Socio-Cultural and Climatic Architectural Strategies for a Sustainable Domestic and Neighbourhood Environment in Qatif, Eastern Province, Saudi Arabia

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ABSTRACT
The purpose of this research is to examine the impact of suburban Western-style planning on socio-cultural norms and energy consumption of the residential units in the Saudi home environment in Qatif. Studies so far have focused on improving the quality of construction materials and have neglected the role of incorporating socio-cultural and climatic aspects in the design of dwellings.

The study investigates the interaction between the contemporary urban form and the contemporary house form in relation to climatic and socio-cultural factors. A working assumption behind this research is that the contemporary home environment would perform better in terms of thermal performance and would reduce its reliance on mechanical cooling systems if climatic and cultural factors worked together to produce an environmentally and culturally appropriate built environment. The traditional home environment, produced through empirical responses to real needs over a very long history, has always been known for its efficiency in accommodating climatic and socio-cultural factors. Thus, a comparative analysis between the traditional town and the contemporary suburban layout, consisting on a macro-scale of the suburban plan and on a micro-scale of the house configuration, is undertaken with the objective of understanding how the economy and cultural balance of the traditional domestic environment has been transformed through processes of modernisation, and to what extent the impact of these processes explain the deficiencies of contemporary planning.

The comparison shows that the problem starts from the methodology of urban planning itself. The adaptation in Saudi Arabia of Western-style suburban planning in the form of inflexible, gridiron neighbourhood layouts of detached houses is a utilitarian response to the modern technologies such as automobiles, and the domestic technologies of mechanical services, and ignores to a significant extent the climatic and socio-cultural factors. In addition, building regulations in Saudi Arabia have also failed in such urban configurations to apply suitable climatic and cultural regulation. Thus, there has developed a huge, and in the long term unsustainable, reliance on air-conditioning and too great a focus on the thermal quality of materials to fill the gap engendered by this deficiency.

The study proves that the neo-Western gridiron plan of detached houses is not suitable for this culture and not suitable for the climatic circumstances of the region. Thus, the thesis ends with design strategies to improve the current situation and suggests a new housing 'economy' that works with climatic and cultural aspects and incorporates them in the future suburban planning and domestic design which will produce a better quality home environment that is compatible with the culture and the climate of the region. The suggestions for the future contained in the thesis conclusions specify working with an urban form that provides outdoor climatic response spaces to encourage social interaction on a suburban level, which would subsequently contribute to reducing cooling loads on a domestic level. The study also suggests a ‘hybrid design’ house-type form that has more flexibility, and provides more choices in adjusting the micro-climate for residents by responding to their climatic and socio-cultural needs.
The research that underlies this thesis focuses on Qatif city in the Eastern Province of Saudi Arabia for the following reasons.

Firstly, Qatif is my home town, I am familiar with the area and have access to data of relevance to the thesis, and I am very familiar with the socio-cultural values and climatic conditions of the area. The sensitive research environment of Saudi Arabia makes it difficult to collect data; however, being known and trusted by the people there was of great importance in being able to carry out this study.

Secondly, I have a strong background in Qatif’s housing and related cultural and environmental issues, in particular the climatic and cultural limitation imposed by the contemporary houses in this area, having worked and previously researched related areas. My understanding of the field of Qatif’s housing was developed through research undertaken for a Master’s Degree in housing in Architecture at the University of Dammam in Saudi Arabia.

Thirdly, comparisons were needed in order to understand the interrelated climatic and cultural aspects, and their outcomes, in both traditional and contemporary houses. Therefore, the case study of the urban layout and housing typologies of Qatif is the focus of this research and is exemplary of the overall situation in Saudi Arabia. Specifically, Qatif city forms a test case for the social and environmental consequences arising from the replacement of an old town of substantial size which is in the process of being entirely replaced by a modern town.
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DEDICATION

To my father
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1.1 INTRODUCTION

This thesis will examine the issue of environmental and social sustainability in relation to residential development in Saudi Arabia, focusing on the Eastern Province city of Qatif.

The broad term ‘sustainability’ incorporates many aspects but is most often associated with development. Although the term is subject to many definitions, the World Commission on Environment and Development (WCED) in 1987 stated that sustainable development is the “development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987, p. 43). The broad subject of sustainability has become a subject of great concern over the last few decades. In particular, energy efficiency has been a challenge following the impact of the oil crisis in the early 1970s, when the OPEC increased the oil price in 1973 (Seitz 2008). Many societies were impacted by the demise of cheap energy. Developed countries’ industries relied on the cheap, plentiful oil imported from the Middle East. Correspondingly, developing nations also adopted an economy based upon energy-intensive industries and transportation. Of relevance to this thesis, net energy exporting nations like Saudi Arabia and the Gulf States underwent a rapid process of modernisation and industrialisation that rapidly transformed the urban structures (planning, building types and services), and impacted the social structures, often with a disruptive effect.

After the oil crisis in 1973, the situation changed when the oil supplies declined and the price kept increasing, and the developed and developing countries had to rely on other sources of energy such as renewable, gas and nuclear energy to save their economies. On the other hand, consumption of the available oil should have been rationed and reduced to save energy (Taleb & Sharples 2011; Aldossary, Rezgui & Kwan 2014). A growing level of commitment to control energy consumption in many sectors emerged, particularly within the building industry: “Buildings are the most important energy-consuming economic sector. The world-wide primary energy consumption of buildings is close to 19 million barrels of oil per day and represents almost the entire daily production of OPEC countries” (Asimakopoulos et al. 2001, p. 8). Therefore, saving energy has become a significant mission for producing nations.
Reducing a building’s operating energy consumption has a considerable impact on both the macro and micro-scales. Reducing energy consumption on the macro-scale, results in minimising the heat and carbon dioxide which is released from buildings, both of which contribute to global warming. Saving operating energy on cooling within the residential sector makes buildings more affordable on the micro-scale. This issue of affordability has been belatedly addressed in oil producing countries such as Saudi Arabia, where Western-style, car-based urbanisation has replaced the traditional compact, low-energy consuming settlements.

A second consequence of the modernisation along post-war car-based Western lines of Saudi cities has been a range of stresses upon the traditional socio-cultural patterns that still characterise Saudi society. The necessity for social sustainability has received insufficient attention during this process of transformation, impacting on social networks, mobility, access to public open space, and consequently, upon psychological well-being and public health.

In this thesis, the researcher will investigate the problem of environmental and social sustainability in Qatif. Thus, this introduction introduces the argument of this research in ten sections. The first section examines the nature of the problem of the housing sector in Saudi Arabia; the second section presents the conceptual framework; the third section highlights the problem of energy scarcity and its relation to the housing sector; the fourth section aims to introduce the work that has been done towards reduction in energy demand in the housing sector in Saudi Arabia; the fifth section highlights the socio-cultural studies related to the home environment in Saudi Arabia; the sixth section sets out the aim and objectives of this research; the seventh section highlights the significance of this study and its contribution to the field of architecture and planning; the eighth section highlights the research challenges; the ninth section highlights the methodology, and the last section presents a summary of the research chapters.
1.2 THE NATURE OF THE PROBLEM IN SAUDI ARABIA

Saudi Arabia has witnessed a radical change in the social, economic and environmental sectors as a result of the economic growth that has accompanied the expansion in production and the exportation of oil, and the rise in the price of oil per barrel relative to gross domestic product (GDP). In referring to the Gulf countries, including Saudi Arabia, Al-Ibrahim states "...in less than a half century, these countries have been transformed from a nomadic and subsistence farming economy into a modern urban/industrial society with per capita incomes that are among the highest in the world" (Al-Ibrahim 1990, p. 64). One of the obvious changes appears in the transformation of the Saudi Arabian built environment. In less than fifty years, the old traditional fabric has been almost entirely replaced by new contemporary gridiron urban plans. The old houses, which were both climatically and culturally compatible with their surrounding environment and which were built with local materials, have been demolished, and the traditional clustered city plan has disappeared (Al-Hathloul & Edadan 1993; Talib 1984; Abu-Ghazze M. 1997). The image of the city and its houses has changed and new images have emerged (Table 1.1).

To manufacture these contemporary houses, new methods of construction and new materials have been introduced to the country, such as using reinforced concrete structure and constructing walls from cement blocks. These new building and manufacturing techniques have, in turn, brought about high energy consumption.

This parallels the trend elsewhere. Asimakopoulos et al. noted that during this period the rapid economic growth and increased population growth in developing countries contributed significantly to the energy consumption especially in the housing sector (Asimakopoulos et al. 2001). Exacerbating this trend, in Saudi Arabia the cheap price of electricity encouraged its high consumption, thus the country is still witnessing an annual increase in power demand of 6%, primarily fuelled by domestic consumption (Alyousef & Stevens 2011). In Saudi Arabia the energy consumption per capita is 6.8 tonnes of oil equivalent (toe) which is four times above the world average of 1.8 toe (Enerdata 2011).
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<td>Hot-dry</td>
<td>Dense compact</td>
<td>Attached Courtyard Houses</td>
</tr>
<tr>
<td>Eastern Region</td>
<td>Composite</td>
<td>Moderate compact</td>
<td>Attached Courtyard Houses</td>
</tr>
<tr>
<td>Western Region</td>
<td>Hot-humid</td>
<td>Loose clusters</td>
<td>Multi-storey Houses</td>
</tr>
<tr>
<td>Southern Region</td>
<td>Upland</td>
<td>Detached tower</td>
<td>Detached Tower Houses</td>
</tr>
<tr>
<td>Traditional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contemporary</td>
<td></td>
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</tr>
<tr>
<td>All contemporary</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1.1:** Settlement form and house form in the traditional towns and contemporary towns in Saudi Arabia.

*Source: Adapted by the author from (Talib, 1984)*
Saudi Arabia is a major consumer of oil and the greatest per capita consumer in the world; however it is likely the country will become a net importer within several decades unless changes take place (Lahn & Stevens 2011). Its economy and infrastructure need to be released from a dependence on the oil economy, or economic collapse will inevitably occur. In relation to the subject of this thesis, the modern Saudi home is entirely dependent on oil-powered electricity. Future Saudi towns and their houses will need to adapt to the new energy consumption paradigm, notably through adaptation and redesign of residential buildings, the focus of this thesis. Residential buildings in Saudi Arabia consume 70% of their total electricity use on air conditioning (Lahn & Stevens 2011). This electricity is 100% generated from fossil fuel (Mundi 2010). It is predicted to be depleted by 2038 and no alternative energy source is being developed (Lahn & Stevens 2011). Therefore, in order to reduce the consumption of fossil fuel, it is critical that both individuals and the state invest in alternative sources of energy consumption, whether that be solar, wind or nuclear, in order to reduce the use of residential air-conditioning.

Secondly, the pattern of urbanism is also based upon the petrol-powered private vehicle. This reliance on a depleting resource will also be unsustainable in the long term, and alternative urban planning strategies need to be created and implemented. The shift in the economy will also make a car-based residential typology unsustainable and non-or–low-carbon-dependent housing alternatives need to be developed.

Thirdly, there has been insufficient attention paid to culturally-specific features in recent Saudi urban planning which, as noted, is currently based in part on a Western car-based suburban model and is structured around the nuclear, two generation family. Inevitably this form of urban planning conflicts with local cultural patterns.

1.3 CONCEPTUAL FRAMEWORK

In the early 1960s, Olgyay, in his book “Design with Climate”, focused on the climatic dimension and its interaction with the building for the purpose of creating an energy efficient building. He argued that in order to produce an energy-efficient building, the design has to work with, rather than against, the climate (Olgyay 1963). That is to say, the
house should respond to climatic conditions which can be achieved by the application of certain design measures, any net energy deficiencies resulting from this passive-solar design (excess temperature or humidity) could be resolved by mechanical systems (Olgyay 1963). Hawkes shares Olgyay’s view, stating that the design priority should be to reduce reliance on air-conditioning by adapting the form of the building to the climate. He states that:

“The environmental process of building should be achieved primarily through its form and construction, and that these should be organized selectively to filter the natural environment as the first step in the process of adaptation. The intention is to minimise dependence upon mechanical systems of environmental control and, hence, to limit negative environmental impact “. (Hawkes, McDonald & Steemers 2002, p. vii).

Design and choice of material play a major role in residential energy efficiency (Shaahid & Elhadidy 2003). Thus, to design an energy efficient house (henceforth EEH), the focus is often on the design of the physical form, which may incorporate many aspects such as fenestration, orientation, shading and choice of material which applies to a single building (Ko 2013). These factors are of great importance, and play a significant role in reducing the energy consumption spent on heating and cooling. However, the majority of studies on EEH usually focus on a few factors which only apply to a single building, rather than placing EEH into a broader context. For example, with regard to materials, the focus is often on the physical property of materials such as heat transfer and thermal conductivity, whereas with regard to design, Wright believes that simple design solutions, such as summer shading could make houses more energy efficient (Wright 2008). However, Hawkes has added another dimension. He combines both climatic and socio-cultural aspects as the main factors influencing the production of the building form, in advocating the ability, through appropriate design, of occupants to practice control over the building configuration for the purpose of modifying the climate and reducing reliance on mechanical cooling (Hawkes, McDonald & Steemers 2002).

Rapoport and Winter share Hawkes’ viewpoint, arguing that to create a successful design there is a need to look at buildings as a social system respecting cultural values (Rapoport 1969; Winter 2013). With reference to the Gulf region, Salama has stated that to achieve
sustainable architecture, there is a need for a cross-disciplinary perspective which combines design, the product and the socio-cultural aspects to achieve successful housing design (Salama 2007). Caton and Ardalan share Salama’s perspective, noting that in the Gulf region there is an urgent need to integrate an environmental and socio-cultural context in design and planning for new Arab cities to achieve sustainable community (Caton & Ardalan 2010). With a focus on the Middle East and North Africa region Wehage states:

“The local and regional contexts, in combination with the population’s socio-cultural background, are major influencing factors in the designing of urban form. Possible contradictions between the requirements of the different components and disciplines involved, need to be balanced in a site specific design solution.” (Wehage 2013: in Pahl-Weber et al. 2013, p. 60)

It is the argument of the present author that it is a major methodological weakness to separate the physical aspects from the socio-cultural aspects. In the traditional town there was a symbiotic relationship between the physical form of the traditional town and the traditional cultural life of its people. Examples of such a relationship include the need for privacy for the women, the physical nature of houses reflecting extended family groups, and the location of houses in close proximity to both markets and mosques. In tackling the social and environmental stresses caused by inappropriate modern development, there is a need to develop parameters which address these aspects in an integrated way. In both retrofitting existing residential environments and in designing new ones, the climatic and socio-cultural factors need to be integrated in the early design stages to achieve social and environmental sustainability. These responses need to be unified to produce the built form. In this sense, the aspects are not only related to the micro-scale, the single housing unit design, but are strongly related to the macro-scale as well (Ratti, Raydan & Steemers 2003; Ko 2013; Ben-Hamouche 2008) which is, in the majority of cases in Saudi Arabia, the suburban form (Eben Saleh 2002).

The research in this thesis focuses on the design decisions that should be undertaken based on both the socio-cultural and climatic needs for a particular culture, and on a specific geographical location and climatic zone. The research looks at the interaction
between both aspects, resulting in a physical form that works with climate and respects cultural norms and practices.

1.4 ENERGY CRISIS AND HOUSING IN SAUDI ARABIA

The population of Saudi Arabia has been increasing at a steady rate since the early 1960s. The available statistics show that in 1960 the population was 4.072 million with an increase of about 4%-6% every four years to reach 26.37 million in 2008 (Bank 2014). The current population of Saudi Arabia is 29.196 million, and it is expected to reach 33.09 million by 2020, which is close to a 13.3% increase from the current population. It is expected that the population will reach 35.5 million by 2025, an increase of 21.1% from the current figure. This is a high population growth rate (Statistics 2013), and one which puts tremendous pressure on the capacity of the residential sector to accommodate the growing population in energy-efficient houses or apartments at a time when it is predicted that income from oil production will be waning. As noted, houses in Saudi Arabia account for the highest percentage of the energy consumption. Indeed, residential buildings in Saudi Arabia consume 70% of their total electricity use on air conditioning and this accounts for 52% of the domestic oil production (Lahn & Stevens 2011). Significantly, this electricity is entirely generated from fossil fuel despite the ideal climatic conditions for solar energy (Mundi 2013), and if the increase in energy demand keeps rising at a similar rate, consumption will be 50% higher by 2021 (Lahn & Stevens 2011). However, despite the massive current oil production, it is expected that Saudi Arabia will face an energy shortage by 2038 if it has not diversified its energy sources in addition to fossil fuels (Lahn & Stevens 2011). As part of a future development plan for sustainable consumption, the government is preparing to preserve energy by changing the consumption pattern, to be effected through a transitional plan to raise the price of electricity (Lahn & Stevens 2011). However, applying extra charges on electricity is going to be difficult to accept, especially for middle and low-income families (Alyousef & Stevens 2011). As a consequence of this impending crisis, it has become imperative that the nation reduce its reliance on air-conditioning in the residential sector and that this

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¹ No statistics before the 1960s are available.
sector (architects, developers, builders, and products manufacturers and importers) together build energy efficient houses and neighbourhoods.

1.5 ENERGY EFFICIENT APPLICATION IN SAUDI ARABIA

Despite the strong relationship between the energy crisis and housing in Saudi Arabia, studies undertaken with regard to energy-efficient housing are scarce. However, similar to other international studies, the available studies in Saudi Arabia always focus on some physical aspects, especially the suitability of particular domestic construction materials, and neglect the role of building regulation and planning.

Thermal insulation in walls and roofs contributes significantly to a reduction in the energy consumption which is spent on air-conditioning in the Saudi contemporary house as elsewhere. Ahmad noted that a well-insulated envelope for a typical detached single family house in the composite climate in Saudi Arabia can result in up to 42% reduction in energy consumption (Ahmad 2004). However, figures still show an increase in energy consumption of 6% per year in the residential sector which is directly attributable to the excessive use of air-conditioning (Alyousef & Stevens 2011), despite the authorities’ efforts to raise the public’s awareness of the issue of high electricity consumption and its long term consequences (Electricity 2014). Excessive reliance on mechanical cooling systems could be a consequence of the following reasons: design weakness, system deficiency or occupants’ behaviour patterns (Radhi, Eltrapolsi & Sharples 2009; Taleb & Sharples 2011). As noted above, in Saudi Arabia, the excessive use of air-conditioning could also be related to cheap plentiful oil which has encouraged such behaviour (Alyousef & Stevens 2011; Taleb & Sharples 2011). However, in the era of energy shortage such behaviour is no longer sustainable. Consequently, the issue of appropriate design becomes significant; it needs to offer alternatives to enable occupants to have other options.

Thus, we see a trending interest in passive cooling techniques, methodologies that are found in many examples of vernacular housing, for example in their technology, thermal mass, ventilation techniques, screening courtyards, shading vegetation and humidifying pools. Vernacular architecture is known for its appropriate technology that evolved to
cope with the climate (Olgyay 1963; Oliver 1969; Rapoport 1969; Rudofsky 1964; Steele 1997). In the hot region of the Middle East, there are numerous examples of different traditional cooling techniques, used to modify the natural climate and provide a comfortable microclimate inside the house. One of the most popular techniques is the use of attached courtyard houses where the courtyard forms the core of the house. However, when an urban form of detached courtyard houses was arranged in a grid-iron plan, the results showed intense exposure to solar heat during the day as a result of high surface to volume ratio. Thus in such cases the detached courtyard arrangement has to implement high thermal mass to work effectively in a hot arid climate (Ratti, Raydan & Steemers 2003). Another attempt to learn from traditional techniques was made by Al-Hemiddi in the hot dry climate of the central region of Saudi Arabia. He chose to use wind catcher towers as a passive cooling element, and integrated it into a detached courtyard house also built with contemporary materials. Although the results showed an improvement in the thermal performance, Al-Hemiddi, however, attributed it to the existence of a pool which was centrally located in the courtyard (Al-Hemiddi & Megren Al-Saud 2001). A fascination with vernacular architecture has also led many researchers to focus on the technical part of the passive cooling elements either by analysing or testing the performance of traditional houses (Al-Bakri 1997; Al-Lyaly 1990). These studies have shown that the physical form configuration of the vernacular house was capable of creating a temperature differential between the outside and the inside of the house. However, the extent of this reduction is not acceptable to present-day residents who are familiar with, and have consequently become habituated to, air-conditioned, sealed buildings. Different levels of personal comfort have become the norm, whereas occupants of traditional houses were more prepared to tolerate higher temperatures (Koch-Nielsen 2002). This is attributed to the “natural relationship between changes in the internal climate and changes in the external climate” (Koch-Nielsen 2002, p. 39). However, despite the importance of their findings, these studies did not highlight the deficiencies of the contemporary home environment in relation to the traditional home environment, so the outcomes were limited to displaying facts of the past.
Advocates of modern technology insist on improving the current situation. A recent attempt to improve the current practice with an aim to establish guidelines for sustainable energy efficient contemporary houses in Saudi Arabia was made by Taleb, Aldossary, Rezqui and Kwan who have tested the performance of contemporary houses through the use of a digital simulation program (Aldossary, Rezgui & Kwan 2014; Taleb & Sharples 2011). Although their results show weaknesses in the current practice, they work on limited variables and accept the current design with some modifications which are easy to apply using basic science. Some recommendations have been set such as the necessity of using double glazed windows and applying shade to them.

On a large scale, a recent movement towards energy efficient buildings in the country is the Saudi Green Building Forum (SGBF) which was established in 2010. Unfortunately, this forum is also working beyond the scope of residential sustainable practice. It is concerned with large projects such as educational institutes, commercial and financial market buildings. These types of buildings require foreign experts who are introduced to the country to accomplish the project under sustainable standards.

King Abdulla University of Science and Technology (KAUST) is an example of a recent large-scale project in Saudi Arabia. It is certified by Leadership in Energy & Environmental Design (LEED) and has achieved a platinum rating. Despite its implementation of scientific technological and sustainable applications it is still an educational institute and it differs from residential projects in the cultural scope. However, it will be of a great benefit to learn sustainable applications from it.

Despite the individual efforts by scholars in the field of architecture, each of the previous studies, for example Ahmad, Alhemmidi, Albakri and Radhi, have focused on one or two aspects of the physical form of the single house. In particular, much attention has been given to the improvement of the physical thermal properties of the envelope. There is no serious sustainable energy conservation application in the residential sector in Saudi Arabia, except the insistence on applying thermal insulation as a solution. This could be for several reasons, but perhaps the main one is that this is the most available and easiest solution to apply.
However, studies such as Hawkes and Salama’s have shown that achieving an energy efficient home environment is much more than just focusing on the physical property of the built form. Thus cultural and behavioural differences would be the unique set of conditions offering a 'new theory' or 'new approach', opposed to the general building science approach alone.

1.6 SOCIO-CULTURAL ASPECTS OF THE SAUDI HOME ENVIRONMENT

According to Rapoport and Oliver, culture is the most powerful influential factor in shaping the physical built environment (Rapoport 1969; Oliver 1969). On the other hand, Rapoport considers that climate is a compelling factor which should not be ignored or separated from the cultural factor (Rapoport 1969).

However, studies often focus on one and ignore the other. Studies related to the built environment in Saudi Arabia frequently focus on the role of socio-cultural aspects in the formation of the traditional urban fabric in different traditional cities such as Alkhalaf in the Southern Province and Alhasa in the Eastern Province. Eben Saleh has conducted a comparative study evaluating the traditional town of Alkhalaf in the Southern Region of Saudi Arabia in relation to the modern gridiron suburban planning. He concludes that the modern suburb lacks the role of encouraging social interaction which was a main feature of the traditional town (Eben Saleh 1997). Alshuwaikhat has stressed the necessity of creating walkable neighbourhoods and integrating public open spaces for social gathering in the Saudi modern neighbourhood similar to the traditional neighbourhood so as to create social interaction (Alshuwaikhat 1993). Furthermore, Ebn saleh has argued that the loss of social gathering spaces, which were a widely found feature of the traditional town, has caused a reduction in safety and security in modern Saudi suburbs (Eben Saleh 2001).

Following a similar approach, Al-Naim has conducted a qualitative study on the traditional home environment in Alhasa in the Eastern province of Saudi Arabia, with a focus on the continuity and change of individual and collective identity and the way they were reflected in the built physical form (Al-Naim 1998). In a similar way, Al-Naim has studied Saudis’ behaviour and their interaction with new imported house images in different
Saudi cities such as Riyadh, Dammam and Khobar, and the way they express their identity and reflect social meaning through the physical form (Al-Naim 2008). Furthermore, Alsolaiman has focused on the development of the Saudi house in relation to the distribution and use of spaces inside the individual Saudi house and its relation to social change in the Saudi society (Alsolaiman 2004).

Although these studies are of great importance in seeking to understand the conflict caused by alien Westernised forms and their clash with cultural values and norms, they lack the climatic considerations. Thus, when comparing the traditional town with new, imposed modern grid-iron planning, the climatic impact receives less attention. This is not limited to the urban form, but studies on individual residential units have also focused on the socio-cultural aspects and the way residents adapted to new box-like forms, again without focus on climate (Akbar 1998; Al-Naim 2008). This is attributed to the presence of mechanical cooling devices which have guaranteed comfortable levels inside the residential unit. Such studies point out very briefly the climatic deficiencies of modern design, but they do not consider the link between the environmental and socio-cultural aspects which are very important when designing the urban form and housing to create a sustainable built environment with less energy demands and more social interaction.

In summary, the research presented in this thesis hypothesises that the contemporary Saudi home environment, based on a Western-style suburban plan and guided by inappropriate building regulations, is designed without interrelated climatic and socio-cultural responses, and that this has resulted in an unsustainable, high energy consumption home environment. This research suggests that basic science, the simple logic and assumption for the need to save energy, has failed or could not be directly used, in the cultural context of Saudi Arabia. It further proposes a series of guidelines, a new ‘pattern language’, that will allow a holistic approach to the provision of socially and environmentally sustainable, energy-efficient housing at the individual, neighbourhood and wider scale.
1.7 AIMS AND OBJECTIVES

Focusing on the study area of the city of Qatif in the Eastern Province of Saudi Arabia, this study aims to establish design solutions that are informed by principles of climate mitigation and cultural aspects. The design solutions, derived from a study of traditional Saudi housing, focus upon sustainable principles for contemporary single Saudi houses and neighbourhoods in the composite climate of Qatif, with the ambition of reducing reliance on air-conditioning and encouraging passive cooling while at the same time respecting cultural norms. In other words, this research will suggest new forms to improve cultural and climatic responses of current and future home environments. The solutions will be on a scale of both the neighbourhood and the individual residential units.

