. | 80 |
| I have worked with this trend with minimal collaboration. | 40 |
| I have worked with this trend more than once. | 20 |
| I have never worked with this trend and looking forward too. | 20 |
| I am looking forward to work with this trend. | 30 |
| I am unaware of this kind of collaboration. | 10 |

5.4.6 Please indicate the aspects you do like most, about traditional features collaboration with modern context

| | |
|---|---|
| None | 160 |
| Others (please specify) | 40 |

5.4.7 Please indicate the aspects you dislike most, about traditional features collaboration with modern context, if none write ANY

| | |
|---|---|
| None | 170 |
| Others (please specify) | 30 |

5.4.8 Please mention your most significant building that might represent most comfortable place with its local context and emphasis on environmental aspects

| | |
|---|---|
| None | 170 |
| Others (please specify) | 30 |

5.5 Measuring respondents' awareness

This section measures the occupants' perception, satisfaction and behaviour on the use of traditional and modern techniques and its impact

5.5.1 The use of traditional features reflects a self-esteem

| | |
|---|---|
| Strongly Agree | 90 |
| Agree | 20 |
| Neutral | 5 |
| Disagree | 50 |
| Strongly Disagree | 35 |

5.5.2 Modern trend is more communicated with indoor spaces

| | |
|---|---|
| Strongly Agree | 30 |
| Agree | 50 |
| Neutral | 40 |
| Disagree | 20 |
| Strongly Disagree | 60 |

5.5.3 The way modern architecture is distributed affects quality of life

| | |
|---|---|
| Strongly Agree | 20 |
| Agree | 35 |
| Neutral | 25 |
| Disagree | 57 |
| Strongly Disagree | 63 |

5.5.4 To what extent do you agree with traditional adaptation to modern context?

| | |
|---|---|
| Strongly Agree | 70 |
| Agree | 60 |
| Neutral | 10 |
| Disagree | 40 |
| Strongly Disagree | 20 |

5.5.5 Traditional architecture in context adds expenses to the project

| | |
|---|---|
| Strongly Agree | 20 |
| Agree | 25 |
| Neutral | 15 |
| Disagree | 50 |
| Strongly Disagree | 95 |

5.5.6 The temperature in the indoor spaces is adequate

| | |
|---|---|
| Strongly Agree | 10 |
| Agree | 25 |
| Neutral | 90 |
| Disagree | 20 |

| | |
|---|---|
| Strongly Disagree | 55 |

5.5.7 The temperature in the indoor spaces is mostly cold

| | |
|---|---|
| Strongly Agree | 40 |
| Agree | 5 |
| Neutral | 100 |
| Disagree | 40 |
| Strongly Disagree | 15 |

5.5.8 The temperature in the indoor spaces is mostly hot

| | |
|---|---|
| Strongly Agree | 30 |
| Agree | 30 |
| Neutral | 20 |
| Disagree | 50 |
| Strongly Disagree | 20 |

5.5.9 Ventilation is more adequate

| | |
|---|---|
| Strongly Agree | 25 |
| Agree | 90 |
| Neutral | 35 |
| Disagree | 20 |
| Strongly Disagree | 30 |

5.5.10 Natural lighting can be better controlled

| | |
|---|---|
| Strongly Agree | 65 |
| Agree | 80 |
| Neutral | 35 |

| | |
|---|---|
| Disagree | 8 |
| Strongly Disagree | 12 |

5.5.11 Improve the quality and quantity of indoor day lighting

| | |
|---|---|
| Strongly Agree | 10 |
| Agree | 5 |
| Neutral | 30 |
| Disagree | 60 |
| Strongly Disagree | 95 |

5.5.12 Enhance daylight appearance

| | |
|---|---|
| Strongly Agree | 20 |
| Agree | 20 |
| Neutral | 15 |
| Disagree | 95 |
| Strongly Disagree | 50 |

5.5.13 The general layout and design is more satisfactory.

| | |
|---|---|
| Strongly Agree | 45 |
| Agree | 90 |
| Neutral | 30 |
| Disagree | 20 |
| Strongly Disagree | 15 |

5.5.14 The visual relationship of indoor and outdoor spaces are more satisfactory.

| | |
|---|---|
| Strongly Agree | 20 |
| Agree | 30 |

| | |
|---|---|
| Neutral | 40 |
| Disagree | 70 |
| Strongly Disagree | 40 |

5.5.15 Improve energy conservation within its local context

| | |
|---|---|
| Strongly Agree | 45 |
| Agree | 95 |
| Neutral | 20 |
| Disagree | 30 |
| Strongly Disagree | 10 |

5.5.16 Emphasis on environmental aspect in relation to the local context

| | |
|---|---|
| Strongly Agree | 30 |
| Agree | 45 |
| Neutral | 15 |
| Disagree | 85 |
| Strongly Disagree | 25 |

5.5.17 Enhance building performance and indoor quality

| | |
|---|---|
| Strongly Agree | 45 |
| Agree | 98 |
| Neutral | 20 |
| Disagree | 22 |
| Strongly Disagree | 15 |

5.5.18 Well integrated with the local context and climate change

| | |
|---|---|
| Strongly Agree | 42 |
| Agree | 86 |
| Neutral | 35 |
| Disagree | 25 |
| Strongly Disagree | 12 |

5.5.19 Traditional features applied to technology comprise a complex system that improves design efficiency.

| | |
|---|---|
| Strongly Agree | 16 |
| Agree | 30 |
| Neutral | 50 |
| Disagree | 76 |
| Strongly Disagree | 28 |

5.5.20 Traditional techniques should be distributed through refurbishment sites only.

| | |
|---|---|
| Strongly Agree | 12 |
| Agree | 30 |
| Neutral | 36 |
| Disagree | 100 |
| Strongly Disagree | 22 |

5.5.21 The final decision for setting a building must be made by local experts.

| | |
|---|---|
| Strongly Agree | 12 |
| Agree | 24 |
| Neutral | 39 |
| Disagree | 92 |

| | |
|---|---|
| Strongly Disagree | 33 |

5.5.22 Academic perspectives and methods of teaching the collaboration between traditional and modern techniques need to be refined.

| | |
|---|---|
| Strongly Agree | 18 |
| Agree | 26 |
| Neutral | 16 |
| Disagree | 98 |
| Strongly Disagree | 42 |