The neighbourhood scale focuses on increasing walkability and social interaction, addressing issues of accessibility and sociability. It also focuses on the reduction of urban heat, and hence also reducing reliance on mechanical cooling, by implementing design strategies that suit the culture and climate. The residential scale works on providing passive cooling through the physical form by implementing privacy through the physical form which is a basic need in this Islamic culture. Thus the research has the following objectives:

- To understand the conceptual climatic and cultural aspects behind the existence of the physical form of the traditional home environment in Qatif.
- To understand the cultural and climatic design deficiencies in the current Saudi home environment that contributes to high energy consumption.
- To find retrofitting solutions to improve the climatic and cultural responses of the current Saudi home environment in Qatif on the suburban and residential unit scale.
- To illustrate the sustainable climatic and cultural benefits associated with the suggested design retrofitting.
- To set climatic and socio-cultural design principles for future domestic planning in Qatif.
1.8 SIGNIFICANCE OF THE STUDY

The significance of this study is that it examines the climatic and cultural performance of the current practice, firstly starting from the suburban car-based layout to the individual residential units, and the impact of such forms on the cultural patterns and norms characteristic of Saudi society, and secondly, the influence of current practice on fossil-based energy demand as can be measured by the above-mentioned increases in overall and per capita energy consumption. Also, the importance of this study lies in the focus upon aspects of the traditional home environment that have been neglected by modern planning. It focuses on how new approaches to the design of collective and individual habitat within Saudi cities like Qatif might accommodate the new paradigm of energy and environmental sustainability, while maximising the freedom of its inhabitants to live their lives in the manner that they find most appropriate without confining them to a static stereotype of 'tradition'. Such research is greatly needed as it sheds light on significant intended and unintended consequences caused by modernisation process which, if they are not solved, will cause a serious crisis in the near future. Also, this research is significant in setting out the principles that should underlie the sustainable design of new habitat, principles which establish a useful basis for the development of new regulations by policy makers. It will help to form future sustainable building regulation in the context of Saudi Arabia.

1.9 METHODOLOGY

Identifying design deficiencies of current buildings and finding solutions to improve the performance with an ambition to minimise electricity use is one of the common methodologies in the field of architectural science. Two studies have been conducted in Saudi Arabia on residential buildings aimed at improving current buildings. In Riyadh in the Central region of Saudi Arabia, a significant reduction in energy consumption between 15%-34% has been achieved by retrofitting buildings by adding shading elements, efficient glazing and onsite renewable energy (Aldossary, Rezgui & Kwan 2014). Another study conducted by Taleb in Jeddah in the Western province of Saudi Arabia proved that
retrofitting an existing building by adding appropriate shading and efficient glazing can improve the sustainability performance by minimising the energy consumption by up to 32.4% (Taleb & Sharples 2011). On an urban scale, Huang in his study on sustainable energy measures in residential areas in Sacramento concludes that adding trees in the suburban area can reduce house cooling loads by up to 40% (Huang 1987 cited in Ko 2013).

Another methodological approach employed by many scholars is the analysis of traditional settlements in order to understand and establish climate and socio-cultural response design principles that may be used for future planning. Al-Lyaly has investigated the urban and house form elements in Jeddah, Saudi Arabia, and used a data logger to study the comfort levels created by the traditional house form, which was in this case a wooden screened tower house type. He concludes that the urban form, in addition to the well-ventilated structure of the house, created a significant cooling effect, thus occupants are able to achieve adequate comfort levels inside the house (Al-Lyaly 1990). On the other hand Al-Bakri has focused on the courtyard house in the central region in Saudi Arabia. He finds that the house form plays the main role in providing comfort levels for the occupants (Al-Bakri 1997).

Based on these methodological approaches, this research combines both techniques; on the one hand investigating the form and climatic and social performance of the traditional urban and house form, and on the other, identifying the deficiencies of the current practice in the light of the traditional fabric in order to improve existing conditions and to set guidelines for future planning.

“The origin of vernacular urban form and its elements are not exactly provable and the characteristics are not always transferable to contemporary and advanced designs. But the knowledge and reflection of main aspects help to find culturally adapted design solutions” (Wirth 2002: Cited by Wehage in Pahl-Weber et al. 2013, p. 60)

Both King and Talib have produced research to suggest that traditional houses in Saudi Arabia were effective in achieving socio-cultural and climatic comfort in the hot weather (King 1998; Talib 1984). Although such studies need to allow for the development over
time of differences in acceptable comfort levels, and in particular, discrepancies in
tolerance of high temperatures and humidity, in this research, building on these previous
studies, the approach is to undertake a thorough, precedent-based qualitative and
comparative study. Comparisons between traditional and contemporary dwellings are
needed in order to understand the interrelated climatic and cultural aspects, and their
material outcomes. Qatif in the Eastern Province is the preferred case study site in this
thesis because, while it is also the author’s home town, and thus very familiar, it also
exemplifies the overall situation in Saudi Arabia. Qatif city was once an old town of
ancient origins and substantial size which has now been replaced entirely by a modern
town. This is not to say that all aspects of Qatif will apply through the country. However,
while climatic factors in different regions in Saudi Arabia may differ, the cultural aspects
will be consistent.

The research progresses through different stages in order to achieve its stated goals and
objectives. Firstly, it starts by collecting data from different resources using various
strategies. Based on the data, a thorough analysis is undertaken of both traditional and
contemporary home environments. Finally, design strategies are articulated for
implementation in the current home environment, and guidelines are suggested for
future planning. A detailed description of these three stages of the methodology is
highlighted in the following chapter.

1.10 RESEARCH METHODOLOGY LIMITATIONS

This research has encountered several challenges, predominantly during the fieldwork
stage. Firstly, the extensive demolition of the traditional town in Qatif, and the poor
conservation practices applied to historical sites in Saudi Arabia, was a significant obstacle
to learning about the traditional town. Thus, the researcher relied on the evidence
provided by the few remaining traditional houses supplemented by information collected
from literature, although very little was written on this specific area. Therefore, it was
necessary to supplement the study with research into traditional housing of similar
cultural patterns and climatic conditions.
Secondly, the conservative Islamic culture in Saudi Arabia has limited the data collection on the domestic level. In Saudi Arabia familial and female privacy inside the house is one of the sensitive domains that should not be intruded upon by strangers. To avoid intrusion into this domestic privacy invasion, the researcher relied on information from two sources. The first source was local architectural offices, as they have daily interaction with the Saudi family needs in Qatif. The second source was the available literature related to domestic patterns of use in the Saudi culture. However, there were exceptional cases where the researcher was able to be introduced to people while collecting data from the traditional town and this will be explained in the following methods chapter.

1.11 TARGET AUDIENCE

The research that forms the basis of this thesis is intended to provide beneficial assistance to planners and legislators as a preliminary study into cultural and energy sustainability in Saudi Arabia. For planners, it embraces the need for a radical change in the current planning strategies. It sheds light on the socio-cultural and climatic deficiencies of the current planning, and establishes principles that should underlay sustainable guidelines for current and future planning. For legislators, this research is of significance in setting out a preliminary framework for the practical implementation of the strategies.

1.12 RESEARCH CHAPTERS

This research consists of seven chapters. It starts with this introductory chapter which places the study within the broad field of sustainability in the housing sector in Saudi Arabia. It demonstrates the key concepts of the study. It establishes the context of energy crisis and the housing sector in Saudi Arabia. It also illustrates the energy efficiency applications in the housing sector in Saudi Arabia and the neglect, up to the present day, of legislation in Saudi Arabia for public and private conservation of energy. This chapter reveals the current knowledge gap and deficiency of practice which has not previously been considered. Thus, the importance of the study will lie in addressing this lack of research, from which the research questions will be raised. It also illustrates the aims and
objectives of the study and clarifies the research challenges, in particular the conservative cultural concerns in the Saudi Islamic culture. Based on the literature review the appropriate methodology for this study will be set out.

Chapter Two highlights the research questions and the fieldwork conducted during the first stage of the dissertation. It sets out the work that has been undertaken in collecting the data needed for the research. It presents the methods of data collection in the traditional town and the contemporary home environment.

Chapter Three sets out an overview of Qatif’s built environment. It includes the historical, geographical and climatic background of the research focus area. It also highlights the effect of population growth on urbanisation. It ends by setting out the expectation of the urban and house form based on the presented data. This will provide a basis in the following chapters for understanding the hidden interrelated factors behind the production of the physical environment.

Chapter Four presents the traditional home environment in Qatif investigating the climatic and socio-cultural qualities of the traditional physical domestic environment. This chapter situates the domestic environment in the context of the neighbourhood and town and the physical configurations of domestic structure in relation to climate and socio-cultural aspects.

Chapter Five sets out the contemporary home environment in the light of the traditional home environment. It illustrates the main climatic and socio-cultural deficiencies of the contemporary residential area in Qatif.

Chapters Six and Seven establish design guidelines based on the previous analysis. In Chapter Six, the guidelines consist of steps that will improve the existing conditions by retrofitting recommendations to enhance the socio-cultural and climatic response of the home environment. Chapter Seven sets out design guidelines for the future climatic and socio-cultural sustainable home environment in Qatif. It also sheds light on the role of policies to assure the best sustainable practice.
The conclusion summarises the research findings, sets out recommendations and offers suggestions for future study.
RESEARCH QUESTIONS & METHODS
2.1 INTRODUCTION

The previous chapter introduced the scope of the study by stating the research problem, namely, the lack of studies in Saudi Arabia that link culture and climate to the production of sustainable socio-cultural and energy-efficient home environment. This chapter introduces the research questions and stages, and outlines the research methodology and the necessary fieldwork to collect the data for the purpose of the study.

This research represents a critical analysis of the sustainability of socio-cultural and climatic response aspects of the contemporary Saudi home environment (with a focus on Qatif) based on a qualitative comparison with the traditional home environment. The comparison helps to identify the problems of the current design practice in Qatif’s modern suburbs.

2.2 RESEARCH QUESTIONS

The research poses six questions classified into three groups, as follows:

Group one: understanding the aspects of the traditional home environment

This group asks: How did climate and culture work together to produce the physical configurations of the traditional town in Qatif? This question aims to investigate and define the mechanism behind the formation of the old town. It also aims to analyse the context starting from the urban form, streets and houses. The analysis investigates the way the physical form facilitates and encourages the daily activities in respect to socio-cultural and climatic concerns. The question is investigated in Chapter Four.

Group two: understanding the deficiencies of the contemporary home environment

This group poses four questions in the light of the traditional town:

1. What are the design deficiencies of the current Saudi home environment that contribute to high energy consumption? This question aims to investigate the current suburban planning characteristics and pattern in relation to climate. It is then connected to the second question, which asks
Chapter 2  
Research Questions and Methods

2. What are the design deficiencies of the current Saudi home environment that contribute to the breakdown of communal social interaction? This question aims to interrogate the link between the climatic response of the physical form and its role in encouraging or discouraging the social interaction.

3. With regard to the issue of energy consumption at the neighbourhood scale, what are the design deficiencies of the current Saudi neighbourhood that contribute to energy consumption and the breakdown of communal social interaction? This question aims to investigate the deficiencies in climatic response on a neighbourhood scale by analysing the housing arrangement in relation to climate and socio-cultural needs.

4. What are the design deficiencies of the current Saudi house design that contribute to energy consumption? This question investigates the effect of the form of the house and the role of building regulations in limiting the choices of the residents by not respecting cultural and climatic needs. This leads to understanding the issue from a different perspective. The questions are investigated in Chapter Five.

Group three: implementation principles, for the current and future domestic environment, that aim to create an environment that respects climate and culture and encourages social interaction, with the ambition to reduce energy consumption spent on active cooling.

Based on the comparative analysis this group asks the question: What are the principles that should underline a social and energy-sustainable domestic environment at the individual, neighbourhood and wider scale? This question looks at setting climatic and socio-cultural design strategies to improve the current home environment in addition to future planning for the Saudi home environment in Qatif. This question is investigated in Chapters Six and Seven.

2.3 RESEARCH STAGES

The research requires a descriptive approach to achieve the goal of illustrating the positive and negative aspects of the contemporary home environment in Qatif. As noted in the introduction, the research is undertaken in accordance with a qualitative,
comparative analysis method. Basically it compares the traditional and contemporary home environments, in particular its physical form in terms of climatic and socio-cultural responses. To achieve the aims and objectives, the research progresses through three main stages: These stages are: the data collection stage, the analysis and the design strategies stage. Each stage incorporates different strategies (Figure 2.1) which are discussed in the following sections.

2.4 DATA COLLECTION

The aim of the data collection is to build a strong understanding of the issues related to the built environment in order to write a critical descriptive analysis. This stage was undertaken in two phases: the literature review and the fieldwork phase.

2.4.1 Literature Review

The literature review is a significant part of the data collection stage which assists in fulfilling the research requirements. The research started with a comprehensive literature search in order to understand the parameters that determine energy consumption in houses in general and in Saudi Arabia in particular. Information was collected through books, papers, and online data about the concept of energy efficient houses and what has been done in the architectural field to make houses more energy efficient. Focus was given to the Gulf countries, especially Saudi Arabia.

2.4.2 Fieldwork

Rubin and Rubin note that “Which data-gathering tools you use depends largely on the research question at hand” (Rubin & Rubin 2012, p. 14). Thus, based on the previously mentioned research questions the data collection was carried out as follows.

The fieldwork was divided into two phases: the traditional and the contemporary fieldwork data collection. The researcher relied on the following tools for data collection: observing and recording, visual photographs and interview.

The fieldwork was based on an observational and recording approach which is an effective architectural research tool that helps in understanding phenomenon in architecture.
Observing and recording traces provides valuable information about the physical environment and the way people use and interact with it (Zeisel 1981). Thus, it was an important task in the fieldwork to record all traces related to culture and climate which helped in understanding the issues related to the research topic.

The visual data was collected through photographs, a practice which is supported by Ball & Smith, who state

“Photographs of people and things stand as evidence in a way that pure narrative cannot. In many senses, visual information of what the people and their world looks like provides harder and more immediate evidence than the written word; photographs can authenticate a research report in a way that words alone cannot.” (Ball & Smith 1992, p. 9).

Although visual data in the form of the photograph is an effective tool, in the Saudi society it should be obtained with caution as it is culturally inappropriate to take photographs of females in public areas as it is considered an intrusion on their privacy. Thus, the visual data collection in the fieldwork focused more on the physical configuration of the built environment.

The interview serves as an important tool for currently topical issues within cultural and sociological studies (Rubin & Rubin 2012). Thus it is one of the research tools that are widely used in architectural research if issues related to specific topics and cultural questions are to be investigated. Its importance derives from the fact that it helps to prove the observations carried out by the researcher. It also aids in the research process used to test the hypothesis.

These data collection strategies were used for both traditional and contemporary home environments. The methodology was as follows:

- **The Traditional Town**

In order to get preliminary information about the traditional town in the Eastern Province, the archives in Dammam’s local museum were examined and discussed in an arranged
meeting with the manager.\(^1\) Visiting the museum enabled the researcher to develop an understanding of the traditional fabric. The museum contains a great deal of information and books about the traditional houses and the way people formerly lived in them.

Unfortunately, the traditional town was almost completely demolished, and only a few houses in a bad condition were available to study.\(^2\) This is an obstacle that, in truth, hindered the investigation process. Consequently, it was necessary to rely upon oral history in order to supplement the dearth of historical data on the traditional town of this area, especially with regard to the urban form which was difficult to imagine as a result of the demolitions.

Through the museum director, the researcher was referred to Mr Algheryafi, a local school teacher, who is an amateur historian with extensive knowledge of the traditional patterns of inhabitation in Qatif. Mr Algheryafi provided detailed information about the processes of local traditional construction. He also guided the researcher on site visits to the remains of the traditional town and three of the surviving traditional houses in the old town where it was possible to record, measure and draw sketches. During these visits the researcher used photography as a tool to get sufficient detail to be able to later digitally model the houses. In relation to these houses, Mr Algheryafi explained the construction materials preparation, pre-construction, the construction process, the use of space in the traditional house and passive cooling building techniques. He also provided the researcher with some photographs from his own collection which explain more about the traditional houses. In addition, his testimony can be verified with other technical and historical reference books and papers.

The three houses Mr Algheryafi referred the researcher to were, despite their bad condition useful in drawing the original plans, and could be photographed and measured; the principles underlying construction of the traditional Qatifi house were drawn from them. In fact the houses, on the basis of other archival information, represent the

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\(^1\) Dammam is the capital city of the Eastern Province of Saudi Arabia which houses the central museum "Dammam’s museum" which contains all historical materials of the cities of the Eastern province including Qatif.

\(^2\) The researcher is confronted with the fact that it is going to be very hard to find a house in a good condition to conduct the study. This is similar to what was encountered by other Saudi researchers when they conducted studies on other regions in Saudi Arabia. This scarcity in the traditional sites is the result of modernisation and lack of awareness as to their value and importance. However, experts in the museum claim that there is one house which is worthwhile to visit and it represents the houses in the old town in this area.
traditional houses of the region, which conform to a typology of regional architecture that had endured for thousands of years. They are all courtyard houses built of local materials (King 1998; Ragette 2003; Talib 1984; Edwards et al. 2006). However, an examination of this particular study area was needed in order to grasp the specificity of such a place. It should be noted here that although the houses were all not in a good condition, the researcher was nevertheless able to choose the one in the best condition which contains the common elements of the other three houses to measure and draw for this research.³

It is important to mention that the fieldwork was carried out over a two month period which was longer than anticipated. The site visits were carried out incrementally because in winter the days are short, and a reliance on daylight was needed to measure and take photos. During several visits to the traditional sites, all comments on the houses made by Mr. Algheryafi were recorded, as well as the researcher’s personal observations and investigations of the site context such as streets, open spaces, the orientation of the openings, and some traces of what could have previously existed. Apart from taking photos and drawing a plan for each house and section to details of some elements in the house, the researcher visually reconstructed the setting as some remaining fragments helped to establish the original traditional situation.

In addition, it was important for this study to focus on the topical part and combine it with a cultural reading. Rubin and Rubin note: “In some cultural studies, the researcher focuses on the ways in which norms, values, and expected behaviours play out in specific settings.” (Rubin & Rubin 2012, p. 33). This is what is called by Rubin & Rubin “topical study” : topical studies answer the questions of “what, when, how, why, or with what consequence” (Rubin & Rubin 2012, p. 32). In this sense the researcher looked at the physical form and its relation to climate and its link with cultural norms and values. In this regard, it was vital to understand and analyse the use of space in the traditional house with regard to weather circumstances and cultural specifications. Despite the difficulty of finding and meeting people who had lived in the traditional town, the researcher managed to meet three people who helped to build the picture. The first house was

³ This house is located on Tarut Island.
occupied by a nuclear family. The head of the family, one of the grandsons, had inherited the house after the death of his parents. He proved to be a good source of information as he has not left his house since he was a child and very informative regarding the use of space. In the second house the researcher met one of the grandsons, who arranged a meeting with his grandmother who can still remember the use of space in the traditional houses and its association with the cultural and climatic concerns. In the third house, the researcher met one of the grandsons who used to live in the house until quite recently and he was a good source of information as well.

The interview consisted of a free exchange between researcher and respondent about the use of spaces and the occupant’s movement and inhabitation in day and night, summer and winter, inside and outside the house. Furthermore, the interview focused on the cultural issues such as the use of space during the attendance of non-familiar male visitors. Also, understanding the focus on the daily routine was important in relation to the climate. The questioner allowed the respondent to talk freely without interruptions as this helped to draw a picture about the use of domestic space in the traditional house which assisted in the interpretation and analysis of the physical form. During the conversation the researcher drew a sketch to record the information about the use of space in relation to climatic and cultural specifications, which was approved by the respondent.

- **The Contemporary Suburb**

The focus in the contemporary home environment was on the common design features in Qatif’s suburbs and houses. As mentioned earlier, the data collection was based on observation and recording, visual photographs and interviews in addition to the information collected from the literature in the first stage.

Observation, recording and photographs were taken by the researcher in different typical suburban situations in Qatif. The purpose of this recording aimed at reflecting and understanding the common practice in Qatif’s contemporary suburbs. During the observation, the photographs pertain to the twin issues of cultural appropriateness and environmental sustainability, with a focus upon energy consumption.
However, with regard to the private Saudi home, there are cultural restrictions on familial privacy. Therefore, it is not acceptable to visit their houses and take photographs. For this reason, in contemporary houses the best way to obtain information was through the following sources:

- **Architectural Offices**

It was very important for this study to grasp the consideration and limitations in the design process when designing a house for a Saudi family in Qatif. It was also important to understand the contribution of energy consumption issues upon design and building regulations. In addition, a focus was given to the climatic and socio-cultural consideration during the interview.

Data on contemporary houses was collected from selected architectural offices that are extensively engaged in modern Saudi housing design in Qatif. Visiting architectural offices served two purposes: firstly, to conduct an interview with the designer, and secondly, to be provided with architectural drawings for current Saudi houses that represent the common design.

Alawami Planners and Consultant Office is one of the biggest, and most awarded architectural offices in Qatif. With this in mind, an interview was conducted with the company Vice-President Mr Hussain Al-Jumaa, focusing on building regulations and their restrictions in terms of climatic and cultural considerations.\(^4\) The interview also focused on Saudi families’ preferences and the architectural offices’ role in designing a satisfactory outcome.

At the end of the interview, the researcher was provided with examples of common plans that represent the current practice for typical size with a common design for a modern Saudi house of a typical Saudi family size in Qatif.\(^5\) These enabled the researcher to later digitally model these houses, to enable environmental and cultural comparisons with the

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\(^4\) Mr Hussain M. S. Al-Jumaa is the vice president of Al-Awami Planners and Consultant Office. He used to meet with Saudi families before and during the design stages to discuss their preferences and changes in design of their houses. On this bases I was confident that the information provided by him is reliable.

\(^5\) For client’s privacy reasons the researcher is not able to get more than three houses. However, they represent the current common practice.
traditional housing case studies. These plans help in the analytical component of this research in understanding Saudi families’ preferences in relation to zonal distribution, and to reveal the effect of building regulations on the design process. They also helped to analyse and understand the effect of the suburban layout on the house plan and the location of particular zones.⁶

- **Interviews with leading researchers in the field of contemporary housing**

In order to establish the extent of current academic and professional research into the environmental performance of Saudi housing the researcher conducted telephone interviews with leading academic researchers, Dr Abbasi, Dr Al-hemeddi, Dr Adas and Dr Alshuwaikhat, regarding the latest work that has been done on environmental and cultural sustainability in the Saudi residential sector. All of them are academics in the architectural department at different universities in Saudi Arabia and are involved in research in the same field. Also, information was gathered from the architect Mr Alfadel, the vice president of the Saudi Green Building Forum SGBF, which was established in 2010, and who is also the manager of Faisal Alfadel Architectural consultant office. In addition, the Architect Mr Alnajim provided the researcher with information and materials around the topic.

### 2.5 INTERPRETATIVE ANALYSIS

The interpretative analysis stage aims to illustrate the aspects of the topic in a descriptive approach that discusses the research based on the data collected. It constitutes a thorough analysis of both the traditional and contemporary home environments. The traditional town is analysed in Chapter Four and the modern equivalent is analysed in Chapter Five. The analysis looks at the urban form, the streets and the houses for both home environments. It examines the climatic and cultural aspects from the following point of view.

The analysis of the urban form examines the urban layout in relation to climate and culture. In this sense the researcher looks at the functionality of the urban formal layout

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⁶ Throughout the study the researcher stayed in contact with the architectural office through emails and phone calls when further explanations or information are needed.
in creating cool public open spaces for social gathering. Secondly, the analysis moves to
the street level, focusing on the street design in relation to the question as to whether the
local climatic conditions encourage or discourage walkability and social interaction. This is
analysed by testing the street dimension and design and its role in creating cool outdoor
shaded space. Thirdly, the analysis focuses on the houses: the reasons underlying the way
houses are grouped, and their evidence for intentional responses in relation to climate
and cultural concerns, and the house form itself, with all the related aspects such as zonal
distribution and the use of space in relation to sun and wind, windows’ orientation and
design, and the options given by the house form to the occupants to tolerate and modify
the weather conditions.

2.6 DESIGN STAGE

The design strategies are presented in Chapters Six and Seven which are the outcome of
extensive architectural research, and constitute the creative component of the thesis.
Chapter Six discusses the retrofitting part and Chapter Seven discusses the proposed
principles for future sustainable neighbourhoods and housing types. Both of these are the
direct outcome of the data obtained through the analytical stage of this research. The
design strategies form an important evaluative and theoretical tool for the government
and the Ministry of Municipalities and Rural Affairs MOMRA in Saudi Arabia as they could
be used to set guidelines to improve the performance of current home environments and
as a guideline for future planning and building regulation. This use of research based
design norms has a precedent in developed countries like, SEPP 65 in Australia; liveable
neighbourhoods design guidelines also in Australia and CABE in England. The two design
foci of retrofitting and future planning are outlined below:

2.6.1 Retrofitting

“Retrofitting is the process of modifying something after it has been manufactured”
(Melbourne 2015). It is an effective architectural design strategy that has been used to
improve existing conditions. This strategy can be implemented on a city scale similar to
Yannas’s work when he implemented retrofitting on urban areas in London, Dhaka and
Athens to improve their microclimate (Yannas 2001). Similar to that was Gehl’s work in
setting recommendations to improve public life in existing conditions in Perth city in Australia (Gehl 2009). In a research project supported by the University of Western Australia, Alhajaj has done similar work in proposing modifications to be implemented on existing conditions on three scales to the city of Jeddah in Saudi Arabia to improve walkability and public health (Alhajaj 2014). On a building scale, retrofitting has been used to improve thermal performance by implementing insulation to old buildings with the ambition of reducing energy demand (Al-Ragom 2003; Yildiz 2008).

However, this research goes further, in looking at climatic and cultural retrofitting which entails making modifications to the existing conditions of streets, open spaces and houses. The retrofitting starts with presenting the traditional cases. Then it looks at the modern analogues from international examples. Finally, it implements principles to suit the climate and culture of the region.

2.6.2 Future Sustainable Domestic Environment

The future planning recommendations in Chapter Seven are also based on the comparative analysis. They focus upon the goal of setting guidelines for future planning that might enhance social interaction by providing a physical environment that works with culture and climate. The future planning chapter starts with the recommendation for a major shift in the principles of current suburban planning. The chapter then moves to the form of houses grouping housing clusters as opposed to disaggregated 'nuclear' housing. The discussion then moves to recommendations for the optimal configuration of the house form in Saudi towns like Qatif. In summary, the future planning is developed from the outcome of extensive research which focuses on improving the culturally and climatically specific context of this region of Saudi Arabia.

2.7 VALIDITY AND RELIABILITY OF RESEARCH METHODOLOGY

This research uses case studies to explore the principles of social and energy sustainability at both an urban and domestic scale for the eastern region of Saudi Arabia, focusing particularly on the coastal city of Qatif. Thus, it is important to state that although the findings are specific to Qatif, it may be possible to implement and adapt the basic
principles of the findings to other cities of similar climatic and socio-cultural aspects, both in Saudi Arabia and beyond, with the intention to minimise energy consumption and promote culturally appropriate social interaction. However, as noted in Chapter One regional differences need to be considered; for example, although the southern highland of Saudi Arabia is of a similar culture, it would be, however, very difficult to implement some of the principles suggested in this thesis because of the very different site topography and cool weather conditions which make it inappropriate to have, for instance, compact suburban planning. Thus, in these conditions, minimising energy usage will demand other strategies and urban layouts, whereas the response to cultural norms might be similar. It is therefore important to consider such regional differences in future planning of national sustainability policies.

2.8 CONCLUSION

This chapter introduces the research questions and the overall methodology used in conducting this research which is concerned with socio-cultural and climatic design aspects that should be considered and implemented in the design of a sustainable home environment with less reliance on air conditioning units. The research has three groups of questions. The first group is concerned with understanding the aspects of the traditional home environment with a focus on the climatic and socio-cultural aspects that led to the formation of the built physical form. The second group focuses on understanding the deficiencies of the contemporary home environment and the reasons that contribute to high energy consumption in the residential environment. The third group is concerned with implementing principles, for the current and future domestic environment, that aim to create an environment that respects climate and culture and encourages social interaction, with the ambition to reduce energy consumption spent on active cooling.

The second part of this chapter presents the data collection which was carried out through the literature review and the fieldwork trips. The literature review was a foundation for this research as it revealed the parameters and the work that was done in this research area. The fieldwork trips were conducted in Qatif by the author to collect the

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7 See Chapter One table 1.1
required data. Several techniques were used for collecting data for both traditional and contemporary home environment: observing and recording, visual photographs and interview. The literature and interviews supplemented missing data. This chapter also reveals the analysis stage which represents a crucial part of this research and comprises interpretive analysis for the urban layout, streets design and house design, based upon the collected data. Finally the chapter explains that the creative work stage will consist of implementing design strategies for both current and future planning. The current design utilises retrofitting for current conditions. This is through proposing forms to be implemented on the suburban as well as the house level to improve the climatic and socio-cultural aspects. For future home environment design principles, the research proposes urban form configurations and a house form that respects climatic and socio-cultural needs with an ambition to create a sustainable home environment with less energy demand.
Chapter 2

Research Questions and Methods

Literature Review

Fieldwork

Analysis

Traditional Home Environment
Contemporary Home Environment

New Design

Retrofitting
Future Planning

Traditional Examples
Modern Analogue

Suburb Planning
Houses Arrangement

Retrofitting
House Form

Figure 2.1: Research Framework and Stages
AN OVERVIEW OF QATIF’S BUILT ENVIRONMENT
3.1 INTRODUCTION

The previous chapter posed the research questions undertaken through this thesis, and the methodology used in order to collect the data for this research. This following chapter introduces the regional town of Qatif, the test scenario for the study, in five main sections: the first section presents the regional location and topography of the town; the second part gives a brief historical background about the development and modern transformation of Qatif; the third section is concerned with the specific local climatic conditions of Qatif; the fourth section focuses on the population growth in Qatif and the effect of urbanisation associated with population growth on the environment, and the fifth highlights the expectations of the urban form and the house form and how they should be responded to, based on the presented data.

3.2 LOCATION AND TOPOGRAPHY

Qatif is located 26.5° N and 50.2° E on the Arabian Gulf in the Eastern Province of Saudi Arabia (Figure 3.1). It is situated to the north of the Tropic of Cancer on the Eastern coast of Saudi Arabia. It belongs to Dammam district which is the capital city of the Eastern Province. \(^1\) Qatif occupies an area that extends 18 miles from north to south and 3 miles from east to west. The eastern side is connected to Tarut Island which belongs to Qatif (Figure 3.2).

Topographically, Qatif is at the centre of a farming district, and is well known for its fertile soil and its palm grove farms. It was also traditionally well known for its natural aquifers supplying the valuable resource of spring water (Talib 1984; Almoslem 2002), thus leading it to be called Qatif oasis. It is the second largest oasis after Alhasa in the Eastern Province. Qatif is bounded by the Arabian Gulf on its eastern and southern flanks and by the desert on its other boundaries. Traditionally, that is to say about seventy years ago, the town served as a harbour on the Arabian Gulf for trade, fishing and pearl divers. Many goods such as spices and clothes were imported to this region coming from different parts of the world. Now a days it is the main fishing port in the region.

\(^1\) Qatif and Dammam are located on the same latitude thus they share the same weather data.
Figure 3.1: Qatif’s location in the Eastern Province on the Arabian Gulf.
Figure 3.2: Qatif connected to Tarut Island on the Arabian Gulf.
3.3 **HISTORICAL BACKGROUND**

Qatif is one of the oldest historical towns in this region.\(^2\) Its history is estimated to extend back at least 5000 years (Emara 2011). Due to its location on the Gulf coast, Qatif has witnessed the passage of many civilizations including the Sasanian Empire. Shapur I, the founder of the Sasanian Empire, took this area as a military base where he built a fortified city in 226-241 AD, which is believed to be Qatif’s traditional town *AlQala’a* (Almoslem 2002). It was built on an elevated plateau of land surrounded by a lofty rampart that contained three large main gates with nine watch towers to protect it from enemies (Figure 3.3).\(^3\) The central area of the citadel was occupied by the royal family. It was filled with gardens, watered by canals penetrating the *AlQala’a* ramparts. After the fall of the Sasanian Empire, the fortified city was then used in the Islamic era as a depot for goods like perfumes and spices coming from Tarut Island, as Qatif was closer to the central market. Then it was finally used as a residential area when it was colonised by the Ottoman Turks in 1871 AD and incorporated into the Ottoman Empire (Almoslem 2002). It was under the Ottoman Empire until the First World War when the forces of Al-Saud recaptured the country, with the support of the British, who were at war with Turkey's ally the German Empire and the Ottomans evacuated (King 1998).

In the early 1900s, after the Arabian Peninsula was united under the ruler King Abdulaziz Ibn Saud, it was renamed Saudi Arabia. From that time onwards, Qatif was ruled by the house of A-I-Saud. King Abdulaziz Ibn Saud brought foreign experts to search for oil. The economic growth started immediately after the Second World War following the discovery of vast reserves of oil in the Eastern Province of Saudi Arabia in 1938. Since then many sites have been found and this has further propelled economic growth. The wealth from the revenues accruing from the discovery of oil has brought about a radical change to the country in all aspects of life. One of the obvious transformation has been the change of the physical built environment (Eben Saleh 2002). Since the 1950s modernisation the inevitable companion of advanced industrialisation, has spread all over Saudi Arabia.

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\(^2\) The name Qatif city refers to the whole area which includes many rural areas besides Tarut Island.

\(^3\) Fortified cities were the main characteristics founded in other traditional Islamic cities such as Cairo, Damascus and Tunisia.
Qatif was no exception to this change and the city of Qatif has expanded in both its commercial and residential districts as a result of the population growth and wealth that accompanied the oil revenues. The expansion caused change which started with the demolition of the *AlQala’a* walls to accommodate the growing population numbers (Almoslem 2002). New suburban planning and a new housing image have been introduced to Qatif, as in the rest of the country, but without adequate concern for climatic and cultural responses that should be offered by the built environment. This will be elaborated in Chapters Four and Five.

![Image](image.jpg)

**Figure 3.3:** The northern wall of Qatif’s traditional town in 1945 before its demolition. The town is bordered with palm trees farms.

### 3.4 CLIMATE

To understand the interaction between a particular urban and house form in a particular climate, and the adaptation to such a climate, it is essential to understand the weather conditions as this will aid the interpretations of the aspects of the physical form in Chapters Four and Five.

Due to its location, Qatif is characterised as belonging to a composite climate zone. In summer the weather is hot and dry or hot and humid. In contrast, in winter the weather is pleasant. The climatic data is set out below.
3.4.1 Solar Position and Regularities Associated with Latitude

Correct building orientation has long been a principle of modernist architecture: “A larger part of the architect’s task is to position a building so as to take best advantage of the sun’s value for thermal effect, hygiene, and psychological benefits” (Olgyay 1963, p. 53). Thus it is important to understand the solar position in relation to the latitude. 4

In winter the sun is lower in the sky; thus the day is shorter and the sun is less intense. The shortest day in winter is the 21st of December. On this day the sun on the latitude of 26.5 N, where Qatif is located, travels at 120 degrees azimuth from sunrise till sunset. The solar altitude at noon is 40.0 degrees. On this day daylight lasts for about 10:29 hours. In winter the latest sunrise has been observed on 12th January at 6:31am and the earliest sunset is on 30th November at 4:48pm (Spark 2012).

In summer the sun is high in the sky. Therefore, the day is longer and the sun is intense. The longest day in summer is on the 20th June, the azimuth is 297 degrees from sunrise till sunset (Figure 3.4 and Figure 3.5). On this day, the day light lasts for about 13:48 hours. The earliest sun rise is on 10th June at 4:47am. The solar altitude at noon at 11:45am is 93.0 degrees. The latest sun set has been observed on 1st July at 6:38pm (Spark 2012).

Due to sun intensity, the urban form should offer effective solutions to protect pedestrians and residents from extensive solar radiation while using the outdoor spaces. This requires a careful consideration of the way buildings are arranged and oriented so as to create shaded pedestrian streets and outdoor spaces. In addition, canopy elements may be provided to create shade. Buildings’ western openings need to provide careful shading due to the sun low angle in the afternoon.

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4 Developers will maximise profit at the expense of good orientation if this enables them to fit more house blocks into development. Therefore legislation is required to ensure compliance. See Chapter Seven.
Figure 3.4: Sun path diagram for 26.5° N
3.4.2 Dry Bulb Air Temperature

Qatif’s temperature tends to vary over the entire year from 10°C to 45°C. The dry bulb air temperature graph shows that the summer months last from early in May until the end of September. The average daily high temperature in summer is over 40°C. On average, the hottest months with the mean maximum dry bulb air temperature are June and July where the temperature can reach up to 45°C. The mean minimum air temperature in the

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1 Dry-bulb refers usually to air temperature in a ventilated area protected from sun radiation.
hottest months is about 30°C. According to the graph, the hottest day of the year is the 21st of July when the temperature can reach its highest at an average 45°C (Spark 2012).

Winter lasts from the end of November to the end of February. During this period the average maximum temperature is less than 25°C. The coldest period is early January when the temperature may reach its minimum at 10°C and its maximum at 21°C (Spark 2012) (Figure 3.6).

Figure 3.6: Daily high and low temperature. (2004-2012)

3.4.3 Relative Humidity

Qatif’s coastal location, bounded by the desert from the other sides, has the largest impact on its weather. Over the course of the year the weather ranges from very dry to humid. The relative humidity ranges from 8% to 79%. The driest month is June with a relative humidity that is below 8% around the end of June. The beginning of February is the most humid period when the humidity may reach above 74%. However, the humidity in this area rarely reaches below 6% or exceed 89% (Spark 2012) (Figure 3.7). This indicates that both the urban and house form, besides shade, should offer well ventilated areas that allow air circulation. Built form that offers shaded spaces in addition to ventilation increases comfort level in the built environment.
3.4.4 Prevailing Wind

According to Olgyay 1963, there are three important sets of wind data that have to be analysed in order to understand the effect of wind on human comfort. With consideration given to its direction, these data are: the prevailing wind direction, the wind velocity interpretation and its effect as a cooling or heating factor (Olgyay 1963).

In Qatif the wind could be described as usually being calm to fresh breeze. This is because throughout the year the wind speed varies from 0m/s to 10m/s. Strong winds with 13m/s or more are rarely experienced. Around the 23rd of June, the area experiences a gentle breeze with the highest average of 5m/s, whereas the average maximum daily fresh wind speed is 9m/s. In mid-October the lowest average wind speed occurs, causing a light breeze with a speed of 3m/s. Whereas the moderate breeze occurs with average daily maximum wind speed of 6m/s (Spark 2012) (Figure 3.8). Qatif witnesses wind coming from the north-west direction 21% of the time; from the north the wind frequency is 19% of the time and from the west the wind incidence is 17% of the time. A southern-western wind direction occurs only 3% of the time (Spark 2012) (Figure 3.9 and Figure 3.10).
Based on the wind data, despite the calmness of the wind it is expected that the built form gets benefit as much as possible from the prevailing wind direction, especially in the traditional town and houses where there was no means of mechanical cooling. Thus, the physical form should allow prevailing wind access to urban spaces; in addition, the houses’ formal configurations should allow air circulation by responding to prevailing wind direction as much as possible.

Figure 3.8: Wind speed between (2004-2012)

Figure 3.9: Wind direction over the course of the year. (2004-2012)
3.4.5 Precipitation

The area witnesses three forms of precipitation during the year: thunderstorm, moderate rain and light rain.

Thunderstorms are detected on 55% of the total days of precipitation; April alone experiences 15% of those days. Moderate rain forms 26% of the precipitation days. The 22nd of January has the highest average incidence of moderate rain (6% of total falls of moderate rain). Light rain forms 18% of the precipitation days. It occurs more frequently in the period around 29th January and it forms 5% of the precipitation days (Spark 2012) (Figure 3.11 and Figure 3.12).
3.4.6 Dew Point

Based on the previous weather data analysis and its variables for the studied area, it is clear that for human comfort, a dry season with less humidity is the optimum condition. This is because dry weather encourages evaporation to occur on the skin and this increases comfort. Thus, weather with low dew point is dry and preferable. Therefore, the period towards summer between the beginning of March and about the 21st July and the winter period between the beginning of November and the 9th December are the most comfortable because they have a low dew point and are the driest periods (Figure 3.13). This indicates that there are about seven months of the year where residents may feel comfortable if passive cooling strategies were applied. This suggests that in the summer dry months between the end of February and the end of July, passive cooling techniques which encourage evaporative cooling will be effective if applied to the physical form.
3.5 URBAN GROWTH AND POPULATION

Qatif’s population was about 12,000 prior to the expansion of the Saudi oil industry (Emara 2011). In 2004 the population reached 473,454 (Information 2010a). In 2010 Qatif’s population was estimated to be 559,263 with a compounded annual growth rate of about 2% every year and approximately 10% every five years (Information 2010b). Thus, it is expected to reach about 599,117 in 2015 in 2020 the population is expected to reach 659,941, and 711,398 by 2025 (Information 2010b). This rapid growth rate puts severe pressure on the area to accommodate the growing population and this has had a negative impact on the area especially compounded by inappropriate urban planning that does not consider the local environmental conditions. This seems to be a significant problem for cities along the Gulf sea shore as Khan and Kumar state:

“Saudi Arabia along with other Arabian Gulf countries has undergone rapid development in infrastructure following the discovery of oil in 1930’s. The coastal cities have seen major expansion resulting in land reclamation and dredging of the adjacent coastal areas. In the Gulf states such activities started in 1960 and are still continuing with the major impact on the coastal areas adjacent to Arabian Gulf Coast.” (Khan & Kumar 2009, p. 161)

Qatif is one of the coastal cities that have been impacted by development. Changes in construction practice and new forms of inhabitation responding to growing population needs have caused many problems for the natural environment in Qatif. According to Alhammad, desertification covers approximately 31% of Qatif’s land. This is a consequence of the deforestation and construction activities which have caused destruction to the natural life and ecological balance (Alhammad 2012). On the basis of current growth being sustained into the future that is, if no serious action were to be taken it is predicted that within one to two decades the green land will disappear completely. In the ten years between 1989 and 1998 the farming land in Qatif was reduced significantly from 7319 hectares to 7020, and in 2002 reduced to less than half the area in comparison to 1998 (Alghanm 2007).

Another environmental problem associated with population growth and inhabitation pattern is the loss of mangrove trees along the coastal area. Urban development in Qatif has extended to the Gulf sea for reclamation activities (Khan & Kumar 2009; Alhammad
2012). A common practice is to fill the sea in order to have more land to build residential areas whereas there is a vast area on the western side of Qatif where residential suburbs could be built (Alghanm 2007; Alhammad 2012). Destroying the green land and filling the sea contribute significantly to increasing heat levels in the area; thus contributing to further reliance on mechanical cooling. Consequently this practice contributes to global warming as well. Thus there is an urgent need to focus on creating a sustainable built environment without contributing to an increase in the urban heat. A detailed discussion is presented in the following chapters.

### 3.6 EXPECTATIONS OF HOME ENVIRONMENT RESPONDENTS IN QATIF

Based on the presented climatic data and on the hypothesis that the traditional urban and house form functioned satisfactorily in extreme climatic conditions (although there were times of the year where the climate offered comfortable conditions), it is expected that the traditional physical urban and house form in uncomfortable summer conditions offered well protected spaces from solar heat and made good use of the prevailing winds and breezes to allow evaporative cooling. An aerial view of the old town of Qatif indicates that it is similar to analogous traditional Gulf towns in the same climatic region which are characterised by narrow streets, courts and dense courtyard houses. Thus it is expected that the urban form offered shaded breezy streets and areas where residents could meet and socialise. Also it is expected that the house offered through its configurations some techniques to deal with the climate. This means that the built form was able to reduce heat to the point where residents felt comfortable.

From the presented data, it is clear that the region witnesses long hot summer months which are difficult to cope with unless there is a significant change in the micro-climate by means of passive cooling or mechanical cooling. In Riyadh in the central region, a traditional town in Saudi Arabia with similar climatic conditions and similar built form to Qatif, it was observed that there was a 5°-15°C difference in day temperatures in the town as a whole and 10°-12°C between the inside and outside of the traditional house (Talib, 1984, p.50 and p.62). This suggests that on the hottest day in July when the temperature reached 45°C, the temperature of outdoor spaces varied from 30°-40°C whereas inside
the house the temperature varied from 33°-35°C. However, these temperatures fall outside the comfort zone in summer according to the comfort zone chart (Figure 3.14). Thus, it is emphasised that people who formerly lived in the traditional towns were accustomed to different comfort levels. These temperature variations would have been acceptable for residents in the traditional town, whereas Saudis in their current houses would not feel comfortable with this level of temperature as they are used to a mechanically cooled environment. The comfort zone chart shows that it is possible to extend the comfort range by applying passive cooling strategies. This has been achieved in modern houses in Qatif by mechanical cooling systems which have allowed residents to become accustomed to a certain level of comfort. The aim of the research focuses on integrating a passive cooling approach in the design in order to achieve a ‘hybrid design’ that combines both active and passive techniques.The research does not intend to copy the traditional but looks at the lessons that can be learned and the principles that can be extracted; the ‘hybrid design’ can then be implemented in the modern home environment to improve the built environment. The research investigates the climatic dimension in conjunction with the cultural dimension through the comparison between the traditional and contemporary home environment and is presented in the following chapters.

[Figure 3.14: The comfort range may be extended significantly with natural ventilation.]

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6 Graph’s analysis is done by the author.

7 It is important to state here that although comfort range could be extended by passive cooling, there are times of the year passive cooling is not going to be effective due to high humidity, particularly in the summer months of May, June and July.
3.7 CONCLUSION

This chapter has, on the basis of the climatic data and the urban and population growth statistics presented above, hypothesized that for Qatif, an ancient city built on the sea front, its location, climate and topography must have had a major influence on the formation of its built environment. On the basis of the data presented in this chapter, the researcher has hypothesized that the traditional urban and house form has evolved in response to the climate. The researcher has also noted the effect of the rapid population growth and rising prosperity stemming from the oil wealth, causing extensive urban expansion. In the following Chapters Four and Five, the researcher will provide evidence that this urban expansion has been undertaken in accordance with urban planning that does not consider cultural and climatic needs, and that this urbanization has also caused dramatic destruction of the natural environment.
CULTURAL AND CLIMATIC RESPONSES IN THE TRADITIONAL HOME ENVIRONMENT
4.1 INTRODUCTION

This chapter presents an analysis of the traditional home environment in Qatif, a town of houses which were traditionally of coral-stone construction, investigating the interrelation of environmental, spatial and cultural factors influencing the town’s morphology and housing typology. The analysis is based on the data collected from the literature and fieldwork by the author.¹ It illustrates the way in which the physical configurations of traditional houses enabled behavioural approaches that adapted to the local climatic and cultural context. Firstly, the morphological approach is illustrated through an empirical analysis of urban scale elements and individual house units. Also, the construction stages of a house and its organisation of spaces are analysed in terms of how they relate to climate responsive design. Secondly, the occupants’ behaviour in the house is discussed in relation to their approach toward physical and socio-cultural comfort in their built environment. These factors are proposed as an essential part of occupants’ adaptation to the climate. This chapter aims to show the interaction between the physical form of the house and occupants’ behaviour in response to both the climate and cultural specificities. In the following chapter, this perspective will contribute towards a culturally-nuanced understanding of the contribution of housing design to energy consumption of the contemporary house within the cultural context of traditional Saudi society.

4.2 THE MORPHOLOGICAL CHARACTER OF THE OLD TOWN IN QATIF

As mentioned in Chapter Three, Qatif’s traditional town was a fortified walled city bounded by a green area of palm groves. Similar to other oriental Islamic cities (Olgyay 1963; Oliver 1969; Ragette 2003), the traditional town of Qatif was characterised by a morphology consisting of a clustering of irregular courtyard houses.² This traditional form was a moderate dense settlement with narrow winding shaded streets (Figure 4.1).

¹ Fieldwork was done by the author in 2011. See Chapter Two.
² The same pattern has been found in other traditional cities with a similar climate of long hot seasons in North Africa, Syria, Iraq and Egypt.
The town was characterised by open courts of different sizes in a clustering of at least 24 houses comprising the residential neighbourhoods. The largest court was located in the northern part of the town. It contained the main mosque and a public bath (*hammam*). However, there were also small mosques in each neighbourhood. The market (*souq*) was located to the south west outside the wall. There were also some small suburbs outside the traditional town occupied by farmers and fishermen (Winterhalter 1981; Almoslem 2002) (Figure 4.2).

However, these characteristics are not limited to this region. As mentioned previously in Chapter One there have been markedly different traditional housing typologies found in Saudi Arabia that possess a different climate to Qatif. This suggests that climate had a major impact on the formation of the traditional settlements, even if the culture was a common factor. However, settlements are the product of interrelated cultural and climatic factors (Oliver 2003; Heath 2009). Rapoport states that socio-cultural forces are primary factors, while other factors are secondary in generating the built form. However, he believes that climatic conditions play a main role in generating the house form in the
absence of technology (Rapoport 1969). Therefore, it is important to understand the interrelation of both factors to be able to extract lessons from the past. The following explains how both factors worked to generate the physical environment in Qatif.

Figure 4.2: Qatif’s traditional town showing different urban court sizes which created hierarchy in the urban space.
4.3 SOCIO-CULTURAL SPECIAL RESPONSE OF THE URBAN SPACES

For centuries, socio-cultural norms and climatic factors evolved to produce the organic physical form of the old town of Qatif. The organic, urban spatial configurations were organised in a social and climatic hierarchy that is evident in the order of the town’s physical configurations. This urban form can be associated with meanings generated from the pattern of use of space and the social network existing within the town’s public, semi-public and private spaces. This is similar to other vernacular Islamic cities with a similar climate such as Baghdad, Damascus, Tunisia and Morocco (Oliver 1969; Ragette 2003).

Public areas such as the town’s main court were spaces where locals from different neighbourhoods would traditionally meet and, due to its large size, was the most exposed urban space to weather conditions. This court included public areas, for example, the market, mosques and main public streets were considered as public urban spaces where culturally significance gathering took place. Strangers were expected to be seen in these areas. In Qatif, like other traditional Saudi towns, there was a graduation from public to private space. Thus, in the residential quarter the streets and lanes became more private and spaces gradually became semi-private, more protected from climatic conditions, fewer strangers were expected and familiar faces of residents living in the same neighbourhood were seen. Because these streets were shared only by residents in the same neighbourhood there would have been a greater sense of privacy and safety. Thus, according to the resident,\(^3\) in these more private streets, a characteristic form of social behaviour was observed in which the neighbourhood children played in front of the houses and residents sat and chatted in the morning or in the afternoons. This pattern of social behaviour was described by Ragette in his study on the Middle-eastern traditional towns as “the balance between segregation and togetherness” (Ragette 2003, p. 51).

This hierarchy, as described by Habraken, is the result of the act of inhabitation which creates what he calls a deep territorial structure. This territorial structure developed in the traditional Middle Eastern towns, such as those found in Tunisia, in a “bottom-up growth”, as it started growing from the dwelling unit, then gradually generates the urban

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\(^3\) Former resident was interviewed by the author on 6\(^{th}\) January 2011.
hierarchy when the density increases (Habraken 2000). Bianca shares Habraken’s viewpoint, adding that the absence of “formal civic institutions” and the complete control in the hands of the residents has resulted in “organic” growth characterised by physical order (hierarchy) of space (Bianca 2000).

4.4 CLIMATIC RESPONSE OF THE PHYSICAL URBAN FORM

In addition to the evidence for incremental growth, based upon neighbourhood grouping, an observation of the traditional urban settlement of Qatif based on the weather data presented earlier shows a direct response to the different climatic conditions. The long, hot season in summer is the most uncomfortable period. Therefore, the objective of the traditional built form was to offer high protection from direct solar radiation exposure as well as to optimise evaporative cooling through natural ventilation. This climatic response is examined in the following sections.

4.4.1 Urban Form in Relation to Wind and Solar Exposure

The organisation of the urban built form indicates a very selective approach by the townsfolk in working with nature. It permitted and excluded climatic conditions according to the residents’ needs through both built form and managed landscape. A careful examination of the urban form from an aerial view reveals two main features that contributed significantly to heat reduction. Firstly, as a result of the dense growth of the palm farming, these palm groves in turn acted as a natural shield to filter sand storms and reduce the heat of the atmosphere before it reached the residential area, thus adding to comfort levels. Olgyay stated that “The viscous surface of leaves catches dust and filters the air” (Olgyay 1963, p. 74) thus, filtered by the grove, this air travelled to the residential area carrying less sand and reducing the effect of heat (Figure 4.3).

![Figure 4.3: The filter effect of the thick palm groves.](image-url)
Secondly, the agglomerated mass of attached houses, in which the built form occupied most of the site, with very little open space, resulted in minimal exposure to the sun (Figure 4.4). Both features had a large impact on reflecting, and thus mitigating, the environmental effect of solar radiation. Vegetation reduces the heat by an evaporative process and by absorbing radiation (Olgyay 1963). In conditions analogous to those found in Qatif, dense green areas can reduce heat up to 6-8°C which is a very effective ameliorative measure, particularly in the summer months (Brown & Dekay 2001, p. 121). In the case of Qatif, the massed houses of the old town acted as reflective surfaces against the solar radiation, both of which reduced the amount of heat absorbed in the urban fabric.

**Figure 4.4:** The dense settlement of courtyard houses in Qatif exposing minimum surface to the sun. Note the preponderance of cul-de-sac streets, small clearings (*baraha*) and private courtyards shielded from the street.

### 4.4.2 Urban Spaces in Qatif, considered in relation to wind and solar exposure

Based on the literature review, climatic data and fieldwork, the examination indicates that in such a climate the main objectives of the traditional built form were to create shade and natural ventilation through air movement. Therefore, urban spaces consisted of a variety of open oriented and shaded spaces which were arranged to take advantage of the
weather conditions to increase residents’ thermal comfort. These included open spaces which were exposed completely to the weather conditions, and semi-open shaded spaces which were exposed partially to the weather conditions (Figure 4.5). They were all arranged in a considered manner to take advantage of or ameliorate the weather conditions.

![Figure 4.5: The compact settlement in Qatif created shaded cool space between houses and in addition it offered open spaces exposed to the weather conditions.](image)

Streets were also laid out in response to the climate. A careful examination of the roads network shows that streets were either oriented toward the prevailing winds coming from North and North West, or were oriented to take advantage of the air movement in the adjacent streets to optimise evaporative cooling through natural ventilation (Figure 4.6). The street network consisted of a few main public streets, off which branched secondary, semi-private streets and private streets that were all connected to each other. The main public streets ran parallel to and oriented toward the northern wind direction. This orientation meant that these streets were exposed to the highest wind velocity where the wind was drawn in (Asfour 2010; Brown & Dekay 2001). However, the narrow width of the street caused reduction in the air volume and therefore increased its velocity (Fathy 1986). This, in turn caused high air pressure on the lower level of the street which created air pressure differences between the lower level of the street and the upper level. The air
pressure differences caused air movement and helped the buildings to take advantage of the incident breeze (Fathy 1986). The secondary streets connected to the main streets also gained advantage from the incident air movement in the main streets. As the secondary streets connected to the main streets, the air travelled at increased velocity and created air turbulence in them. This in turn increased the effectiveness of the cross ventilation of flanking building (Brown & Dekay 2001). In addition, it has been observed that the east-west streets were tilted about 20-30° from the northern wind and this in turn created more effective air movement in the streets and a more cooling effect (Givoni 1994; Fathy 1986; Asfour 2010) (Figure 4.6).

Figure 4.6: The winding narrow streets network responding to the wind in the traditional town.

Another important urban space in the old town of Qatif was the baraha (Figure 4.7). Barahas were open urban spaces created by street intersections that also acted as climatic ameliorators. As they were relatively wide, open areas, the air would travel at a low pressure coming from the high pressure windy oriented street, resulting in a breezy open space. According to the residents, the baraha was an important communal space in each neighbourhood, the pleasant micro-climate, in addition to its short distance from
homes, encouraged children to play there and communal occasions like marriage and other social gatherings took place there (Figure 4.7). Thus it was common to see benches built into the wall in barahas and some alleys where residents met in the afternoon (Winterhalter 1981).

The use of barahas was an effective passive cooling strategy in such a climate. In hot-humid seasons the region experiences moisture-saturated hot winds coming from the east and south from the Gulf Sea. Due to the humidity, which can reach 80%, evaporative cooling encouraged by air circulation became an essential contributor to increase comfort in barahas. The interviewed residents recalled that barahas were breezy points in the traditional town.

Another urban space which was often seen in this traditional town in Qatif was the cul-de-sac street (Winterhalter 1981; Talib 1984). They were dead-end streets shared by adjoined houses (Hakim 2008; M. Al-Naim 1998). They were also pleasant shaded breezy narrow areas. However, they were used and controlled mostly by the residents of the cul-de-sac. Thus it was used mainly by children and male adults of the neighbouring houses for recreation and social gathering (Figure 4.7).

Figure 4.7: Semi-private cool space baraha for neighbour’s social gathering in the residential quarter between houses.

Residents were interviewed by the author in January 2011.
In response to the need to minimise solar exposure in the hot months, an examination of plans and old photographs of the traditional town of Qatif shows that streets were narrow and shaded. The percentage of shading varied according to the street orientation. Streets running along the north-south axis were shaded all day in summer, except at midday when the sun is directly overhead (Brown & Dekay 2001). Streets running along the east-west axis were kept narrow to allow them to be shaded by the flanking buildings as possible (Ibid) (Figure 4.8).

Figure 4.8: Shaded streets between houses in Qatif. They offered cooling outdoor space for pedestrians. The observation shows that the market (souq) street was also oriented in relation to the prevailing wind direction, however, a shading element was needed because the shops were of single-storey height and thus not high enough to cast shade during the critical hot hours of the day. In addition, the trading hours were during the hot daylight period. Thus the best orientation was to the cooling breeze direction and shading elements were provided (Figure 4.9).

Figure 4.9: The traditional market street is located outside the wall running north-south in the prevailing wind direction. The shops were one storey high thus they do not shade the street so a shading element that allows breeze was used.
As revealed by old photographs and surviving structures (Figure 4.10) underpasses, called sabats, were another important common urban space in this region. The sabat was a totally protected, shaded street underneath a bridge room and was therefore cool all year. The change of temperature between shaded and unshaded streets caused sabats to be breezy. This area was described by locals as the coolest external domestic space and was the location where locals sat and socialised, and their children played, on the hot summer days.

Figure 4.10: Shaded streets sabat under bridged room between houses.

An examination of surviving structures, and the documentary evidence of old photographs and plans indicates that the urban spatial order gave the residents flexibility in tolerating the weather conditions, while using the outdoor spaces. Walking for pedestrians in the streets was a pleasant journey, as the breeze and shaded areas improved the climatic comfort. Also, the walking distance was relatively short, not exceeding 600m for everyday activities. For longer journeys, animals such as donkeys were used as transport.

4.4.3 Socio-cultural Grouping of Buildings

Two factors affected the grouping of buildings: the social relationships and climatic conditions.

The urban fabric consisted of individual urban quarters or neighbourhoods. The traditional neighbourhood was established on the basis of customary, unwritten law and a

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5 Sabats were also found in the traditional city of Hafuf in the Eastern Province of Saudi Arabia.
6 This was stated by former residents interviewed by the author during fieldwork in the period between 1st-7th January 2011.
heightened sense of communal responsibility. Firstly, a nuclear family chose a plot to build the house. Then, the selected plot was defined by a boundary wall within which the house was constructed with rooms around the open space of a courtyard. As the family grew, more rooms were added and another floor constructed. Another house occupied by relatives or friends would be constructed, attached to the first house. This process of aggregation would ultimately form a clan-based neighbourhood. There were no physical boundaries for a traditional neighbourhood, but rather, the traditional neighbourhood was defined by social relationships (Winterhalter 1981; M Al-Naim 1998). Qatif’s traditional town consisted of four neighbourhoods, each of which consisted of a grouping of houses inhabited by people bonded by kinship ties or social relationships. These neighbourhoods were given common names by locals such as fareeg Alsidra, fareeg Alkhan fareeg Alzrabe and fareeg Alwaresh. Fareeg is the local word for neighbourhood that means group. It refers to a grouping of people who share the same values, customs and trends, thus reflecting the sense of togetherness (M Al-Naim 1998).

4.4.4 Groupings in relation to wind and solar exposure

As discussed above, the observation of the old town of Qatif has shown that the dense urban fabric was arranged in a considered manner to take advantage of the weather. The intention was to maximise prevailing wind access to buildings and to minimise solar exposure as much as possible. Houses were of a grouped and attached courtyard typology, sharing at least three walls, and thus forming a clustered plan. They were arranged in a way to allow breeze access to the houses and to protect from solar radiation as much as possible.

In this regard the clustering of dwellings around courtyards and sharing of walls helped to minimise the surface area exposed to solar radiation, and as a consequence, the building mass occupied about 90% of the site. From examining the proportion of the house heights to the street widths, it was found that H/W= 3:1. This proportion indicates that the house facades were in shade most of the day as the narrow width of the street and height of the houses prevented the solar radiation from striking the house facades, this in turn, also

7 The English name is Neighbourhood of Alsidra, Neighbourhood of Alkhan, and Neighbourhood of Alzrabe.
protected the streets from absorbing heat from direct solar radiation (Ahmed 1994 cited in Brown & Dekay 2001; AlLayaly 1990). This was an effective strategy because it helped to maintain communal interaction by encouraging residents to use outdoor shaded breezy spaces, as stated by local people in the fieldwork (Figure 4.11).

Figure 4.11: Attached courtyard houses occupying most of the site to themselves, thus exposing less area to the sun. In addition, houses were grouped to get advantage of the breeze travelling in the streets.

4.5 THE CULTURAL AND CLIMATIC RESPONSE OF THE TRADITIONAL HOUSE

As noted above, the traditional house organisation in this region was influenced by the local cultural values as well as climatic factors. Gender segregation has influenced the
Saudi house for centuries. Rapoport argues that “building a house is a cultural phenomenon, its form and organization are greatly influenced by the cultural milieu to which it belongs.” (Rapoport 1969, p. 46). Traditional houses in the Islamic world were significantly influenced by the Islamic rules. According to traditional Islamic customs in this region, women should be separated from males when not with the family. Bahammam notes, in this regard, that according to such values “the Muslim woman is not allowed to reveal her figure to anybody other than her husband, family members, and/or close women friends” (Bahammam in Edwards et al. 2006, p. 79). As a consequence, gender segregation has helped shape the physical environment. The need for privacy and gender separation has been spatially translated in the arrangement of the house zones. According to Bahammam, two types of privacy have influenced the Saudi traditional house: female privacy and familial privacy (Bahammam in Edwards et al. 2006). Therefore, the house was physically divided into two domains: family and male guests. Thus, there were two transitional areas connected to the main entrance that led to each domain. One was called dehleeze which was used by the family members and it led to the private family domain. The main function of the dehleeze was to preserve the family privacy from the street and from pedestrians’ sight. The other transitional zone was a hall that led to the male’s domain. Male strangers are not allowed to enter the family domain. Instead, in the traditional house, they had their special zone called Almajlis which, in the traditional Saudi house in Qatif, was usually located on the first floor with windows facing the street. Houses were built in such a way that non-familial males could pass through the house to Almajlis without interfering with or exposing the family zone. They entered the house from the main entrance door and walked through a transitional hall to the upper floor where Almajlis was located. Almajlis was the only room that was always considered to be located in the prevailing cooling wind direction. Welcoming guests was and still is one of the most appreciated customs in Saudi Arabian society. Therefore, the best and the largest place used to be assigned at the very early stages of the house construction. This was combined with the cultural values of the spatial segregation of non-familial males and

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8 Decorating the interior of the reception room (almajlis) and the main house entrance door also was one of the obvious characteristics of the houses in this region to reflect guests welcoming and status. This also was found in the western and southern region of Saudi Arabia.
preservation of the family privacy. Therefore, the room was located facing the northern
direction on the first floor, with direct access from the entrance door by means of a
staircase into the male guest room. In addition, this room had a direct stair case access to
the roof, as the roof could be used as a warm place in winter to sit with guests (Figure 4.12).  

Figure 4.12: Zonal distribution of the traditional house in Qatif showing the physical separation between
males’ zone and the family zone.
All rooms in the house other than the Almajlis hall and Almajlis were considered to be a
private family domain. In order to maintain familial privacy, most of the courtyard houses

9 The plan shown here is a representative of Qatif’s traditional houses.
in this area did not have exterior openings on the ground floor (Figure 4.13). If there were any exterior openings they were small and were located above the pedestrians’ eye level.

Another socio-cultural aspect of the houses in this region is that they were usually occupied by an extended family of up to four generations.\textsuperscript{10} Talib notes that “an Arab house is never complete” (Talib 1984, p. 54) as the house has the flexibility and the potential to expand, adding rooms around two to three courtyards, to accommodate the growing number of family members. The house usually started with a single storey with a courtyard and the rooms surrounding it. However, the future expansion was always considered in the construction phases. For example, the wooden beams used to construct the house ceilings were always left extended to the outside, in provision for future expansion, when they would be connected to the new beams. Also, the ground floor walls were always thicker than the other floors to carry the loads when floors were added. Therefore, the final house size was not able to be predicted at the early stages of occupancy. However, the final size reflects the family size.

\textbf{Figure 4.13:} Openings above eye level on the exterior façade to preserve privacy while allowing cross ventilation.

\textsuperscript{10} An extended family is a family that consists of nuclear families. When the sons get married they stay with their wives and children with their parents. One house could be occupied by fifty family members. Each nuclear family stays in one room with their children. When the children grow up they are separated according to their gender, male and female.
4.6 CLIMATIC RESPONSE OF THE TRADITIONAL HOUSE

4.6.1 Construction Materials

Traditional Saudi houses of the kind found in Qatif were built of available local materials, thus minimising transportation and cost. Master builders were very aware and selective in choosing and applying the construction materials according to their properties. This inherited experience and deep understanding evolved and developed over centuries. The builders’ main concern was, as much as possible, to provide cool houses. Therefore, the construction techniques, layered materials propositions and their thickness affected a particular climatic benefit. The elements of the traditional house are described below.

4.6.2 Walls

Houses were built on an exposed and levelled piece of ground. The house construction process started with the walls, which were thick, in order to respond to the climate and to carry the heavy superstructure.

In Qatif, these walls were typically built from coral stones, the thickness of which varied from 50-65cm (Figure 4.14). Such walls had a good insulation quality because of their low thermal conductivity of 0.35 W/M°K (Aldosary & Alsaleh 1983). The thickness combined with the high insulation property, caused heat resistance and delayed heat transfer through the structure to a time lag of 16 hrs (Aldosary & Alsaleh 1983). This assured a great minimisation of the heat flow through the walls from the outside to the inside thus reducing temperature fluctuation and resulting in a differential between the inside and outside temperatures of about 10° to 12°C (Talib 1984). The time lag had a great influence on domestic comfort because it delayed the heat transfer, thus keeping the rooms cool during the hot days in summer.

In addition to the walls’ thermal properties, all exterior walls in this region were painted with a light, off-white colour which, given its high reflectivity of solar radiation, increased the thermal resistance of the walls. The off-white colour has been found to reflect about 80% of the solar radiation (Aldosary & Alsaleh 1983). Therefore, it reduced the amount of

11 See construction process in Appendix 1
heat absorbed by the building envelope and helped to cool the surface of materials (Santamouris 2001; Akbari, Pomerantz & Taha 2001; Brown & Dekay 2001).

![Figure 4.14: Coral stone was the main construction material for walls in traditional Qatifi houses.](image)

### 4.6.3 Ceilings

Ceilings including the roof on the top floor were flat and had similar insulative properties to the walls. The ceiling layers consisted of palm tree trunk posts lying across the width of the room on top of the walls. These posts would not exceed 3.5m, which therefore limited the width of the room. Taller palm trees were not used to avoid bending in the ceiling. Then, a diagonal grid of palm tree trunks was placed on the supporting beams. After that a mat made of palm tree leafs was placed on top of the structural grid. Finally, a layer of mortar and small crushed coral stones was distributed evenly and levelled (Figure 4.15 and Figure 4.16). The total thickness of the ceilings was about 40cm. This thick construction and the materials had its insulating characteristics as well. Colour also had its effect on the thermal properties of the roof, which was coloured the same as the walls for the same reflective and cooling effect.

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12 Taller palm trees were not used to avoid bending in the ceiling.
4.6.4 Form

In Qatif’s hot climate protection from the hot, humid summer conditions outweighs the need to protect against the winter climate. Therefore, the principle of a climatic hierarchy consisting of a variety of ventilated shaded and open spaces was applied inside the house and affected its physical form. Firstly, there was always a central open courtyard, open to
the sky and completely exposed to the weather conditions (Figure 4.17). Secondly, the semi-open spaces provided partial shade and shelter from the weather conditions by forming a colonnaded passage in front of the rooms. Finally, enclosed full shade interior spaces adapted to weather conditions by opening or closing windows and doors in order to achieve internal comfort (Figure 4.18). In addition, these rooms which were deeply embedded in the plan, were surrounded by shading, and were enclosed by thick insulative walls. These factors made the rooms the coolest zones in the houses. The spatial order gave the occupants flexibility in adjusting to and tolerating different weather conditions.

The courtyard has always been used as a passive cooling strategy in hot climates. The wind condition inside a courtyard is determined by the proportion of the width to the height of the building (Brown & Dekay 2001). In this respect, the courtyards in this town were usually square and their sizes varied from 4 to 6 meters square with H/W= 2/1.13 This indicates that such a dimension would optimise solar protection by maximising shade. Also, this courtyard proportion allowed the effect of stack ventilation. Such a central open space was needed on hot humid days to encourage air movement when the sun struck the courtyard floor, as the air close to the floor surface heated up and it started to raise the cool air, creating air movement. The rooms surrounding the courtyard got benefit from the cool air when it escaped into the rooms. In winter the courtyard acted as a sun collector, the solar heat gain helping to warm the surrounding rooms (Figure 4.19).

![Figure 4.17: A courtyard surrounded by rooms is the basic form of traditional houses in Qatif.](image)

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13 Observations made by author during fieldwork survey in January 2011.
4.6.5 Openings

As mentioned previously the main objective of openings in the traditional Qatifi house was to facilitate cross ventilation that would encourage evaporative cooling. Therefore, each room needed to have openings either onto the courtyard or onto the outside, as long as this did not expose the occupants to the neighbours. Some rooms had windows that opened to the outside and to the courtyard as well. As previously mentioned the exterior walls on the ground floor did not have any windows that opened to the outside except some small openings above the pedestrians’ eye-level, but instead there were windows that opened from these outer rooms onto the courtyard (Figure 4.20). Openings
were usually windows of a dimension of 50 × 70 cm with vertical steel bars and two wooden shutters. On the first floor there were always small uncovered ventilation openings 25 × 30 cm on top of each window. These uncovered ventilators were effective when the hot air started to rise, as an opening was required to enable it to escape and be replaced by the cool air coming from the outside, especially at night in summer. They were permanent openings with cast gypsum ornamentation (Figure 4.21). \(^\text{14}\)

Doors and windows played a major role in increasing occupants comfort. They could be opened to maximise the air movement inside the room. Windows opening onto the courtyard were always protected from direct solar exposure by the shaded colonnaded passage which helped the air to cool down before entering the room. The wooden shutters for windows exposed to the street were a flexible means of blocking the sun or allowing it in by opening or closing them.

### 4.6.6 Wind Catchers

The roof of the traditional house consisted of defined open zones to allow air movement as much as possible. It would be surrounded by a parapet wall of 100cm height, consisting of wind catchers (*badgirs*). These *badgirs* were double-walled and acted as a passive cooling strategy in all houses in this area. They were constructed to encourage air movement and to direct the air to the lower part of the occupied zone. Therefore, in hot-humid days when the wind speed was not so effective, the *badgirs* worked to enhance the air movement and the cooling effect on the roof (Figure 4.22).

It is important to note here that the traditional houses in this region shared a common design language of simplicity, delicacy and strength. The aesthetic characteristic of the old town was the result of the natural plain material used in the facades. It hardly evidenced any decoration on the exterior walls except for the gypsum ventilation panels on top of the windows. The whole physical built environment was coherent and unified because the houses had the same façade treatment and were built of similar materials and colours.

\(^\text{14}\) Ventilation openings were made of casted gypsum panel.
Figure 4.20: (a) Window opens to the courtyard inside the house; (b) and (c) Openings open to the street above the eye level.

Figure 4.21: Different types of openings: (a) Windows on the exterior façade with wooden shutters; (b, c, d) Different styles of ventilators usually found above windows.
4.7 BEHAVIOUR AND USE OF SPACE TO ADAPT TO THE WEATHER CONDITIONS

4.7.1 Daily Activities

The traditional Saudi house of the Qatif type was built to provide passive heat minimisation, through its massing, construction, colour, and multi-functioning spaces. In such vernacular houses electricity was not introduced until after the discovery of oil in 1933. Therefore, there was no means of using mechanical cooling systems. So, in addition to the climate affecting the form of the house, how were daily activities affected? First of all, two factors affected the daily activities: nature and worship. The natural factors included the thermal differences between day and night, and between summer and winter. Worship was also a factor, as daily prayer time regulated human activity. Such factors have affected most of the traditional Islamic societies in the Middle East.

External activities started in the early morning. They were performed in daytime in public spaces outside the house and comprised shopping, attending schools,\(^{15}\) and traditional forms of work such as fishing and farming. At night the streets were dark and quiet and most people were inside their homes. The same cycle of activities applied inside the house. The family’s daily activities were strictly associated with diurnal and nocturnal prayers times. The family woke up before sun-rise to be ready to perform the *Fajr*

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\(^{15}\) Schools at that time were informal schools where people go to learn reading, writing and some math before the introduction of formal schools in 1948 (Almoslem 2002).
prayer, and then they started the day by having breakfast. The head of the family would then leave the house and go to his place of work. Women stayed at home looking after the children, cleaning and preparing for lunch; they also socialised and visited their neighbours in the morning in the absence of men. The family would gather for lunch right after performing the Duhr prayer which is around noon. After that they would take an afternoon nap for about an hour. After the Asr prayer (afternoon prayer) the head of the family would leave again to his work and come back after the day ended at sunset time which is the Maghrib prayer time. Then the family would gather for dinner before going to sleep. At night the house zones were dark so they would tend to use gasoline lights, or fanoos, to light the occupied place (Figure 4.23).

4.7.2 Multi-functional Use of Interior Spaces

The cycle of activities was also reflected in the changing pattern of space occupation. As previously noted, zones in the traditional house were multifunctional, changing use in accordance with the circumstances and the seasonal conditions. In summer, the family activities were concentrated in the shaded areas on the ground and the first floor. The family members started their day in the early morning by having breakfast in the shaded area of the courtyard or in the colonnaded passage. At lunch time, which was usually at noon, when the sun was overhead and it was too hot to sit in the courtyard, the family

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16 Praying is one of the five pillars of Islam. Muslims perform five prayers every day. These prayers are associated with certain times according to sun-rise and sunset. The Fajr prayer should be performed before sun-rise, the Duhr prayer at about noon; the Asr prayer in the mid-afternoon, the Maghrib is at sun-set and the Isha after the sun-set.
would gather in one of the ground floor rooms. Northern located rooms were preferable for use at lunch time and in the afternoon if they had a northern breeze access. At the end of the day, they would retire to the roof to sleep. This pattern of movement is described by Al-Lyaly, Oliver and Ragette as horizontal and vertical migration (Al-Lyaly 1990; Ragette 2003; Oliver 1969). Horizontal movement took place during the day as the occupants moved horizontally from a room to another to tolerate the weather, and vertical movement took place by the occupants moving vertically at night to the breezy zone on the roof. Thus, the household residents would tend to sleep on the roof on summer nights. As mentioned earlier, the time lag for walls in a traditional house is 16 hours (Talib 1984). As a consequence, the ground floor rooms were hot at night as the walls stored the heat during the day and then released it inside the room at night, so it would not be comfortable for nocturnal sleep.

In winter, the family used the sunny zones inside the house for their daily activities (Figure 4.24). They had their breakfast and lunch in the unshaded area in the courtyard. In the evening when it grew cold, they used the southern room to gather and have their dinner. At sleeping time, the rooms on the ground floor and first floor were used. As the walls stored heat during the day, this heat would be released to warm the room at night and therefore rooms would be comfortably warm to sleep in on cold nights.

Because of the pattern of movement maintained by the occupants in order to tolerate the weather, floor plans were duplicated and all rooms were furnished with simple movable furniture which made changing a room’s function easy and flexible. One of the most popular and practical pieces of furniture used in the traditional house was the dawshag, a foldable, portable and multi-use mattress that could be used for sitting or sleeping (Figure 4.25). A room could be transformed easily from bedroom to a living room when required.

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17 Ragette and Oliver found that, in the traditional courtyard houses in Iraq, the occupants’ respond to climate by practicing vertical migration or what Ragette called “vertical nomadism” every day. Traditional courtyard houses in Iraq consisted of basement, ground floor, first floor and a roof. Occupants used to stay in the basement in the excessive heat period in the afternoon and they spent the morning in the first floor and at night they used to sleep on the roof. This pattern of movement has been found in Jeddah’s traditional tower houses in the western province in Saudi Arabia. However, Jeddah’s traditional homes were not courtyard houses. They were multi-story houses with wooden screen facades.

18 The rooms in the southern direction were preferable in winter as they were exposed to the sun so they were warm as a result of collecting the sun heat.

19 Dawshag has been used in most of the traditional houses in Saudi Arabia.
by rearranging the *dawashags* against the wall and taking away the sleeping pillows and blankets. The middle of the room was left free for circulation and for children to play. The centre of the room was used temporarily for meals. Therefore, it was furnished with a central rug, so the family could sit on the floor around a sheet of fabric specially used for the daily meals. It was then cleaned to be used again for another meal.

**Figure 4.24**: Summer and winter inhabitation of domestic space in the courtyard house in Qatif.
4.7.3 Control over the environment

As noted above residents of traditional houses could adjust the windows and doors to maximise their comfort. For example, window shutters or doors could be opened to encourage air movement or be closed to avoid the heat on hot days (Figure 4.26). The form of the house respected the cultural needs by maintaining family privacy, thus allowing control of the micro-climate by opening and closing windows without interfering with neighbour’s privacy. This ensured that the occupants had the freedom and the choice to increase their comfort when needed. Also, it was popular in former times to use a hand fan to increase comfort (Figure 4.27). On hot-humid days when the wind was not effective, especially at night time, people used the hand fan to encourage air movement over their bodies.

Figure 4.25: Foldable mattresses were the main piece of furniture in the traditional house in the Gulf counties and in Qatif. They were flexible to fold and move and were used to sit on or to sleep on.
4.7.4 Clothing

In Saudi Arabia, one of the means to adapt to both hot humid and hot dry weather was the wearing of appropriate clothing. “It is important for the cooling effect on the body that evaporation takes place on the surface of the skin and not on the surface of the cloth.” (Koch-Nielsen 2002, p. 36). Hence, clothing in this region, for both genders, whether internal or outdoor clothing, was designed to offer shade and air movement. Therefore, in order to feel cooler, men and women in this region tended to wear loose light-coloured cotton clothes.
Men’s traditional house clothing consisted of two pieces: a full-length ample white cotton pants and, on top, a white cotton shirt. On extremely hot days the pants would be replaced with knee length wide cotton shorts and on top of it an ankle length wrapped skirt called izar. The traditional outside cloth was a loose white cotton dress with long wide sleeves (thawb) that was worn on top of the cotton under-shirt and the ample pants. Also, a loose head cover was popularly worn outside the house to provide shade on the face and neck and allow air movement around the head (Figure 4.28). In winter, the men’s thawb was a thick material of a dark colour material.

For women, the same concept of wide loose traditional clothes was essential for cooling. However, this function of providing thermal comfort was combined with a cultural value of giving them seclusion. Inside the house, women’s clothing consisted of full-length coloured cotton ample pants and, on top, a wide dress with wide short or long sleeves. Women’s clothing outside the house was intended to provide seclusion for them. Therefore, they wore a full-length costume called the abaya that covered them from head to toes (Figure 4.29).

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20 It is still common to ware thawb in Saudi Arabia.
21 Dress with long sleeves would be worn in winter.
Clothing design and material for both genders encouraged evaporative cooling as the air passed through the cloth and created air-movement between the body and the clothing. The air movement thus evaporated sweat and cooled down the body. This has been described by Elawa and Koch-Nielsen as the chimney-stack effect (Figure 4.30) (Koch-Nielsen 2002; Elawa 1981). A long, loose dress will act as a chimney when the hot air rises from the feet to the neckline (Koch-Nielsen 2002). Traditional clothing was adduced to give a cooling effect of 0.4 CLO.22 This is considered to be a high cooling effect for clothing in comparison to modern Western outfits (Figure 4.31) (Koch-Nielsen 2002). In winter, people tended to wear thick winter clothes underneath to reduce the air movement and trap the body heat. The head would be covered by thick cloths wrapped around the head. Some people tended to sleep with it for a more warming effect.

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22 “The thermal insulation value, used internationally to measure the effect of clothing, is expressed in terms of CLO units (1 CLO = 0.155 m C/W). International standard have set one CLO equal value of a standard Western business suit Koch-Nielsen, H 2002, Stay Cool: A Design Guide for the Built Environment in Hot Climates, James & James (Science Publishers) Ltd, UK., p. 36
Figure 4.30: The evaporative cooling effect of the traditional dress.

Figure 4.31: CLO units of different clothing.
4.8 EVALUATION

Louis Sullivan’s famous phrase ‘form follows function’ could be applied to Qatif’s traditional architecture. The functional needs in this traditional settlement were climatic amelioration and facilitation of and adherence to socio-cultural norms of behaviour. The traditional houses were built to perfectly suit particular climatic, socio-cultural conditions and the way of life of a group of people in a particular time when things tended to change very slowly. The traditional house of this region, by its entire means, represented the perfect solution for the composite-climate region.

The urban plan worked with the climate, as its untutored designers considered the width and orientation of the streets for better shade and air movement. The whole town formed a pedestrian zone, therefore maximising pedestrians’ comfort while use of the outdoor spaces was a main characteristic of the town.

The form of the house was compatible with all the climatic and socio-cultural needs of the inhabitants. The form offered a variety of zones from full-sun to full-shade so residents could tolerate the weather conditions. The physical form satisfied the cultural needs for privacy; and so, the form had worked to meet all local climatic and cultural needs.

The behavioural response to climate led to an outcome that downplayed an individual role for furniture pieces, and instead, rooms were furnished with simple multifunctional and mobile pieces of furniture that allowed for easy transportation of such furniture inside the house to different zones when needed.

Social life was enhanced by the pursuit of thermal comfort. The breezy open urban spaces encouraged socialising between the members of the local society. Furthermore, in public, the short distance between open or semi-open spaces generated from the attached houses enhanced the social relationship between neighbours, because it created safe comfortable zones where neighbours could socialise. Also, inside the house the family gathered in the most thermally comfortable places.
Occupants had control over their physical environment, having the choice to modify the microclimate to a certain degree by opening or closing windows and doors as long as they were not interfering with their neighbours’ privacy.

Master builders were expert and very knowledgeable about the properties of the available local material, and cultural and climatic needs. Thus, they applied the best solutions. House orientation, façade composition, location and size of openings, material selection and choice of colours all reflected a deep understanding of the socio-cultural and climatic circumstances.

The entire urban fabric, from the smallest details of all houses, was built to perfectly suit and satisfies the needs of the inhabitants. The clustered, condensed urban plan and courtyard house represented an appropriate physical form that worked very well in such a climate for a particular culture over a long duration. While the need to respond to climatic factors had the largest impact, the traditional Saudi house, exemplified by the case study of Qatif worked in harmony with socio-cultural norms to produce a traditional domestic environment.

4.9 CONCLUSION

This chapter demonstrates that the socio-cultural and climatic aspects were the main factors behind the formation of the physical home environment. The dense urban form surrounded by the palm groves played a major role in moderating the climate. The urban formal configurations, which consisted of different urban courts, attached houses and narrow shaded streets, all worked together cooperatively to satisfy the residents’ needs for climatic amelioration and socio-cultural appropriateness. The urban form created shaded social gathering areas where locals used to meet and socialise. There were different public open spaces in different approximates from the residential units which created options for residents and created a hierarchy of public open spaces. The streets encouraged walkability in the residential area because of the cooling effect of shade.

On the domestic scale, the form also worked in response to socio-cultural and climatic needs. Thus the courtyard house was the optimal form with which to create enclosed,
private open space inside the house to preserve familial privacy. In addition, the courtyard gave complete privacy by having windows opened to the courtyard. The courtyard form also allowed the houses to be attached to form clusters of houses based on kinship, which was an important social need. This was a unique feature offered by the introverted form. Also, the courtyard was environmentally suitable for this climatic region as it created a variety of hierarchal climatic spaces from full shade to full sun. Thus it gave options for residents inside the house to maximise their comfort. The urban form and the house form were responding to the climatic and socio-cultural needs.
AFTER THE OIL BOOM:
THE MODERN TRANSFORMATION OF QATIF
5.1 INTRODUCTION

This chapter analyses the modern Saudi home environment in Qatif in terms of its urban configuration and house unit plan. It aims to highlight the contemporary responses to climatic and socio-cultural factors in comparison to those of the traditional home environment in Qatif. The analysis reveals the way in which the contemporary urban and domestic physical forms have or have not responded to socio-cultural and climatic factors. The comparison allows a better understanding of the factors affecting social life, cultural values and the thermal performance and the reasons behind excessive energy consumption in the home environment in Qatif.

5.2 CONTROL AND CHOICE IN THE BUILT ENVIRONMENT

It is important to understand at the beginning that a major hidden difference between the traditional town and modern town in Saudi Arabia is the form of control. Users’ control over their choice of physical environment, which was in their hands in the past, was withdrawn from them and given to a central authority (Mubarak 2004). This has, in turn, had a significant impact on the built environment. Previously, solutions to climatic and socio-cultural factors in the traditional home environment were generated by the users themselves, stemming from a deep understanding of their needs. This understanding was developed after centuries from a trial and error approach. Therefore, the users produced solutions compatible with their socio-cultural and climatic needs (Fathy 1986; Mubarak 2004).

Opposite to this long-practiced compatibility is the nature of contemporary planning. In the transitional period in Saudi Arabia, when the Council of Ministers was established in 1955 (MOMRA 2013), the government urged the establishment of institutional planning. As a result, the Deputy Ministry of Municipal and Rural Affairs (MOMRA) was established within the Ministry of the Interior (Ibid). This centralised authority withdrew, and has continued to withhold, control from the users, and limited their choices in the built environment, by establishing rigid suburban planning based on European and American
suburb models and by setting building regulations also based on Western standards and cultural and climatic contexts (Eben Saleh 1997). This has caused a disjunction between the organically responsive climatic responses evident in known examples of traditional house and communal design, and a lack of regional climatic and cultural responsiveness in the new, generic house design. Although the community response to both climate and culture has changed to the point where what is provided is the accepted norm, this has caused the generation of physical house forms that are neither compatible with climate nor with traditional culture on both the macro and micro scales. The reasons for this conflict are explained and analysed in this chapter.

In this contemporary form of planning in Qatif, the suburbs are typically located on the periphery of an established urban core. Then the infrastructure, such as roads, sewers, electricity and schools, for example, is provided to this new suburb. The land is then divided into lots with defined sizes. Houses are then built under new land ownership and new building regulations decided by the municipality. This action has its consequences on the thermal performance as well as the social life of the residents.

5.3 NATURE AND MODERNISATION

A careful examination of the aerial view resulting from the current planning controls of Qatif shows characteristics that have significantly changed from the traditional town. Notably, on an urban scale there is a vast reduction of the vegetation area on the edge of the city, resulting from clearing for the construction of new suburbs. According to Brown and Dekay, it is highly recommended to have a linear green area of a width of no less than 100m on the city periphery to promote a cooling effect (Brown & Dekay 2001). However, the construction practice in Qatif has had an aggressively destructive effect not only on the natural flora but also the fauna. Thus, when Saudi Arabia engaged with modernity and planning for urban development started to expand, the first victim was the natural environment (Talib 1984). In Qatif, the change happened virtually overnight when the government decided to demolish the old wall surrounding the old town in order to
construct two intersecting main streets in the middle of the traditional town to accommodate cars (Figure 5.1) (Talib 1984; Almoslem 2002).

![Figure 5.1: The first fragmentation of the traditional town physical form of Qatif accompanied modernisation. Roads were constructed to accommodate motor vehicles.](image)

Soon after, the traditional town was largely demolished, and the farming area surrounding the old town was destroyed to allow for new suburbs to be planned (Figure 5.2). This destruction has continued until today, causing the plantation shield which was the main factor in modifying the climate to be lost.

### 5.4 THE CHARACTER OF THE MODERN SUBURB IN QATIF

A close examination shows that the recently constructed suburbs of Qatif are similar in their layout and character to other modern suburbs in Saudi Arabia. Despite the climatic differences in each region of Saudi Arabia, the suburbs are all planned in a similar way, characterised by a dispersed layout consisting of a gridiron plan with wide, intersecting vehicle-oriented streets (Figure 5.3). Houses are arranged in blocks in a gridiron alignment. These blocks are two lots in depth and divided into particular lot sizes ranging from 400-1000 square meters. Contemporary houses are box-like detached houses situated in the middle of the lot and surrounded by a 2m setback on three sides and a minimum 6m front setback as required by building regulations. This dominant
characteristic poses the question about the degree to which climatic consideration has influenced local planning.

Figure 5.2: Qatif’s city expansion and its effect on the natural landscape. Notice the reduction in the green area.
5.5 URBAN SPACES AND CLIMATE IN QATIF

The main climatic objective of the traditional physical form in this region was to create shade and encourage evaporative cooling through air movement. However, as revealed by a recent aerial view of the current suburbs in Qatif, the design and configuration of their urban form shows a lack of considered response to these aspects. Urban spaces in the new suburbs are extremely exposed to wind and sun conditions, indicating that their design contributes to the increased suburban heat level and an increase in residents’ discomfort. This is explained in the following section.

5.5.1 Streets in relation to wind and solar exposure

In the traditional town, a combination of narrow winding streets and temperature differentials resulting from shaded and unshaded area had created breezy streets. On-site observation by the author reveals that in the current suburbs in Qatif, streets lack both factors. Streets are wide and inadequately shaded. In the dispersed gridiron urban form in Qatif, streets are classified either as arterial roads of a width of about 40-60m, which link
different suburbs, main streets with a minimum width of 20m surrounding each suburb, or secondary streets inside the suburb with a minimum width of 12-15m (Figure 5.4). This arrangement, and the street dimensions, has no positive contributive effect on wind velocity in them even for streets running in the prevailing wind direction compared to the traditional street layout. In order to generate breezes in a street in a dispersed gridiron pattern, the streets need to be at an oblique angle of 30-60° to the direction of the prevailing wind (Givoni 1992, p. 399). This orientation will offer shaded streets for pedestrians as well. However, streets in Qatif are arranged in a perpendicular arrangement following a cardinal orientation. This means that streets are not acting effectively in relation to either wind or shade.

When the northern prevailing wind blows towards the residential areas, it travels without obstacles. As a result of the loss of vegetation the wind picks up and circulates dust and dirt (Figure 5.5). In addition, also as a result of reduced or eliminated vegetation, the heat of the wind is not reduced. As explained in Chapter Four, appropriately located vegetation can be effective in urban areas when used as a climatic modifier, reducing the heat by up to 5.6°-8.3°C in urban areas (Brown & Dekay 2001, p. 132), a factor lost in the new grid-iron street suburbs with their extensive clearing of vegetation.

In addition, the whole composition acts against effective air circulation. As a result of the dimension of the street, the wind is channelled down them without reduction in its volume or acceleration of its velocity, both of which are necessary in this climatic region to encourage evaporative cooling, as occurs with the traditional streets.

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1 The information is according to the fieldwork and data collection by the author on 15th-20th January 2011.
2 The diagram is a representative of the common ongoing practice in the contemporary suburbs in Qatif.
Chapter 5

After the Oil Boom: The Modern Transformation of Qatif

Extremely wide streets

Northern wind travelling without obstacles

Figure 5.4: Ineffective domination of vehicle streets in Qatif’s suburbs

Arterial road  Main streets  Secondary streets

Figure 5.5: Common street design in contemporary suburbs in Qatif showing the negative impact of planning on wind. Wind travels without any climatic modifications. The northern direction is where the vegetation was.
In examining the streets’ exposure to the sun, Brown and Dekay note the integral relationship between building form, spacing and height, and the degree of shading that can be provided to the adjacent streets and open spaces. They state: “The amount of shade cast by a building onto the street and the opposite building is a function of the street orientation and width, the building height and the sun angle.” (Brown & Dekay 2001, p. 84). However, with regard to the need to minimise solar exposure, a factor addressed in the traditional urban layout of clustered houses grouped around internal courtyards, the new suburban street layout in Qatif again fails to perform effectively.

In the Western-style grid residential subdivisions in Qatif, street width and inappropriate design has prevented buildings from being effective in casting shade to protect the streets. North-south oriented streets which provide more opportunity for buildings to enable benefit from shade are also limited by this planning. Streets are edged by the front setback of the houses which is usually not less than 6m in width. This means that even the shade cast by the house for facades running north-south will fall only within the front setback (Figure 5.6 and Figure 5.7). For facades facing east-west streets, neither the facades nor the streets benefit from shade at all.  

Figure 5.6: The poor effect of proportion on casting shade in the Saudi contemporary streets in Qatif on the 21

For visualisation of the study area see Appendix 2, Part One: baseline community.
Chapter 5

After the Oil Boom: The Modern Transformation of Qatif

Shadows in streets at 9:00 am

Wide streets with no plantation and no shaded footpaths

Shadows in streets at 12:00 pm

Extreme exposure to weather conditions caused by:

- Poor proportions (streets width and setback regulations)

Caused:

- Uncomfortable micro-climate by increasing accumulated heat.

Shadows in streets at 3:00 pm

Figure 5.7 The effect of the street design in Qatif on providing shadows in the street. Shadows in the streets on June 21st. Streets are not receiving enough shade at the critical time of the day. Notice the east-west-east oriented street gets no shade at all throughout the day.
In addition, streets in the Saudi contemporary suburbs in Qatif are very deficient in providing shading elements and tree plantings at street level, both of which would have contributed positively to the microclimate (Figure 5.8 and Figure 5.9). Shaded areas under trees in this climatic region could be 8°C less than the ambient temperature (Talib 1984, p. 35). In addition, green areas may contribute to up to 20% of energy saving if properly implemented (Akbari, Pomerantz & Taha 2001). However, the neglect of such aspects in the planning of residential subdivision in Qatif is still very common.

Figure 5.8: Extremely wide un-shaded streets and lack of plantation in Qatif.

Figure 5.9: Green areas in Qatif’s neighbourhoods. Notice plantation is in the houses. Also notice the small size of the park and its sparse green coverage. Streets also lack plantation zones.

This has caused all streets to share the same climatic hierarchy. There is no specific climatic feature for each street. This is because streets are totally exposed to wind and sun in the same manner, bringing more heat to the streets and residential area and also, critically, reducing heat shedding in the evening as a result of lack of shade. This loss of climatic hierarchy is especially noticeable on hot summer days and has cost the residents
the chance to tolerate the weather conditions while walking in the streets, an opportunity that should be offered by the streets’ design, both for socialisation and health benefits.

In addition, street design in the Saudi contemporary suburb has completely neglected the needs of pedestrians. In Qatif there are no shaded pedestrian footpaths at all in the suburbs. This causes residents to walk in streets, competing for space with cars, making these streets unsafe (Figure 5.10). This has exacerbated the residents’ reliance on motor vehicles for spatial communication, even over comparatively short distances, as it becomes safer to travel by car from one place to another (Bahammam 1995). Streets are also no longer used as outdoor spaces for play and social interaction by families, but rather, their main function is limited to facilitation of travel by car from one place to another (Al-Hathloul & Mughal 2004; Eben Saleh 2002). This also has a negative health effect as it contributes to the prevalence of obesity in Saudi Arabia: in Saudi Arabia, according to the World Health Organisation WHO, 39.1% of females and 28.6% of males are obese (Organization 2014). Thus, one of the major factors that contribute significantly to obesity is the form of suburban planning (Valko et al. 2011). Obesity and health problems are major issues observed in the city of Jeddah in Saudi Arabia which is of similar planning to Qatif, in the absence of adequate public open spaces and shady pedestrian passages (Alhajaj 2014). Streets should provide a convenient walking distance for pedestrians to main areas in the suburb. A convenient walking distance in a suburb for main activity areas should not take more than ten minutes on average, which is about 2000 feet (about 600m), however, the distance could be more or less depending on climate and site topography (Calthorpe 1993). This means that in a city like Qatif with its harsh climatic conditions, especially in summer, walking distances should be short and protected from the sun. Nevertheless, by examining Qatif suburbs both aspects are not provided. 

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4 For the visualisation by the author of current practice see Appendix 2, Part One: baseline community.
In summary, through poor and inappropriate design of alignments, setbacks and footpaths, the street has lost its function as a means to enhance not only climatic moderation, but also social interaction.

Figure 5.10: Biking and walking in the motor vehicle street as a result of lack of footpaths in Qatif.

On the basis of the discussion so far in this chapter, it is interesting to compare the percentage of the built area in relation to that of the unbuilt area in both the traditional and modern urban fabric in Qatif. Thus, to understand the contribution of streets to the
heat on the suburb level, a percentage has been calculated in the selected area to show the street area to the houses’ foot print and to estimate the effect.

Examination by the author of a representative suburban neighbourhood area in Qatif has shown that 30% of the total area is comprised of the streets and 70% is comprised of the built area, that is, 70% left for building allotments. However, of this area, 60% of the land is occupied by the building footprint in accordance with the building regulations and the rest comprises the setbacks which are, literally, waste spaces. This indicates that the percentage of the actual unbuilt area in the suburb is high amounting to 70%, including the setbacks around the house and the streets (Figure 5.11). However, in the traditional town the percentage of the un-built area was 25%, comprised of streets and courtyards. These climatic modifiers, used as communal spaces that enhanced social interaction, represent a significant difference between the two fabrics.

Figure 5.11: Differences between the modern and the traditional fabric. Notice that in the traditional town the outdoor spaces were completely devoted for pedestrians, unlike the contemporary suburban design.

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5 This is because the cultural conflict created by this arrangement. See house and socio-cultural responses of this chapter.
5.5.2 Blocks in relation to solar exposure and wind

In the modern subdivision in Qatif, the contemporary block arrangement has also caused houses to be exposed to the maximum weather conditions. In relation to solar exposure, as a result of spacing imposed by building regulations, houses in their detached forms on these blocks are exposed to the maximum surface area of heat from solar radiation, and they are not acting to shade each other effectively. The examination shows that house facades, especially those on the southern and western sides, are exposed to intensive solar radiation, especially during summer days. The facades facing south are exposed to the sun all day. The western façades are in shade all morning while they receive substantial sun in the afternoon. The eastern facades have the inverse situation, as they are in sun all morning and in shade in the afternoon. Additionally, the ratio between building height to streets width (H/W) is not effective in creating shade at thermally critical times during summer days. Facades facing the street invariably fail to benefit from shade as a result of the extremely wide street. Indeed, the shade cast from neighbouring houses is negligible as a result of the building regulation requirement that there be a minimum of 2m site setback from the three sides of the house. The ratio between houses’ height to setback indicates that shade will be cast by the house on the setback width rather than on the neighbouring house (Figure 5.12). This indicates that the required spacing between houses is not effective in providing mutually beneficial shade when it is most needed in the early afternoon when the sun is overhead.

In relation to wind in the traditional town, buildings’ access to breeze was achieved by two factors. The breezy streets and the airy structure of the courtyard form provided cross ventilation. Neither aspect is applied to the modern suburbs in Qatif.

According to Asfour, the induced wind flow and its ventilation effectiveness is determined by spacing, building form and orientation in relation to the prevailing wind direction (Asfour 2010). The wind speed in this climatic region needs to be encouraged to increase its velocity by the physical built form arrangement in order to encourage cross ventilation and consequently evaporative cooling, and to mitigate the effects of heat and humidity.
This occurred in the traditional town due to the physical characteristics. However, the selected area in the new development indicates that the dispersed grid-aligned plan acts in the opposite way.

As mentioned previously, wind movement through the residential area carries dust and heat. In this perpendicular arrangement, once the wind reaches the residential units, the windward façades will act as a wind shield. They will experience the highest pressure differences as a result of the perpendicular wind (Olgyay 1963). The leeward facades experience less wind pressure as a result of the shielding effect (Ibid). This causes the wind to travel with less velocity, thus reducing its cooling effect. In the setback that results in a narrow dimension of about 4m between adjacent houses, an air vortex will occur. However, as the overall wind speed has been reduced and the distance is too short to create efficient air movement, this setback distance seems not to be efficient for cross ventilation. Thus, for example, this arrangement is not effective on humid days (Figure 5.13).

5.6 SUBURBAN FORM AND SOCIO-CULTURAL RESPONSES

To enhance the quality of residential environment, its planning should enhance the potential for social interaction through physical territories (Rapoport 1977). As discussed in Chapter Four this was achieved in the old settlement by adapting the town’s physical configuration to form outdoor spaces that were organised in a hierarchal order to serve both climate and social needs. In fact, social interaction was enhanced by providing outdoor climatic modified comfort spaces like baraha, sabat and cul-de-sac streets. However, in the case of the modern neighbourhood the opposite has been achieved.

5.6.1 Socio-cultural responses of streets

Unlike the traditional town, the urban spatial configuration in the modern suburb in Qatif lacks climatically modified spaces where residents can meet and socialise on a daily basis. The only form of outdoor space provided by the current planning in Qatif is a central park which is usually located at a great distance from many houses. In addition, parks in Qatif
lack climatic and cultural responses. In terms of climatic responses, parks lack adequately shaded seating areas. In addition, parks do not offer gender-specific, semi-private shaded seating enclosures; significantly, given the cultural norms concerning female privacy, this lack has resulted in women and teenage girls being discouraged from using parks when not in the company of their husbands or fathers, and as a consequence such parks are not efficiently utilised (Figure 5.14).

Figure 5.12: A common block dimensions in Qatif. Shadows on the summer solstice 21st June. The effect of the gridiron block and dimensions set by building regulations on creating shadows. Notice that even the shadows created are the result of the sun position. The configuration has no effect on creating an effective shade.
Figure 5.13: A common neighbourhood house blocks arrangement in Qatif. Note the weak cooling effect of wind on the blocks.

Figure 5.14: Parks in Qatif lack effective plantation that provide shade and cooling effect. Also they lack shaded seating elements and semi-private seating areas where females can preserve their privacy while using the space.
The urban spatial configuration in the modern suburb in Qatif also lacks a spatial hierarchy which was an obvious feature of the traditional town (Figure 5.15). As a result of the vehicle-oriented planning, spaces in the neighbourhood are classified as either public or private (Figure 5.16). This simplistic binary system is described by Habraken as a ‘shallow spatial depth’ (Habraken 2000, p. 149). In this plan, public spaces are constituted by the streets that are dominated by motor-vehicles, and private spaces consist of the houses. This loss of such an important aspect of the street, a graduation between publicness and privacy, causes the loss of residents’ sense of identification with, and ownership of the street territory closest to their residential unit (Habraken 2000). Streets no longer serve or promote social gathering. Instead, they became associated with publicness because free car access is allowed by this plan. This means that strangers are allowed to pass through the street, creating an unsafe feeling for residents. Thus, this indicates that social interaction on a daily basis between residents and children playing in the street has been reduced significantly in such current planning, as a result of a perceived safety reduction that has been created by the street configuration (Figure 5.17).

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**Figure 5.15:** Spatial hierarchy of the traditional town in Qatif.

**Private spaces:** the houses.

**Semi-private:** is the space shared between a group of houses.

**Semi-public:** is the space where people from different neighbourhoods might meet.

**Public-space:** is the space that is shared by everyone and strangers are expected.
5.6.2 Social responses of grouping of houses

Another negative impact on the social relationships caused by modern planning, and a consequence of the modern capitalist economy which is opposite to the subsistence economy of the traditional time, is that under the rigid new suburban plan controlled by strict land-ownership rules and building regulations, people cannot choose their
neighbours anymore, unless they can afford to buy a house in the same area. This is unlike the traditional suburban configuration where the irregular flexible form of the town facilitated the addition of extra houses without concerns for the shape and appearance of the urban form, but with a real concern to ‘performative spatial relations’ between related houses reflecting kinship. The social relationships were enhanced by this additive flexibility of the urban form. As noted in Chapter Four, kinship groups could expand over successive generations, reflecting the traditional clan structure.

Also, the contemporary strict building arrangement lacks flexibility in not allowing the formation of outdoor, climatically modified communal spaces similar to the baraha, sabat, and cul-de-sac streets formed by building arrangements in the traditional town. As stated in Chapter Four these neighbourhood and semi-private spaces enabled social interaction without the insecurity caused by the uncontrolled presence or passage of strangers through the streets as happens in the modern suburb. This has resulted in a reduction in social interaction among neighbours. However, it is occasionally common to see residents trying to create social spaces when it is possible (Figure 5.18).

As discussed in Chapter Four, in the traditional town, open outdoor spaces resulted from building and street arrangements and were characterized by a comfortable micro-climate, contributing to a decrease in heat on a suburban level. In contrast, the only outdoor spaces between houses resulting from the arrangement of new suburban subdivisions are the setbacks areas that can be overlooked by neighbours. Thus, a common practice in Qatif is to see an extra high boundary wall built on top of the main fence. In this sense the setback becomes un-private as it interferes with the family privacy and it is not a public space where pedestrians can use it or pass through as it is constrained by the setback fence (Figure 5.19). Thus, it remains un-used space and it is common to see residents include as large an area as possible of the setback into the house footprint regardless of building regulations (Figure 5.20).
Figure 5.18: Inadequate planning has caused residents to create some social spaces. (a) Gathering area in front of the house where residents meet to chat and drink coffee. (b) The garage has been used as a shaded area to meet neighbours and friends.

Figure 5.19: The effect of unworkable spacing between houses. (a) Windows exposed to neighbours. (b,c,d,e) An extra partition was built to maintain privacy.
5.7 THE MODERN HOUSE IN QATIF

5.7.1 The character of the modern house

The traditional expression of cultural identity in domestic architecture in Qatif has been lost. Instead, the style of the house is imported from foreign cultures; there is no such thing as a Saudi regional architecture any more (Al-Naim 2008; Eben Saleh 2002). The first impression when looking at a modern Saudi house in Qatif is that it is a copy of a Western house (Figure 5.21). This is because of the box form and the façade treatment copied from Western designs. Facades are one of the house elements that are governed by the taste of the owners, typically influenced by the same capitalist consumerism that underlies the entire transformation of the urban structure from clan-based to cadastral, which has had such an evidently destructive effect upon Saudi traditional culture (Abu-Ghazze & M. 1997).

Figure 5.20: As a result of the housing arrangement in the block, setbacks lack privacy. Thus a large area of the front setback is included into the house. Therefore, cars are often seen parked in the street.
In Saudi Arabia, access to foreign cultures has resulted from greater mobility through the development of communication and transportation systems and modern technology that accompanied the oil boom (Al-Lyal 1990). The trend has continued, enhanced by the introduction of satellite dishes and the internet into Saudi Arabia, bringing more awareness of the outside world into the country (Alsolaiman 2004). This has caused individualism and the desire for differentiation, which is an inherent characteristic of modern consumerism. The spread of individualism throughout the country is reflected in the physical domestic built environment with much focus on aesthetic and visual qualities (Ibid). Building materials are readily available in the market, as are architects who are capable of creating different designs to satisfy customer individuality needs a result of the wealth created by the oil revenues.

Thus, there started a growing trend for Saudis to reflect their status through facade decoration and the use of different materials to express their individuality (Alsolaiman 2004). As a consequence, they copy any design they like, producing incoherent facades and incongruous images of the domestic built environment. Unlike the traditional houses,
modern houses no longer share a common architectural language, with a consequent loss of regional and communal identity. The same modern house can be seen anywhere in any Saudi city or indeed in other countries, unlike the traditional regional architecture which was specific and unique to its region.

5.7.2 The contemporary house and socio-cultural responses

Moving to the scale of the individual, modern Saudi house, climate is no longer determining the form and spatial organisation of the house. The previous role of the house form and envelope configuration of providing a comfortable interior environment to the occupants has been neglected as a consequence of the relative climatic freedom of selection offered by the installation of mechanical air-conditioning units, with their mechanical equilibration of comfort levels, and the role of the physical form of the house is now reduced to dealing with the cultural aspects.

The detached box form permits the location of windows to be set in the exterior walls. However, in this socio-cultural milieu the location of windows takes on a different dimension. Permitting windows to be set on the house facades has caused cultural conflicts and privacy issues. Neighbours’ windows are exposed to each other and interfere with the family privacy; the rigid inflexible form of the detached house has caused visual intrusion (Figure 5.22). The family zone, for instance, is exposed to the neighbours’ gaze. A common reaction is to use reflective double glazed windows, however, the physical properties of this type of glazing allows this solution to only work for part of the day. This type of window might maintain privacy during the day, but at night the glass acts in the opposite way, permitting the interior of the house to be seen from the outside. Consequently windows and curtains remain closed most of the day, during daylight to protect from heat and at night to preserve privacy. This means, effectively, that the air-conditioning remains on all day, especially in summer. This is not limited to the front façade only, but applies to the windows in all rooms that are exposed to the outside.
5.7.3 House spatial organisation

Despite its western external appearance, unreflective of local cultural identity, the Saudi house in Qatif maintains and applies cultural aspects inside the house. However, the influence of globalisation and localisation has created an architectural schizophrenia, what has been entitled “modern-traditional, Islamic-Western, and local-international” (Mahgoub 2004, p. 505). The cultural aspects inside the house can be seen in the zonal distribution inside the house (Figure 5.23), in which familial and female privacy as an important socio-cultural need is still a main factor.\(^6\) The Saudi house in Qatif usually consists of three floors: a ground floor which is divided physically into a private domain which is the family area and a public domain which is the male guests’ and strangers’ area, a first floor which comprises the bedrooms and the roof which comprises the maid’s room

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\(^6\) This is a fixed cultural value controlling the design concept and space distribution when designing Saudi modern houses in general.
and a storage area. Therefore, the house usually has two entrances: one is the family entrance and the other is the male guests’ entrance. There is always a direct access from the main house gate to the male guests’ reception room (or majlis). There is usually a guests’ dining room attached to the majlis. In the second domain, the family zone contains the living room, kitchen and a toilet. The living room is usually the largest zone in the house as it is the most occupied zone and is considered to be a multifunctional room where the family members gather, have meals and watch television.

Usually, there is a main kitchen and a heavy-duty kitchen. The main kitchen is located nearby in order to serve the family area and the male guests’ dining area. It has a door that opens onto the setback, with a direct access to the heavy-duty kitchen which is used for cooking heavy oil and unpleasant food smells.

**Figure 5.23:** A typical ground floor plan for a modern Saudi house in Qatif. It shows the two man domains inside the house family zone and male guest’s zone, including majlis. There is a direct access to each domain to preserve family privacy.
The first floor is the most private zone where the bedrooms are located. Indeed, this floor forms another level of privacy, in the sense that no one is allowed to enter except close relatives. It usually contains the master bedroom with a private toilet, and the children’s bedrooms with a shared toilet. The number of bedrooms varies according to the number of the family members, but typically, there are not less than four bedrooms. There is usually a girl’s room and a boy’s room (Figure 5.24). Similar to Western houses, the bedrooms in the contemporary Saudi house are often furnished with a framed bed and a cupboard.

The third floor is the roof where the female servant is usually accommodated together with storage and a laundry room. There is direct access from the ground floor to the first floor then to the roof (Figure 5.25).

A majority of the families in Qatif have drivers. In relation to the protocol governing domestic privacy, these men are considered to be strangers. Therefore, to preserve the family privacy and to prevent him from overlooking the interior of the house a room is built for the driver within the front setback, attached to the fence with a door facing the street with a small kitchen and a toilet (Figure 5.23).

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7 It is part of the cultural norms to have female servants to preserve the females’ privacy inside the family.

8 The introduction of vehicle network and city expansion is an aspect of modernisation. This has caused difficulties in keeping in-touch, unlike the traditional town where all places were reachable by a convenient walking distance. In addition, unlike the traditional time, women have become educated and employed. Thus there has been a socio-cultural need to provide mobility for them by having a private driver in most of the houses, given that the country’s rules still do not allow women to drive.
Chapter 5

After the Oil Boom: The Modern Transformation of Qatif

5.8 HOUSE AND CLIMATE

5.8.1 Materials

An energy efficient building needs to work with the climate, not against it (Olgyay 1963). However, the loss of control over windows created by a lack of cultural response to the pattern of subdivision has resulted in the urban house being in a state of total isolation.
from nature. Thus much attention has been given to the optimal comfort level of air-conditioning and the improvement of building materials’ thermal properties in order to reach an acceptable microclimate. Furthermore, none of the traditional local materials and construction techniques are used in the contemporary Saudi home environment. Materials are now locally manufactured according to Western standards.

Materials with good thermal property contribute significantly to the reduction of energy spent on air-conditioning. The issue of the rising energy consumption of houses now focuses on the thermal quality of materials (Ahmad 2004). Therefore, Saudi authorities and the construction industry seek the experience of Western experts and material production companies. This has resulted in Western building suppliers promoting their products and their use is widespread in all parts of Saudi Arabia.

The typical construction of a Western-style Saudi house is as follows. The main structural skeleton consists of reinforced concrete columns and beams carrying reinforced concrete ribbed ceilings and roof, the latter usually being thermally insulated. Walls are double skinned with insulation in the middle. They are usually 20cm in thickness and constructed of insulated concrete blocks (Figure 5.26). Internal walls are usually 15cm concrete blocks. Reflective double glazed windows of varied sizes and shapes are a typical feature.

Although materials that control heat transfer into the house play a significant role in reducing the amount of energy spent on air-conditioning (Al-Ajlan 2006), this strategy is not enough if the design components of the house are not working with the climate. The traditional home environment had worked brilliantly with all factors combined to provide passive climatic modification. However, it seems that in the modern house, the provision of insulation materials, and climatic cooling systems are the only solutions which inhabitants can control.

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9 For cooling loads computation see Appendix 2.
5.8.2 House size

It is important to note here that good materials and the introduction of air-conditioning has caused a major change in the physical form, size and the use of spaces inside the house. Firstly, people build houses of any form and any size providing comfort is achieved by mechanical air-conditioning and materials.\textsuperscript{10} Therefore, unlike the traditional house, the modern house size no longer reflects the family size. It would seem that, similar to current trends in the affluent West, the bigger the house, the fewer number of people there are living in it (Alsolaiman 2004). A modern house for a typical nuclear Saudi family that consists of six family members is now built on the same area of a traditional house that had been occupied by an extended family of about fifty members (Figure 5.27). This

\textsuperscript{10} This was stated by the architectural office (Sea fieldwork in Chapter Two) that climatic consideration is not a place of negotiation, when preparing the architectural design drawings, between the client and the architect as the mechanical cooling system is assumed to be the best solution.
also could be due to the imposition of functional specialisation of spaces rather than the multi-functionality that was a characteristic of the traditional Saudi house.

Another factor that contributes to the large house size is the culturally unworkable form. As mentioned before, the detached form arranged in a grid-iron pattern causes conflict with privacy, which is a basic Saudi cultural need. This conflict has caused the setback of the house to not maintain the family privacy as the neighbours overlook this space. Thus, occupants typically use the full 60% of the lot to be occupied by the house footprint and the minimum 2m setback to make an efficient and beneficial use of the lot. This means that even in the smallest lot of 400 square metres an area of 224 square metre/ floor is built. Thus the size of the house is still huge and requires high cooling loads.

![Diagram of traditional and contemporary houses](image)

**Figure 5.27:** The size of a traditional house occupied by an extended family is about the same size of a modern house which is occupied by a nuclear family.

### 5.8.3 Openings

The separation of houses and the pattern of subdivision have created contradiction with the main climatic and cultural objectives of windows in such a context. Windows no
longer facilitate cross ventilation nor are they designed to deal with visual intrusion as was the case in the traditional house. Large glazed facades have become a distinctive feature of the Saudi modern house (Alsolaiman 2004; Al-Lyaly 1990). In Qatif, the use of full height, unshaded and visually unprotected windows is very common in the main front facades facing the street (Figure 5.28).¹¹ Alsolaiman explains the phenomenon as an expression of status and welcoming (Alsolaiman 2004). In addition, all rooms have at least one window of a size no less than 180cm×100cm. These dimensions indicate that a large area of the exterior surface of the house is glazed, contributing to the high energy consumption in buildings (Radhi, Eltrapolsi & Sharples 2009).

The problem with the large glazed area is that it is usually not protected from solar heat by appropriate shading devices. Shade is one of the most effective passive solar control strategies (Olgyay 1963), one which was used extensively in the traditional town and in the traditional houses. The reason for not shading the glazed surface seems to be that such a large fenestration area needs a large shading element in order to shade effectively. This means that part of the front setback area is considered for shading. However, occupants would rather add this area to the house volume and rely completely on air-conditioning.

¹¹ Expression of welcoming in the traditional house was achieved by locating the males’ reception room in the best breezy orientation with openings facing the street. See Chapter Four.
5.8.4 Rooms’ orientation
The layout of the street based on grid planning results in a high percentage of the rooms having poor orientation. The highly inhabited spaces in many cases are located with the wrong orientation for passive solar control. In the modern Saudi houses, the family living room is always located in the front of the house (Alsolaiman 2004) with a large unshaded glazed area facing the street. This has been observed in Qatif. This means that the family living room which is the most occupied space in the house is always located in relation to the street regardless of the direction of the street, whether north or south. Thus, if the main façade of the house is oriented to the south which is subject to the greatest heat loads all day, the family living room will still be located there.

The conflict between social norm and insensitive mechanistic suburb block planning is better understood by an examination of a selected area which shows that there are 60 houses out of 172, thus comprising about 35% of the houses in that area, that have family rooms located adjacent to the main unshaded façade facing south and west that are subjected to solar exposure all day.

5.8.5 Behaviour and assigned functions
The use of air conditioning causes rooms to be assigned to a certain function. They are decided and assigned at early design stages and furnished accordingly without the flexibility to allow change (Akbar 1998). Thus occupants’ migration inside the house over the daily cycle to dwell in the most comfortable place is not applicable any more. This also has caused some rooms to be located in a climatically non-preferable orientation.

5.8.6 Control over the physical form
Maintaining familial privacy and modifying the microclimate, which had been solved in the traditional house by the form which allowed the openings to be directed to the courtyard is not applied in the typical modern Saudi house. Instead, as noted above, form has

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12 Based on the interview with professionals in the field. Mr Aljumaa and Alnajim stated that about 90-95% of the Saudi families prefer to have the living room in the main front façade.

13 Unlike the traditional furniture, the modern Saudi house furniture is no longer movable furniture. It is highly influenced by the Western furniture as well. Even local furniture factories are designing furniture based on Western style standards. However, the Saudi family arranges and uses the furniture in a way that suits their use of space.
affected the family privacy by exposing neighbours’ windows to each other. Consequently, this exposure has resulted in a limitation upon the occupants’ control of their windows.

Several authors have argued that, to maximise control of their environment, occupants should have the right to practice some control over the physical form by opening or closing windows to adjust the microclimate to their desired level of comfort (Hawkes, McDonald & Steemers 2002; Koch-Nielsen 2002). In Qatif this is an important aspect to facilitate cross-ventilation, and to encourage evaporative cooling through openings. Control over such configurations decreases the reliance on air-conditioning and makes users more tolerant to temperature changes (Koch-Nielsen 2002). However, compared to the traditional house, the modern suburban home environment in Qatif loses the choice of control on openings, a fact that has been neglected by suburban planning and building arrangements. Occupants cannot open windows to modify the climate because of cultural concerns. As noted, the form has caused interference with family privacy. Neighbours’ windows are exposed to each other on at least two sides of the house, thus limiting the users’ control in adjusting their interior climate by opening their windows. Thus, as mentioned earlier, it is common in Saudi neighbourhoods to see houses with an extra boundary wall situated on the main fence to preserve the family privacy.\(^{14}\)

The secret behind the success and uniqueness of the traditional physical form of the Saudi house was that it brilliantly solved the equation that contains different social and environmental variables in a very advanced manner. None of the variables were ignored; however in the case of the modern Saudi house the issue is different.

The physical environment of the new housing has led to reliance upon an inward-focused home-based life. This has caused a further increase in the domestic mechanical air-conditioning load. In addition, such a physical environment has a destructive effect on communal and interpersonal relations when compared with the traditional way of life enabled by the traditional house and its setting. The resultant social dislocation poses a

\(^{14}\) For computation of the hourly temperature profile of the contemporary house which is modelled in this chapter see Appendix 3.
real risk of social isolation, exacerbating psychiatric disorders and leading to an increased prevalence of obesity (Alhajaj 2014).

5.9 EVALUATION

In this chapter, the modern Saudi house in Qatif has been shown to respond inadequately response to climatic and socio-cultural factors. The problem of the modern Saudi home environment in Qatif and its high energy consumption starts from the urban planning. Destroying the natural shield of the farming area is the greatest evidence of such practice. In addition, the copied Western-style urban layout does not indicate any understanding of the climatic or socio-cultural needs either on a suburban or domestic scale, resulting in much greater energy loads required to cool the house.

Unlike the traditional domestic environment, it is surprising, in such a technologically advanced era, that the design of the typical built form is so deficient in many aspects. It does not represent any response to, or accommodation of, the climatic or socio-cultural needs. The urban pattern fails to respond adequately to these factors and the house is left alone facing interrelated climatic and cultural issues which have caused an intensive reliance on mechanical systems as a compensation for a non-responsive design. In contrast, as noted in Chapter Four, in the traditional town the entire configuration from the largest to the smallest detail, worked together in a highly organic, empirical and mutually supportive manner.

The urban planning configurations in the modern Saudi suburb in Qatif do not work with the climate, thus totally exposing streets and houses to the weather conditions and increasing the heat at the suburb level, and furthermore reducing social interaction. This is in contrast to the traditional home environment where the urban plan played a major role in modifying the climate on the urban and domestic scales and thus also enhancing and enabling social interaction.

Furthermore, the cubic, detached form of the house does not indicate any understanding of the climatic and socio-cultural needs of the inhabitants. In relation to climatic needs,
the form is totally isolated from nature rather than working with it. Facade orientation and large glazed unshaded windows indicate a lack of understanding of the role of the physical form in corresponding to the various factors. Thus, to cope with the climate, high quality, expensive materials are used and the role of design is neglected. Therefore the better the materials, the worse the design becomes. More energy is spent in overcoming such inefficient design, whereas working with the climate reduces the amount of energy spent on reaching the comfort level.

In relation to socio-cultural needs, the use of such detached forms within the inflexible formal urban plan has caused interference with family privacy, a major cultural issue which has not been resolved. As a result neighbours overlook each other and windows are closed all day and night.

With regard to the zonal distribution inside the houses in Qatif, the spatial arrangement shows cultural influences. This is achieved through the adaptation of Western-style houses in accommodating the inhabitants’ cultural needs in relation to gender segregation. Thus, the zones are divided into public, semi-public, and private zones.

However, the relationship between the zone function and the best orientation has not been considered. The location of spaces is governed by the street location. This means that the most occupied space might be located in the hottest orientation. In addition, the inflexible, furnished mono-functionality of the space resulting from the reduced necessity for correct exposure to achieve comfort permitted by the mechanical cooling systems makes changing the use of space difficult. This is not like the traditional houses where the change of the use of space according to the weather conditions was easy because of the movable flexible and multi-functional pieces of furniture. Thus, in the modern house, unmodifiable, inflexible space puts tremendous pressure on the cooling loads of the house.

Finally, the modern suburb represents an incoherent visual image resulting from modern technology, unlike the traditional home which represented a unified and coherent
appearance as a result of a common shared language of simplicity and professionalism in using the local materials.

5.10 CONCLUSION

The pattern of subdivision, the detached cubical form of houses, and the building regulations are not compatible with climatic or socio-cultural needs and the increased reliance on mechanical air-conditioning. Users have lost their control and choice in relation to their built environment. The only control they can practice to some extent is the spatial distribution inside the house to suit their socio-cultural need of privacy. Exotic Saudis, through a long period of trial and error, had succeeded in adapting the physical form of the modern house to suit their cultural needs in the form despite its alien features. In this sense, the researcher refers to the zonal planning of the house and the reaction of behaviour to such form. Since they have more control on the interior configuration of the house, they can apply their cultural needs to some extent. However, as they do not have control on both urban planning and building regulations, they do the best they can do to solve the cultural issues in their own way in a contradictory built environment.

This discussion shows that designing an energy efficient house cannot be achieved just by basic science and the simple logic and assumption of the need to save energy. In this cultural context there are interrelated socio-cultural and climatic factors that should be considered in the design of the neighbourhood subdivision layout and the design of the individual dwellings. Basic science and cultural factors need to be combined to produce an architecture and urban layout suitable for a particular culture in a specific climatic condition.
RETROFITTING
6.1 INTRODUCTION

The previous discussion showed that the main difference between the traditional and contemporary home environment in the Eastern Province in Qatif is that, on a macro-scale, the traditional town was unlike the contemporary town, walkable and pedestrian friendly, offering wellbeing and a sense of belonging to the residents through social interaction that was enhanced by the climatic responses of the physical configuration of the town. The environmental comfort was provided by deliberate shading and an adjacent plantation of palm groves. In contrast, the contemporary home environment does not offer any of these aspects through its planning.

On a micro-scale, the traditional house offered a variety of micro-climatic spaces inside the house. In addition, it offered complete familial privacy and complete control of, and through, the physical form. The contemporary house, again, does not offer any of these aspects through its design, and in fact imposes additional limitations upon residents’ freedom. Its physical form is the result of Western-style gridiron planning and building regulations which have limited occupants’ choice and, in relation to climatic control, has produced an unsustainably inefficient physical form.

As argued in this thesis, the main objectives that should underlie the physical configurations of a contemporary Saudi home environment in the composite climate in the Eastern Province in Qatif are:

- To provide more sustainable climate control through passive cooling techniques at both macro and micro-scales notably by minimising heat gain through maximum shading of buildings and external areas.
- To promote physical and social health through encouraging walkability and social interaction in the residential area, by careful and appropriate design of streets, squares, and landscaping, thus enabling under-provided groups, like mothers and their young children, to interact in a safe and culturally appropriate manner.
Based upon the previous analysis, the following chapter develops design guidelines that address these objectives in relation to retrofitting of the existing domestic and neighbourhood environments. To increase the social interaction and climatic responses in present day Qatif’s residential areas there should be improvement in the availability of usable and culturally appropriate neighbourhood spaces for family groups, groups of mothers and playing children, and groups of men on three hierarchal spatial levels: streets, parks and houses. The aim is to provide climatic comfort and domestic neighbourhood gathering spaces, analogous to the traditional town.

6.2 STREETS

The streets’ modifications focus on creating public outdoor open spaces, in and adjacent to the street, which have passive surveillance from the neighbouring houses, provide a sense of security and limit access to cars in the residential area. Also the aim of the modifications is to contribute to temperature reduction by implementing green and shaded areas on the street level. Such spaces are the equivalent of the traditional domestic cul-de-sac laneways, barahas and streets, with their opportunities for interaction between residents, supervised play spaces and more public widened streets, which were a gathering space for local men. These outdoor modified spaces are classified according to the following forms: linear form, cul-de-sac, reduced street width and creation of pedestrian streets. Similar public open spaces have been proposed to increase the public outdoor spaces POS in Jeddah in Saudi Arabia, with the added target of increasing walkability and public health (Alhajaj 2014). Each of the following modifications could be implemented in certain situations:

- **Linear form**

In this situation, the whole street would be transformed into a green public outdoor open space. This is inspired by the *baraha* in the traditional town which was a safe, cool outdoor space between houses where children played and neighbours could meet. This could be applied in the following cases (Table 6.1) and (Figure 6.1):
1. On a minor street between the short side of two residential blocks.
2. On a street between an existing green area and residential units where access is not restricted.
3. On a street between the sides of two large buildings.
4. On a secondary street between a large building and an existing green area.

- **Cul-de-sac form**

In this form, a part of the street would be transformed into a green area. This requires a two-way street to give cars a space in which to navigate. This treatment is inspired by the cul-de-sac in the traditional town where pedestrians’ access was limited by the cul-de-sac street. However, the aim here is to limit vehicular access and provide pedestrians with safer streets. This could be implemented in the following spatial conditions (Table 6.2):

1. At a T-junction of a main and a secondary street between the sides of two residential units between two opposing blocks.
2. To vertically extend an existing horizontal linear green area at a T-junction between a major and a minor street where access to residential units is not restricted.
3. Along an L-shape street between existing green area and residential units with unrestricted access.
4. On a minor street between an existing green area and a large public building like a school, a charity building or a mosque.
5. At the intersection between three blocks where access to residential units is not restricted.

- **Reducing street width**

This transformation would be achieved by applying green verges along the sides of the streets - this could be applied in all places where the street width permits (Table 6.3 and Figure 6.2). This includes footways which are fundamental to implement as a strip surrounding the residential blocks. This idea is inspired by the narrow, shaded and safe streets of the traditional town. However, the current streets still need to be wide enough to accommodate cars.
• **Pedestrian streets**

Pedestrianisation is more relevant in relation to the degraded areas of the traditional town. This treatment requires the implementation of a one-way street system and removal of street parking for houses that lack private parking within the house boundaries. In such cases, the cars parking spaces would be excluded, and replaced by secure peripheral parking garages and the vehicular street transformed to form a restricted pedestrian street. This could be achieved in the following cases (Table 6.3):

1. In a narrow street flanked by houses that lack car parking within the cadastral boundaries.
2. On a narrow street between houses that lack private car parking and an existing green area.
3. On a narrow street between houses that lack private car parking and a public building, such as a mosque.

In all cases car restricted access is needed and this could be achieved by applying car access restriction protocols and secure car parking areas should be provided in the area.

### 6.2.1 Advantages of the Street Treatments

- Reduction in streets' area which means less asphalt material and more green areas.
- Reduction of heat and provision of cooling effect in the residential area as result of implementing green and shaded areas.
- Reduction of extent of car access and vehicular speed and thus more safety and less pollution in the residential area.
- Greater chance for social interaction between neighbours as a consequence of the close proximity of outdoor public spaces.
- Increased walkability and physical activity, thus improving health by close proximity of outdoor public spaces.  

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1 Visualization of the principles illustrated by the author in Appendix 2, Part Two: retrofitting.
## Proposed Street Modifications

<table>
<thead>
<tr>
<th>Form</th>
<th>Before</th>
<th>After</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td><img src="linear_before.png" alt="Diagram" /></td>
<td><img src="linear_after.png" alt="Diagram" /></td>
<td>1. On a minor street between the short side of two residential blocks.</td>
</tr>
<tr>
<td></td>
<td><img src="linear_before.png" alt="Diagram" /></td>
<td><img src="linear_after.png" alt="Diagram" /></td>
<td>2. On a street between an existing green area and residential units where access is not restricted.</td>
</tr>
<tr>
<td></td>
<td><img src="linear_before.png" alt="Diagram" /></td>
<td><img src="linear_after.png" alt="Diagram" /></td>
<td>3. On a street between the sides of two large buildings.</td>
</tr>
<tr>
<td></td>
<td><img src="linear_before.png" alt="Diagram" /></td>
<td><img src="linear_after.png" alt="Diagram" /></td>
<td>4. On a secondary street between a large building and an existing green area.</td>
</tr>
</tbody>
</table>

Table 6.1: Conditions of implementing linear form in existing streets in Qatif to create climatic modified space for social gathering similar to *baraha* concept in the traditional town.

*Source:* Created by the author 2014.
Advantages:
Providing a close recreation area to the residential units
Providing semi-private shaded area for females
Providing a safe playground for children
Reducing car access and asphalt area, thus contributing to heat reduction
Planting that contributes to heat reduction

**Figure 6.1:** Linear form creating *baraha* concept by converting a two-way street between two blocks to a playground.
Proposed Street Modifications

<table>
<thead>
<tr>
<th>Form</th>
<th>Before</th>
<th>After</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cul-de-sac</td>
<td><img src="Image1" alt="Before" /></td>
<td><img src="Image2" alt="After" /></td>
<td>1. At a T-junction of a main and a secondary street between the sides of two residential units between two opposing blocks.</td>
</tr>
<tr>
<td></td>
<td><img src="Image3" alt="Before" /></td>
<td><img src="Image4" alt="After" /></td>
<td>2. To vertically extend an existing horizontal linear green area at a T-junction between a major and a minor street where access to residential units is not restricted.</td>
</tr>
<tr>
<td></td>
<td><img src="Image5" alt="Before" /></td>
<td><img src="Image6" alt="After" /></td>
<td>3. Along an L-shape street between existing green area and residential units with un-restricted access.</td>
</tr>
<tr>
<td></td>
<td><img src="Image7" alt="Before" /></td>
<td><img src="Image8" alt="After" /></td>
<td>4. On a minor street between existing green area and a large public building like a school, a charity building or a mosque.</td>
</tr>
<tr>
<td></td>
<td><img src="Image9" alt="Before" /></td>
<td><img src="Image10" alt="After" /></td>
<td>5. At the intersection between three blocks where access to residential units is not restricted.</td>
</tr>
</tbody>
</table>

*Table 6.2: Conditions of implementing cul-de-sac streets in the current streets in Qatif.*

*Source: Created by the author 2014.*
## Proposed Street Modifications

<table>
<thead>
<tr>
<th>Form</th>
<th>Before</th>
<th>After</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing Street Width</td>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
<td>1. Everywhere where the street width permits, a green verge could be applied.</td>
</tr>
<tr>
<td></td>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
<td>2. In a narrow street flanked by houses that lack car parking.</td>
</tr>
<tr>
<td>Pedestrian Street</td>
<td><img src="image5.png" alt="Image" /></td>
<td><img src="image6.png" alt="Image" /></td>
<td>3. On a narrow street between houses that lack private car parking and existing green area.</td>
</tr>
<tr>
<td></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td>4. On a narrow street between houses that lack private car parking and a public building like a mosque.</td>
</tr>
</tbody>
</table>

*Table 6.3:* Conditions of implementing the reduction of street width and creating pedestrian streets.  
*Source:* Created by the author 2014.
Advantages:
The street width and the asphalt area are reduced.
Vehicles accessibility is reduced by reducing the street width.
Plants are implemented for shading and cooling effect.
A safe pedestrian footpath is provided.
Walkability is encouraged and social interaction by the shaded footpath.

Figure 6.2: Section of proposed model. Reducing streets width by offering shaded footpaths and plantation.
6.2.2 Policies and Social and Climatic Functionality

The socio-cultural and climatic sustainable outcomes discussed above cannot be achieved without crucial policy innovations that implement public transport and introduce car parking solutions to increase functionality.

Connectivity is a main concern in relation to public transport, thus the separated suburbs in Qatif need to be connected by an integrated public transport system. Also, public transport is needed to connect the areas of high daily use such as the neighbourhood, mosque, the local school, neighbourhood parks and shops. This will eventually reduce reliance on cars.

New neighbourhood planning policies in Saudi Arabia need to integrate car parking strategies, through which car parking buildings are provided at strategic location in suburbs so residents will be able to leave their cars in a secure place (Alhajaj 2014). These strategies are vital, especially in areas that lack adequate private car parking. Streets in the whole residential area could be transformed to pedestrian streets if car parking policies were to be implemented.

6.3 PARK SPACES

Within park spaces, shade structures should be provided to encourage the use of the space by both genders (Figure 6.3). However, the space should respect cultural concerns and thus should offer privacy for females through provision of semi-private physical elements. The traditional town did not offer specific outdoor spaces for women because of their attachment to family life inside their houses; however, outdoor structure may be introduced, inspired by the traditional house and its elements, in order to create units that are suitable for women to use in public spaces. This provision needs to be combined with designs that take into account the climatic considerations. In this sense the park recreational areas need to provide shade both from overhanging trees and built shade structures, while providing privacy and gender separation at the same time (Figure 6.4).
6.4 HOUSING MODIFICATIONS

Modifications to the modern house in Qatif are concerned with the following configurations: the setback, the openings and the roof; these configurations are flexible and allow for change and adaptation. The proposed modifications result from an understanding of the forms of the traditional houses, with their climatic and cultural dimensions in comparison to the current house design as has been analysed in Chapters Four and Five of this thesis. However, as the current house is a box-like form, the proposed solutions were aided by looking at examples from other comparable parts of the world to help in finding solutions that could be implemented to the detached cubic Saudi residential form. After that, the focus was on proposing residential forms that suit the culture and work with the climate. They are as follows.

Figure 6.3: Different shading styles in parks in Australia. They provide shade and privacy in the public area.

Figure 6.4: Mashrabiya concept is suitable to create an outdoor semi-private unit where females can sit with privacy in a shaded ventilated area. It also allows for supervision of children.
6.4.1 Setback modifications

The setback modifications could be applied in three areas: the main entrance door, the front setback area and the fence. The aim of the setback modifications is to provide full use of the area surrounding the house by enhancing the socio-cultural and climatic response.

- **Entrance Room**

The front area of the traditional entrance door played a major role in enhancing social bonds between neighbours. The front area was always shaded by the houses, thus creating a cool area (Figure 6.5). Neighbours would meet and sit on the threshold or on a seat in front of the door if there was enough space (Al-Naim 1998; Talib 1984), whereas the main entrance door into the property in the current Saudi house in Qatif lacks the social role (Figure 6.6). Thus the main entrance door into the property is here proposed to be transformed into an entrance room. This treatment focuses on creating a social function for the main entrance door similar to the gate set in the street wall of the traditional house which adds to the territorial depth of the residential area. In this treatment the residents would move from the public zone of the street to a semi-public one which is the vestibule of the main entrance door. This could be achieved by creating a climatically modified shaded entrance (more like a room). This treatment requires relocating the entrance door and having a shading roof and a wall on the sides of the door. This area may include a bench in order to be utilised as a seating area for social gatherings of small groups of people (Figure 6.7).

- **Front Setback Shade**

The front setback treatments aim to provide private outdoor space for the family by providing climatic spaces which are graduated from full sun to full shade within the house boundaries. This idea was inspired by the traditional courtyard house in which there was diurnal and nocturnal climatic cycle of spaces created inside the house (Figure 6.8). Thus, retrofitting contemporary Qatif houses requires the creation of shaded areas by implementing shading elements (Figure 6.9).

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2 The modifications are concerned with the minimum setback spacing required by the municipality.
3 See Chapter Four.
The shading elements are here classified as attached or detached. The attached case may connect either to the fence or to the house front façade. In both cases, the shade structure provides privacy, as the shaded area is used by guests and does not overlook the house’s interior spaces. Additionally, the entrance room has the advantage of providing privacy to the windows behind it, besides providing a cooling effect by lowering the temperature of air entering the interior space (Figure 6.10).

The detached form treatment is more concerned with freestanding shading elements, such as pergolas. However, this treatment is more applicable to houses with a larger setback, as it requires more space to allow circulation around it. Nevertheless, in a large setback a combination of attached and detached forms of shading elements may be used.

In addition to the advantages of shading elements, the role of plants and green areas in the setback should not be neglected. Plants, especially overhanging trees, have the advantage of providing shade and a cooling effect they may also provide privacy if planted appropriately. This could be achieved by planting groups of trees in front of windows or close to the shading elements for privacy and a cooling effect. Green areas combined with water in other parts of the setback may be implemented. Properly planted trees may be used to create potential for social spaces within the setback area for families to sit and socialise privately.

- **Extended Fence**

The manipulation of fencing focuses on increasing the current three meter height by adding elements on the existing fence wall to create a private outdoor space for the family. This solution was inspired by the enclosed private outdoor space created by the rooms surrounding the courtyard in the traditional house (Figure 6.11). This application has been implemented in modern architectural examples (Figure 6.12). This idea requires a partition of a reasonable height in order to provide visual privacy for the family, especially post-pubescent females, while using the setback for their daily activities. In addition, the extension has the advantage of providing shade in the 2m setback as a result of the new proportion created by the extension which would be in the proportion of H/W: 3/1 which is ideal for shading. However, in the 6m front spacing the shading effect is not
significant. Thus, the aid of other applications of shading elements would be needed (Figure 6.13).

![Figure 6.5: (a) The traditional entrance door acted as a place for socialising in Qatif. (b) Built-in seat outside the entrance door in a traditional Tunisian town. (c) Built-in seat inside the entrance door in a traditional in Alhasa, Saudi Arabia.](image)

![Figure 6.6: (a) and (b) The current entrance door design of a typical modern Qatif house lacks a social role enhanced by the climatic role. (c) The Müller house entrance vestibule, which provides a shaded seating area in front of the house thus enhances social interaction (Adolf Loos, Müller house Prague, 1930).](image)

![Figure 6.7: Entrance door treatment: Creating an entrance in the current Saudi house in Qatif to add a social dimension to the entrance door enhanced by shade and ventilation openings.](image)
Figure 6.8: Shaded areas inside the traditional courtyard houses with full privacy. (a) In Qatif (b) In Syria (c) In Egypt.

Figure 6.9: Shade structure attached to the façade of a cube house form in modern architecture does not provide privacy.

Figure 6.10: Shade attached to the façade with elements that provide privacy, shade and allow air circulation. The sides of the shade provide privacy and allow air movement.
Chapter 6

Retrofitting

Figure 6.11: (a) In the traditional Qatifi house, the enclosed outdoor private area created by the high walls surrounding the courtyard has created privacy. In (b) and (c) the roof of this house was also surrounded with high boundary walls to preserve females’ privacy. Thus females had freedom to use the outdoor space with complete privacy within the house boundaries.

Figure 6.12: Modern partitions provide a cooling effect while maintaining privacy.

Figure 6.13: Retrofitting to current fence: Increasing the original fence height by adding extra partition such as green partitions or louvres protects residents from neighbours’ gaze and gives privacy for the family while using the setback area and allows air circulation as well.
6.4.2 Modification of Openings

It is important to restate here that contemporary Saudi residents are used to the comfort level associated with an air-conditioned environment. In addition, the weather data shows that there are times of the year when it is difficult for contemporary residents who are accustomed to a certain comfort level not to use air-conditioning. However, it also shows that the reliance on air-conditioning could be reduced significantly in some months of the year. Thus, the following treatments do not impose the cessation of mechanical cooling, but they do give more options for the occupants to tolerate the weather without the mediation of mechanical cooling. This is considered as a step forward toward the objective of reducing reliance on mechanical cooling system which is one of the main goals of this research.

In proposing the following opening retro-treatments of modern Qatifi houses, the aim is to preserve culturally appropriate privacy, thus increasing control over windows to be opened to achieve passive cooling when needed. The contemporary domestic building form is an extroverted detached box form, the consequence of which is that full control of opening windows to benefit from ventilation is limited because of the cultural concerns for privacy of women. A solution is therefore required that will provide privacy as well as increasing control of window operating in order to manage comfort levels and to encourage air-circulation. The types of opening treatments are primarily classified here in relation to first floor treatments and ground floor treatments, and could be achieved by implementing the following:

6.4.2.1. First Floor Opening Treatments

The first floor treatments are based on structures which were found in similar extroverted forms. They require a projection, and thus they cannot be used on the ground floor.

- **Mashrabiya**

  The optimal solution to be found in such extroverted form in a similar culture is the use of screened openings that are the practical equivalent of *mashrabiya*, screened openings that were efficient in providing privacy, shade and encouraging air circulation by
permitting the opening of windows while screening the occupants within (Figure 6.14). Also, in relation to the expression of cultural identity, there was an additional cultural benefit as the *mashrabiya* offered an opportunity to apply Islamic geometric art for a practical purpose, and *mashrabiya* were one of the most evocative and decorative urban expressions of cultural intent, contrasting appealingly with the stereo-metric appearance of the external walls. The *mashrabiya* was used very widely in the facades of the traditional houses in the western region in Saudi Arabia. In the modern era such functional and cultural purposiveness has been neglected (Figure 6.15). Thus, whereas the *mashrabiya* was used both for aesthetic and functional purposes, its effect could be achieved by contemporary architecture, with the same cultural and environmental benefit. Indeed, there is a possibility to use *mashrabiya* or technologically equivalent screening in the current houses to maximise comfort. This element could be installed as a projection on the first floor facades, as applied to currently existing openings. In contemporary houses the sliding window glass may be kept for better weather control. In case of full-height windows, *mashrabiya* could be used as a seating area (Figure 6.16).

- **Balcony**

The balcony is another form of shaded projection, one which is equivalent to the *mashrabiya*, and that could be applied to an existing opening of full-height on the first floor. Balconies were criticised when they were introduced to the country by foreign architects in the early seventies and tended to remain unused, as they caused conflict with cultural norms by exposing residents to the view of neighbours (Figure 6.17). Consequently, they disappeared in later designs until the present day (Akbar 1998). However, balconies could still be used if they were appropriately designed to obey climatic and cultural needs. A balcony could be useful if it were screened above the eye-level with an opening left on the top for ventilation. This idea is inspired by the openings above eye-level in the traditional house, and has a precedent in the ATBAT Semiramis housing type developed by Georges Candilis in Casablanca, Morocco (Figure 6.18 and Figure 6.19).

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*It was also used in the traditional houses in Egypt, Iraq, Turkey and Syria.*
A screened balcony and *mashrabiya* both help occupants to tolerate the weather by adding to the gradation of hierarchal climatic comfort levels when used as a seating area and thus would be a good space to catch any breeze that exists. Having balconies and *mashrabiyas* as shaded projections creates a variety of spaces from the fully enclosed space of the room to the external private shaded area of the screened projection. Both may be combined with external fans to create heat differentials and thus generate air movement.

**Figure 6.14:** The traditional *mashrabiya* was a projected wooden screen which allowed air circulation and gave privacy, while permitting occupants to see out and catch cooling breezes.

**Figure 6.15:** (a) and (b) *Mashrabiya* in Middle Eastern modern architecture is used for aesthetic purposes as air-conditioning still dominates buildings. However, some Western architects in Australia have used a similar *mashrabiya* concept of window screenings to control sun and wind (c) and (d).

**Figure 6.16:** Retrofitting to current window: *Mashrabiya* with glass sliding door that provides privacy and gives more options to the occupants.
Figure 6.17: The seventies Saudi balconies in Qatif. They are inappropriate balconies in the Saudi culture. They remained un-used or they were added to the interior space. Then they disappeared in late designs until present day.

Figure 6.18: (a) and (b) Western style balconies are not suitable for the Saudi culture. (c) However, the Candilis Semiramis balcony concept allows privacy and air-circulation. Thus, the concept could be used in the Saudi culture.

Figure 6.19: Retrofitting to existing windows in a Saudi house. A balcony design which provides privacy, shade and allows air circulation. It could be used by females allowing complete privacy.
6.4.2.2. Ground Floor Opening Treatments

The following treatments are concerned with the ground floor openings. It is difficult to have a screened mashrabyia or a balcony on the ground floor openings because the space is limited by the setback which acts as a circulation area bounded by the fence. However, treatments of ground floor openings could be applied to the first floor as well.

- **Vertical shading element**

  Another form of treatment is vertical shading. In this type of treatment, a vertical screen is required to be installed in front of the existing opening (Figure 6.20). The screen needs to be controllable in order to allow or exclude solar radiation and wind. This is inspired by the idea of shaded windows in the colonnaded passage in the traditional courtyard house, combined with the need for privacy in relation to windows. This results in the need to screen the window with vertical shading (Figure 6.21).

- **Bridging shading element**

  This treatment was inspired by the sabat in the traditional town (Figure 6.22). This aspect has a presence in modern architecture to create cool shading streets (Figure 6.23). In this type of treatment, there are three possibilities that could be applied: the first possibility relates to openings on the ground floor this requires the installation of a horizontal shading element extended from above the opening to the fence (Figure 6.24). The second possibility relates to openings on the first floor. In this case the bridging shading element would be extended from above the window to the opposing neighbour’s window (Figure 6.25). In both cases the shading element may be controlled manually or electrically so it could be extended or folded to tolerate weather conditions. This strategy has the advantage of providing shade to the setback area as well. The third possibility is implementing a bridged room. This bridged room may be a connection between two houses. A room is attached to each house, sharing a wall with the neighbouring house (Figure 6.26). Thus, if this type of treatment is used, there would be a need to address the rules for the property boundaries. However, in the current residential area in Qatif, the bridged room would shade part of the setback which is used privately by the family, unlike the shaded public street in the traditional town which was created by the bridged room.

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5 See Chapter Four.
- **Ventilators**

This strategy was inspired by the ventilators in the traditional house (Figure 6.27). Similar elements have been used above windows in modern architecture to increase air circulation (Figure 6.28). This treatment is also applicable for ground and first floor openings, and requires having extra openings on top of the original opening (Figure 6.29). However, unlike the traditional permanent ventilator, they need to be controllable. Thus a cover would need to be provided in order to open or close the ventilator when required. It aims to encourage air circulation when both window and ventilators are opened. Also, such ventilation openings provide a second option when the occupants need to open them for fresh air.  

> Visualization of the principles and cooling loads computation is illustrated in Appendix 2.

**Figure 6.20:** Vertical shading is an equivalent element to *mashrabiya* in modern architecture that could be used to allow visual screening and allow breeze access.

**Figure 6.21:** Vertical windows shade that give privacy, shade and allow full control over windows so occupants can open the window for natural ventilation. This treatment is effective especially for the western windows to prevent from afternoon solar radiation.

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6 Visualizaiton of the principles and cooling loads computation is illustrated in Appendix 2.
Visual privacy and ventilation provided by bridged shading element

The bridged shade gives privacy and creates shaded areas in the setback as well

**Figure 6.22:** Bridged rooms shading the street and created (sabat) underneath in the traditional town in Qatif.

**Figure 6.23:** (a) The Avery Coonley House 1907 by Frank Lloyd Wright is an example of creating shaded streets by building a bridged room. (b) and (c) the use of horizontal shaded elements to create shaded streets.

**Figure 6.24:** Adding bridged shading above windows on the ground floor in an existing condition. The shading element has to provide privacy and should allow breeze.
Figure 6.25: Bridged shading on the first floor between two neighbouring houses. This type of bridged shade provides shade over windows and in some parts of the setback. However, it does not apply privacy over windows. Thus, it should be used with other window treatments to give privacy.

Figure 6.26: Two bridged rooms may be built to connect between two houses. This treatment has the advantage of shading the setback and the rooms may be used for the family.
Figure 6.27: Ventilators on top of the windows and doors to encourage air circulation in the traditional houses. (a) and (b) In Qatif. (c) Dubai, United Arab Emirates

Figure 6.28: Ventilators in modern architecture. They may be used on top of windows to improve air circulation inside the room.

Figure 6.29: Adding a ventilator to an existing window. Controllable ventilators above the eye level on top of the window in the modern Saudi house may be implemented to encourage air-circulation.
6.4.3 Roof

Roof treatments focus on increasing the outdoor private open space for the Saudi family within the house boundaries. Their aim is to provide a variety of climatic modified spaces from full sun to full shade. This was also inspired by the climate modifying spaces that were offered by the traditional house (Figure 6.30). Yannas used a similar approach by creating a garden on the building’s roof to create a pleasant microclimate and to contribute to reduction of cooling loads inside the building (Yannas 2001). In some modern architectural projects, the roof has been used effectively as a functional space (Figure 6.31). The roof area in the contemporary Qatif house is big enough to accommodate various spaces for different activities for the family. The suggested treatment is a roof garden with a variety of spaces. This treatment, inspired by the private courtyard garden found in the traditional houses in Syria and Egypt, finds its cultural and environmental equivalent in the climatically-modified roof terrace in the modern Saudi house. Having a roof garden has a nocturnal cooling benefit for residents, in addition to which it creates a recreational area for the family with complete privacy. The suggested treatments may be applied all at once or partially depending on the occupants’ preferences and needs.

- Shade

Full shade may be provided by the construction of a habitable room on the roof, for which a northern orientation is preferable for catching available breezes. This room needs to be designed with large ventilated openings and shade for a cooling effect. However, privacy is not restricted on openings except if they are facing open windows on the neighbour’s roof (Figure 6.32).

Shaded external areas may be implemented through the creation of a double roof which gives shade and allows air circulation as well. This treatment could be applied to all the roof area or to a partial area. The ‘second’ roof could be a light-weight structure; as long as it prevents the solar radiation from hitting the roof slab it should perform adequately, and in this case would not require structural strengthening of the existing house. Shading

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7 The roof is also the place where solar cells could be implemented. They are suitable to apply to generate electricity in this climatic region due to the availability of sun.
elements like plants or partitions are recommended on the western side to prevent direct solar radiation in the afternoon (Figure 6.32).

- **Full Sun**

  This strategy requires exposing an area to the sun. However, the design should offer an optional controllable shade which can be implemented when needed, particularly in allowing or excluding direct solar radiation (Figure 6.32).

![Images of architectural designs](image)

**Figure 6.30:** (a) Mecca, Saudi Arabia (b) Iraq (c) Aseer, Saudi Arabia. The roof in the traditional house was an important inhabitable space and was utilised to tolerate the weather conditions.

![Images of architectural designs](image)

**Figure 6.31:** (a) Le Corbusier, Villa Savoye, France (b) Jose Luis, Sert-Miro Foundation, Spain (c) Le Corbusier, Villa Shodan, India. Inhabitable roof spaces in modern projects. Notice the use of a double roof to tolerate the hot weather in India.
Figure 6.32: Utilizing the roof for the family as a private outdoor space. A variety of microclimate spaces is provided to assist residents to tolerate the weather.
### Proposed House Modifications

<table>
<thead>
<tr>
<th>Form</th>
<th>Before</th>
<th>After</th>
<th>Modification</th>
</tr>
</thead>
</table>
| **Entrance Room** | ![Before](image1) | ![After](image2) | - Relocating the entrance door and having a shading roof and a wall on the sides of the door.  
- Bench may be included in order to be utilised as a seating area for social gatherings of small groups of people. |
| **Front Setback shade** | ![Before](image3) | ![After](image4) | - Attached shade may be connected either to the fence or to the house front façade. |
| **Extended Fence** | ![Before](image5) | ![After](image6) | - Adding elements on the existing fence wall to create a private outdoor space |

**Table 6.4:** Setback proposed modifications to make the setback usable space.  
*Source: Created by the author 2014.*
# Proposed House Modifications

<table>
<thead>
<tr>
<th>Level</th>
<th>Form</th>
<th>Modification</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Floor</td>
<td>Mashrabiya</td>
<td>- Installed as a projection on the first floor facades applied to currently existing openings.</td>
<td>- The sliding window glass may be kept for better weather control.</td>
</tr>
<tr>
<td></td>
<td>Balcony</td>
<td>- Balcony has to be screened above the eye-level with an opening left on the top for ventilation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vertical Shade</td>
<td>- A vertical screen is required to be installed in front of the existing opening.</td>
<td>- The screen needs to be controllable in order to allow or exclude solar radiation and wind.</td>
</tr>
<tr>
<td></td>
<td>Bridged Shade</td>
<td>- A horizontal shading element extended from above the opening to the fence.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ventilation</td>
<td>- A horizontal bridging shading element or bridged room will be extended from above the window to the opposing neighbour’s window.</td>
<td>- Shading elements on windows are required to achieve visual privacy.</td>
</tr>
</tbody>
</table>

- This treatment is also applicable for ground and first floor openings, and requires having extra openings on top of the original opening.

**Table 6.5:** Proposed openings modifications. They aim to give occupant control to open windows by applying privacy.

*Source: Created by the author 2014.*
Proposed House Modifications

<table>
<thead>
<tr>
<th>Roof</th>
<th>Form</th>
<th>Modification</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Shade</td>
<td>- Requires providing a room with</td>
<td>- Requires providing a room with openings oriented to the Northern direction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>openings oriented to the Northern direction.</td>
<td>- Privacy is needed on windows if facing neighbours.</td>
</tr>
<tr>
<td></td>
<td>shade</td>
<td>- Requires the creation of a double roof.</td>
<td>- Requires the creation of a double roof.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Could be applied on all the roof area or on a</td>
<td>- Could be applied on all the roof area or on a partial area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>partial area.</td>
<td>- Light-weight structure is recommended.</td>
</tr>
<tr>
<td></td>
<td>Full sun</td>
<td>- Requires exposing an area to the sun.</td>
<td>- Requires exposing an area to the sun.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Optional controllable shade may be provided.</td>
<td>- Optional controllable shade may be provided.</td>
</tr>
</tbody>
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Table 6.6: Proposed roof modifications. They aim to create an outdoor private space within the house boundaries with a variety of micro-climate spaces. 

Source: Created by the author 2014.
6.5 CONCLUSION

This chapter illustrates possible solutions that if implemented they would increase climatic responses, the socio-cultural interaction and walkability in the residential area. The chapter proposes forms inspired by the traditional home environment. These forms work on three levels: streets, parks and house unit. On the street level the proposed modifications aim to increase the public open spaces in the residential area, leading to increase social interaction, walkability, heat reduction absorbed by the streets and the creation of a healthy environment. On the parks level the proposal focuses mainly on making the park area suitable for women thus shaded semi-private provision is proposed to encourage a social role for women, in such a preserved culture. On the house scale modifications are proposed to make the setback a usable space and make windows openable. Roof modifications also are proposed to make it a private outdoor space for the family with a variety of climatic modified spaces. The implementation of the proposed forms would be a step forward in improving the current unsustainable condition of Qatif’s suburbs.
FUTURE SUSTAINABLE DOMESTIC ENVIRONMENT
### 7.1 INTRODUCTION

The previous chapter has proposed modifications that would improve the current built environment in Qatif. On the suburban level, the proposed modifications are inspired by the forms of spaces in the traditional town, and aim at reducing the street area and creating a walkable neighbourhood with more social gathering areas. On the domestic scale, modifications are also proposed, based on the forms that are climatically and culturally applicable in the traditional house. The proposed solution aims at facilitating more outdoor space for the family within the house’s property boundaries while maintaining complete privacy, and aims at improving passive cooling by giving occupants, through implementing privacy, the option to open windows to increase their comfort level.

With the previous aspects in mind, this chapter sets out principles for future planning of modern suburbs in Qatif, deriving from the comparisons which were undertaken in Chapters Four and Five. The proposed guidelines are formulated with the intention of overcoming the problems of the current situation, learning from the environmental and cultural sustainable principles of the traditional town, and adapting them in formulating a basis for future practice. Similar to the previous chapter, the principles in this chapter have been based upon a methodology that combines a study of the local traditional housing principles, as well as studying examples of relevant international best practice in developing guidelines that can be implemented. It is important to re-emphasise here that this chapter does not intend to call for a slavish and traditionalist copying of the past as the social situation has changed. The old city would no longer suit modern citizens, in a new social situation where a high percentage work and no longer live in tribal enclaves. In addition, the social role of women has changed, and they have become more involved in social life and less attached to the house. Thus, the future planning has to accommodate these substantial and ongoing changes.

It is also important to restate that enhancing the climatic response of the physical environment also facilitates social interaction, as was stated earlier in this research.
Therefore, the drive behind new residential planning in Qatif should be to create climatic responses as well as socio-cultural interaction. These two interlinked aspects have to be the intended objects informing design decisions on both the macro and micro scales. This could be achieved by applying the principles set out below:

### 7.2 FUTURE URBAN FORM

It is important to highlight here, as stated above that present-day residents in Qatif differ in their lifestyle, and indeed cultural norms, from the residents of the traditional town. As a result of their work commitments, many of them are employed outside the town. Most of their relationships have become established with work colleagues, while their kinship relations are, in many cases, located outside the residential area or outside the town. Modern social mobility has responded to the creation of new centres of industrial and other employment. Thus, an aspect that has been neglected by the current planning in Qatif and which is essential for the socially sustainable design of the future neighbourhoods is the enhancement of non-kinship related social interaction in the residential area. This would create opportunities for social interaction similar to what was created through the physical form in the traditional town, in order to improve the socio-cultural quality of life of the residential areas.

#### 7.2.1 Shade as a Prioritised Aspect

Protection from direct solar radiation should be a priority of the built physical form, with adequate shaded outdoor spaces provided in new neighbourhoods. This would enhance walkability and social life in the residential area. Thus, shade needs to be implemented for all streets, footpaths, playgrounds and social gathering areas as the physical features of the road play a main role in encouraging walkability, even for a short distance (Calthorpe 1993; Gehl 2010). Shade may be provided by the arrangement of buildings and the physical configurations of the urban form. This was clearly one of the main aspects of the traditional town in Qatif which encouraged residents to use the outdoor spaces.\(^1\)

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\(^1\) See Chapter Four.
However, wherever shade is not achieved by the arrangement of buildings, overhead shading elements and trees must be used (Figure 7.1).

**Figure 7.1:** Shade in the residential area has to be implemented by building, trees or shading elements. They create cool outdoor spaces where residents are supposed to meet. In addition they act against direct solar radiation thus they reduce the amount of heat absorbed in the residential area which impacts on the cooling loads of dwellings.
7.2.2 Compactness

The first lesson to learn from the traditional town is that to work with climate and to create a cool built environment with less energy consumption and potential for social interaction, the urban form must create shaded, walkable, and interconnected residential areas. This could be achieved by thinking beyond the current gridiron urban form which has proven unsuitable for this climatic region as discussed in Chapter Five. Thus, a compact, walkable urban plan is the optimal configuration. This aspect is a characteristic of several significant modern urban housing schemes, where the urban form is walkable and conflict between pedestrians and cars is minimised. This concept, probably first realised in the West at Radburn New Jersey, master-planned by Clarence Stein and Henry Wright in 1928 (Figure 7.2), is totally ignored in the current planning in Qatif, which is instead structured around car-based planning.

Figure 7.2: Radburn, New Jersey is a modern example of a neighbourhood where pedestrians were given a priority by increasing the walkable area and minimising car access. Main wide roads are connected to secondary roads that lead to the residential area. Houses are grouped in clusters to form cul-de-sac streets which the neighbouring houses share. However, the plan is dispersed and thus does not suit Qatif’s climatic conditions.

2 Refer to the urban form in Chapter Four.
Compactness and the promotion of walkability would be efficiently achieved if cars were excluded from the immediate residential area (Figure 7.3 and Figure 7.4). However, parking may be provided within close walking distance on the periphery of the neighbourhood cluster or suburb, or in underground or multi-storey parking structures in a secure area where residents feel confident in leaving their cars parked. With fewer vehicular roads in the immediate vicinity of residential areas, and with designated pedestrian streets and courtyards, more social interactivity would be achieved (Appleyard 1980; Gehl & Gemzøe 2003). If this policy were implemented, heat and pollution caused by carbon dioxide would be reduced on a suburban level. In addition, the asphalt area, which is also a primary source of heat, would also be reduced. The reduced heat sink effect would in turn lower the ambient temperature of air reaching individual residences, thus in turn reducing heat transfer, and lowering the demand for mechanical cooling.

Within the context of Saudi culture this aspect of vehicular reduction in residential areas requires time to be accepted, as Saudis, because of the current planning regime, are so reliant on their cars for mobility. The introduction of appropriate planning policies in this regard legislated by authorities to reduce the reliance on vehicles, and to develop public health policies by encouraging the habit of walking in the neighbourhood through appropriate pedestrian networks and public open spaces.

**Figure 7.3:** Appleyard in 1969 showed the effect of traffic on social interaction in the neighbourhood. The light traffic street showed high social bonds and more gathering opportunities created by light traffic.

**Figure 7.4:** City centre of Copenhagen where a car-free network was developed between 1962-2000 by Jan Gehl to create a liveable city centre area and more interaction among people in the city.
7.2.3 Connectivity

Another aspect that should be clearly emphasised by the urban form is the connectivity between main activity areas and the residential neighbourhoods. This aspect has been implemented in some modern projects of similar climates (Figure 7.5). The main daily activity areas like mosques, schools, shops, and parks should be assigned an appropriate site at an early design stage. They should be connected with one or more primary pedestrian spines to connect with secondary streets that access the residential areas within a convenient walking distance of not more than 500-600m a maximum 10 minute walk (Calthorpe 1993; Gehl 2010). Furthermore, a convenient walking distance would create accidental meeting opportunities which would encourage social interaction (Henriksen & Tjora 2014). Connecting main and secondary streets together in a ‘tree structure’ rather than gridiron structure would reinstate the streets’ hierarchy which was one of the obvious features of the streets in the traditional town. This gave residents the feeling of intimacy and safety the closer they came to their residential units (Figure 7.6).

Although the focus is on creating a walkable urban form, the main activities also have to be connected with a public transport system, ideally an electric tram system, in order to reduce reliance on cars, and to reduce pollution. Public transport would provide another option for residents when needed.

Implementing the strategies of connecting shaded main and secondary footpaths with convenient walking distances would have the benefit of encouraging people to walk in the residential area in a safe, climatically modified pedestrian street in order to perform their daily needs. It would also increase the opportunity for people to meet, creating the basis for a residential area with high levels of social interaction and less urban heat, in stark contrast to the current car-based planning that hinders such qualities.

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3 A similar approach of specifying distance to create a liveable walkable neighbourhood in Australia was proposed in 2007 by the Department of Planning and Infrastructure in Western Australia to create neighbourhoods with less car dependence. 
4 For visualisation of the future development principles see Appendix 4.
Figure 7.5: Modern projects. Housing developments by Hasan Fathy in Bariz, Egypt 1967 and Masdar city, Abu Dhabi by a team led by Foster and Associates which has been under construction since 2007. Both are modern projects which are built in similar climatic and cultural regions. The dimension of the public open spaces and pedestrian armatures is scaled to achieve shade, while the building massing is compact, in order to minimise external surfaces exposed to solar radiation. They are also planned with a hierarchy of streets and open public spaces based on the traditional town concept, so as to achieve the desired socio-cultural interaction.

Figure 7.6: Diagrammatic zoning showing the tree connectivity concept that should be implemented in Qatif in the pedestrian neighbourhood by main pedestrian spine connecting between the residential areas and public areas.
7.2.4 Public Open Spaces

In the traditional town in Qatif, the urban fabric consisted of different social gathering public spaces which played an integral role in the daily social interaction (Figure 7.7). The provision of social gathering spaces in modern neighbourhood design is an important aspect that should be considered from the inception of the urban plan in order to improve its quality (Henriksen & Tjora 2014). This aspect is barely addressed in the current planning, which has contributed to the low social interaction on the current suburban level. As such, it leads to negative consequences, such as poor public health and social isolation (Alhajaj 2014). Thus, the urban layout needs to provide, through its planning, a variety of vistas and outdoor public spaces and seating areas. The traditional town provided these types of areas which had a significant role in encouraging people to gather and socialise, and furthermore provided playgrounds for children. According to Randolph, social relationships on a neighborhood scale are strongly related to children, thus it is important to create urban spaces for children so parents can meet and socialise (Randolph 2006). These areas should vary in size from intimate to expansive; reflecting changes in urban function and should be protected from direct solar radiation, and be distributed hierarchically throughout the residential area. Importantly, the intimate areas would serve the same purpose as the *baraha* and cul-de-sac did in the traditional town. Other large and mixed use green public open spaces of different sizes should be adequately distributed in the residential areas to create different social gathering points for different activities.\(^5\)

Having diverse green open spaces sheltered from the sun would encourage residents to use the provided spaces effectively. In addition, integrating green areas in future planning is a strategy that, if implemented, would provide ‘urban orchards’ within the city. New green zones would act as buffers against the wind-borne and heat-related problems caused by the previous urban expansion that destroyed the former buffer palm groves. This strategy would reintroduce the environmentally ameliorative effects that the former grove provided. The minimum temperature would be reduced in the built area by up to

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\(^5\) The role of municipality and authority is to specify the percentage area for vehicular streets, built area, public open spaces and green areas. The built and green areas should have the highest percentage and walkability should be prioritised in planning and methods for funding public open spaces should be created. For example, in the city of Vancouver a specified percentage of 5% of the development value is usually used to construct public open spaces (Newman & Jennings 2008).
4°C if the green coverage was 10-20% and a maximum decrease of about 6°C if the vegetation was to cover 50% (Myrup 1969, p. 918). Also, the air temperature within the green area itself may be up to 15°C lower than the surrounding areas in the afternoon (Givoni 1991, p. 292). In addition, reserves of heavy tree planting on the periphery of Qatif city, especially to the north and west, would ameliorate the climate by filtering the sandy wind coming from the desert.6

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**Figure 7.7:** A variety of public open spaces connected by shaded pedestrian streets in the traditional town in Qatif encouraged walkability and social interaction which is one of the major qualities that should be offered by the neighbourhood configurations.

6 For visualisation of the principles see Appendix 4.
7.2.5 Public Spaces and Women

Public open areas should accommodate a full range of recreational possibilities for all sections of the society, not just men. As discussed above, it should be emphasised that women in the current Saudi culture differ in their lifestyle and social expectations from women in traditional times. They have become educated and are often employed, thus they have become less attached to the house and more involved in social life. Thus, they need to be considered in future planning and their social role should be encouraged. However, the requirement for women to maintain their privacy within specific norms is still a cultural value that has not changed. Therefore, Saudi women would need to preserve their privacy while using the outdoor public spaces proposed above in relation to the design of future neighbourhoods (Alhajaj 2014). This aspect is not considered at all in the current planning provisions. Consequently, the future urban open spaces should accommodate private areas for females where they can exercise or recreate with their families or other women in public while maintaining their privacy. This would add more socialising opportunities for women in public and, furthermore, improve the physical and mental health of the female population. In addition, in parks and playgrounds areas where there is a presence of men, the future planning should consider implementing provisions of semi-private enclosures which may give women a sense of privacy and encourage social gathering with other women in public spaces. This could be achieved by the provision of shaded elements similar to pergolas that give shade and privacy at the same time.⁷ The semi-private provisions should be placed with an adequate distance from one another to give adequate visual privacy as well (Figure 7.8). In this cultural context the adequate distance would be not less than seven metres to achieve the required privacy in open public spaces (Hammadi 1993).

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⁷ See the parks section in Chapter Six.
Chapter 7
Future Sustainable Domestic Environment

7.3 GROUPING OF DWELLINGS

With regard to the domestic neighbourhood configuration, clusters of houses may be arranged to form a common outdoor space. This adds to the spatial hierarchy of the neighbourhood and creates a semi-private space that is shared among the immediately neighbouring houses, is convenient for use by women and children and, given adequate visual surveillance, would create a feeling of safety. In addition, clustered houses create more chance for shaded streets and outdoor spaces. This was observed in the traditional town in configurations where a group of houses formed such open spaces, thus preventing the opportunity for strangers to traverse through the neighbourhood and creating a common breezy, shaded space for the residents in the same area (Figure 7.9). Similarly, in future suburban neighbourhoods, houses may be arranged to form shared outdoor spaces and to create narrow, breezy, north-south oriented pedestrians’ streets

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See urban spaces in Chapter Four.
which would provide shade for most of the day (Figure 7.10). East-west pedestrian streets, where required, would require the implementation of overhead shading elements to achieve optimal shade, analogous to the sabat created under the bridged room in the traditional town.9

The optimal form that facilitates an attached, dense arrangement is precisely that introverted form of the courtyard house that was investigated in the traditional fabric in Qatif.10 This typology is optimal, because it allows minimum openings on the exterior façade, thus providing more flexibility in attaching houses in different cluster patterns, as houses can share up to three exterior walls as long as it does not interfere with neighbours’ privacy. In contrast, were an extroverted form to be used, this would require more distance between residential units as a result of having windows on the exterior walls and thus a careful treatment would be needed to preserve familial and females’ visual privacy.11

It may be claimed that with the modern, high thermal quality material of current Saudi houses, the attached arrangement is no longer useful. However, the attached cluster arrangement not only provides thermal quality benefits inside the house, but has the ability and the flexibility to be arranged to form a variety of configurations to achieve a dense urban pattern that generates cool outdoor spaces, an outcome that should be a priority of the urban form.

**Figure 7.9:** Groups of dwellings in the traditional town created shared semi-private public open spaces where neighbours and children met in a safe climatic modified area.

9 For principle illustrations see Appendix 4.
10 See house form in Chapter Four.
11 See windows treatment in Chapter Six.
Returning to the issue of the house form and its suitability for the occupants and climate in Qatif, it must be stated that, based upon the research described in Chapters Four and Five, the introverted courtyard form is still the optimal type, with regard to both climate and cultural specificity. In the traditional house in Qatif the courtyard house respected cultural values through its form, which facilitated windows to be opened onto the courtyard instead of facing neighbours, and thus contributed to the effect of increasing occupants’ control over the physical form, whereby they could increase their comfort by opening windows when needed without conflict with their cultural norms. This unique feature of the physical form is still needed in the Saudi house, as the current Western-inspired detached box form has proved inadequate with respect to these norms, as explained in Chapter Five. In addition, this form would allow an efficient utilisation of the property allotment. The courtyard house offers a private outdoor space inside the house which cannot be achieved with the typical contemporary box form with its setback (Figure 7.11). Thus, the courtyard is a form that needs to be integrated in the Saudi home environment.\textsuperscript{12}

\textsuperscript{12} See Appendix 4.
However, there are issues that need to be addressed here. Firstly, this is not a call to completely neglect active cooling devices, given that, historically, the wet and dry bulb perceived threshold comfort level for Saudis residents has lowered as they became accustomed to the levels achievable in an air-conditioned environment. But it is a call to offer a variety of formal configurations that help people to become accustomed to the idea of being connected with nature, facilitated by the physical form and the options it offers which would contribute eventually to a reduced reliance on active cooling systems (Aldossary, Rezgui & Kwan 2014). This issue is emphasised by Hawkes who argues that this is an important step forward to create a physical environment with less energy demand for cooling or heating (Hawkes, McDonald & Steemers 2002). Intelligently designed courtyard housing, integrated with a hierarchy of spaces inside the house, but

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13 See Chapter Three.
supplemented by mechanical cooling, will generate what is called a ‘hybrid design’.\(^1\) As mentioned in Chapter Five, there are times of the year when occupants can live without air-conditioning and this would be encouraged by adopting a courtyard form that provides opportunities for both passive and active cooling strategies. It should also be made clear through this discussion that using the introverted house form does not impose the idea of internal seasonal migration as was the case in the traditional house. This is because in the proposed hybrid courtyard form the mechanical cooling would help to reach comfort levels when needed, without migration. In addition, the bulky modern furniture in the Saudi modern house hinders being able to change the use of the space to some extent. Nonetheless, the creation of efficiently designed, adaptable domestic spaces would improve the performance, and potentially lower the cost, of future housing.

For the latter two reasons, the house orientation and rooms’ distribution should be carefully assigned. The optimal house orientation for this climatic region is to have the facades of the largest area facing north and south to receive the lowest direct solar radiation. If the design did not allow for the best orientation, and the western facade is extensive, it should be double skinned and appropriate shading solutions especially for western openings would be needed.

The location within the house plan of room functions needs to be assigned carefully, based on the frequency of use. For example, the living room, being the most extensively occupied space for the family, should be located to the north where passive cooling will be most effective. Bedrooms may be located to the east, and storage areas and toilets to the west in order to buffer the heat (Figure 7.12).

In terms of cultural responses of the house, it also should be restated here that traditional cultural norms still shape the Saudi house. Thus, the males’ reception room, or ‘majlis’, needs to be located in a place that does not interfere with the family privacy. Thus the best location is with a direct access from the entrance to assure adequate privacy. Furthermore, it is preferable to locate the bedrooms on the first floor as it would ensure a

\(^{1}\) ‘Hybrid design’ is a term that refers to a building that combines both passive and active cooling systems in their design.
greater level of privacy for the family.\textsuperscript{15} Finally, it should be a requirement that the roof be wisely utilised as a private space for the family, offering a variety of outdoor spaces.\textsuperscript{16}

It is important to highlight here that residents should be encouraged to install passive sustainable additions and solar power arrays. Climatic responsive design with passive cooling strategies combined with the efficient use of solar arrays to generate electricity would save 15\%-34\% annually (Aldossary, Rezgui & Kwan 2014). This implementation could be achieved by applying a state tax on unsustainable houses, or by subsidising conforming new houses or retrofitting of existing houses with the objective of creating long-term independence from fossil fuel.

Adalberth believes that wise design could dramatically reduce the consumption of energy stating that “in order to save energy it is essential to produce dwellings that require a small amount of energy during their management phases” (Adalberth 1997, p. 328). In this sense, minimising the house footprint would be of great benefit in reducing the amount of energy spent on cooling. The Saudi house size could be reduced significantly by deciding the rooms’ sizes according to their exact needs. Minimising the house footprint means smaller areas would be exposed to weather conditions and less energy would be spent on cooling the residential unit. In addition, a more compact house size may contribute to doubling the density on an urban level. This leads to the issue of affordability of houses. Reducing the size and the amount of energy spent makes houses more affordable to build and operate and this would be of great importance in the future in the era of energy shortage. In addition, doubling the urban density would be of great benefit in reducing the destruction to the farming area and allowing for more green areas in Qatif.

Although the focus of this research is on the single house, it should be highlighted that there is a need for greater variety of housing types to suit the needs of the population such as small and large apartments, single person dwellings, elderly people’s housing, for example. All these dwelling typologies should be environmentally and culturally suitable.

\textsuperscript{15} This is applicable unless there has been different request by occupants and unless a radical cultural change occurred. However, this is a cultural value which is unlikely to change in the future as it originated from religious values.
\textsuperscript{16} See roof treatments in Chapter Six.
7.4.1 Openings

As mentioned earlier in this chapter, openings on the exterior façade of future dwellings would be required, in accordance with cultural norms, to implement visual privacy. Thus, treatments to implement privacy will be needed.\(^\text{17}\) Openings on the western side, being the most vulnerable section of the dwelling to afternoon solar heat, due to the low angle of the sun, should be carefully treated to minimise solar exposure during these hours.\(^\text{18}\) Openings on the north and south could be protected from solar radiation by a small overhang. Encouraging ventilation through the provision of a small opening on a wall and another large opening on the opposite wall would accelerate air-movement and evaporative cooling (Koch-Nielsen 2002) as was observed in the traditional house (Figure 7.13).\(^\text{19}\)

These strategies open the way for a future sustainable home environment with less energy consumption and higher levels of social interaction. However, policy implementation becomes an important factor and will be discussed in the next section.

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\(^\text{17}\) See Chapter Six for openings treatments.
\(^\text{18}\) See Chapter Six for vertical shading treatment.
\(^\text{19}\) See Chapter Four openings section.
The planning process in Saudi Arabia often focuses on economic sustainability and gives it a priority over social and environmental sustainability (Alshuwaikhat & Aina 2006). The future design of residential areas, based upon the above proposals for appropriate socio-cultural and climatic responses, promises a high quality, low energy residential environment. Thus, there is an urgent need to integrate sustainability parameters into the decision making process (Alshuwaikhat & Aina 2004). Therefore, the quality of the residential area should be guided by strict standards and guidelines that ensure adherence. This is the role of both the municipality and the national authority.

In the planning of future neighbourhoods and suburbs, the role of the municipality should be to identify the sustainable socio-cultural and energy-efficient design strategies and integrate them in the building regulations for long-term benefit. This should further be combined with campaigns aimed at increasing the locals' awareness of the benefits of such applications in the long run with the aim of eventually creating cultural change.
The following section illustrates the current practice and the proposed layers of standards and guidelines to improve it, with an ambition to create a sustainable domestic environment with efficient responses to climatic and socio-cultural needs.

7.5.1 Current legislative framework

Planning and building regulations are set and controlled by the Ministry of Municipality and Rural Affairs (MOMRA). Furthermore, there are municipalities in each province under the control of MOMRA. The role of these municipalities is to assure the implementation of the rules and regulations set by MOMRA. The process for planning and constructing residential areas is set out below.20

In Qatif the property sites are privately owned. In Saudi Arabia in general the process of planning for private sites progresses through five main stages. The first stage entails approving the documents and checking the site. At this stage, the municipality is required to certify the ownership documents of the site, then to check the site’s suitability for the required project. The landlord must obtain the approval from the municipality prior to commencing the planning of the site.

The second stage entails the general site planning. At this stage, site measurements will be taken either by the municipality or by an approved consultant office. During this stage, the planning should show the site topography, infrastructure and the location of governmental and private sites. A report will be prepared to show the suitability of the site for construction. Then an initial drawing is prepared to show the connection between the proposed site and the other sites.

The third stage entails preparing a detailed plan. At this stage, the site should be planned with details that show the suburb’s cadastral subdivision into discrete lot sizes with a clear car access for each lot. Streets in such subdivisions should be no less than 12m in width. Under current planning law, the planning is required to contain a mosque, a school and a park (Figure 7.14).

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20 The information presented here is based on documents obtained from the Ministry of Municipalities and Rural Affairs site which explain the planning and design stages [http://www.momra.gov.sa/](http://www.momra.gov.sa/).
The fourth stage entails the authorities checking the detailed plan and its suitability for the site. In this stage, the municipality, through the agency of a planning official, will undertake a site visit to compare between the plan and the real site. The site visit focuses on the topography, in order to check that there is no obstacle for implementing the proposed plan, such as easements or protected structures. Then the plan is required to be approved and signed by the municipality, after which the set of plans and documents must be approved by the Ministry of Planning before the landlord starts constructing streets and providing infrastructure. After approval is granted, the landlord may commence selling the lots, whereas the municipality will be responsible for the maintenance of streets, parking and parks. Funds are obtained from the government for the construction of public open spaces, particularly for parks.

The fifth stage entails the construction of individual residences after the lots have been sold. The purchaser of the lot needs to enter into a contract for the design and construction of the house under strict building regulations as explained in Chapter Five.

Figure 7.14: A diagrammatic suburb plan by the Ministry of Municipality and Rural Affairs for future planning 2014-2030. The diagram shows the typical planning for the residential area dominated by vehicle streets and connected to main roads. There are two mosques attached to a small park which are not sufficient for the number of residents and there are two schools.
Source: http://www.momra.gov.sa/
7.5.2 Shortcoming of the Current Regulatory Framework

The current framework is inadequate in that it does not guarantee the implementation of a culturally or environmentally sustainable home environment. This failure results from the absence of an adequate level of surveillance that assures the implementation of quality measures. In addition, the legislative framework lacks the implementation of mechanisms to encourage developers to apply sustainable planning. In the absence of appropriate legislative mechanisms, landlords prioritise profit rather than environmental and socio-cultural sustainability in the home environment. In response to this failure, the following proposal for a revised regulatory structure argues for the interpolation of new layers which add transparency to the legislative framework, so as to assure sustainable practice.

7.5.3 Future legislative framework

In order to achieve the performance requirement for the proposed future planning principles of neighbourhoods, the proposed legislative system should be rigorous in implementing cultural and environmental measures. Thus, there is a need to develop new mechanisms for enabling change. This could be achieved by establishing a new level of legislation enacted by MOMRA.

As has been shown previously, the current directory for planning residential areas leads to the implementation of the unsustainable and unresponsive gridiron plan which was analysed and discussed in Chapter Five. Thus, there is an urgent need for the design and planning stage to be directed by appropriate guidelines in accordance with the principles and the vision for future planning, to be published and distributed by MOMRA to the certified architectural and planning offices. It should contain new qualitative and quantitative sustainability measures, and should implement a radically different direction for future planning which insists on socio-cultural and climatically responsive planning.21

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21 This is similar to the document ‘Liveable Neighbourhoods: a Western Australian Government Sustainable Cities Initiative’ published in 2007 by the Department for Planning and Infrastructure in Western Australia which aimed at creating sustainable communities by focusing on creating walkable neighbourhoods and integrating public open spaces for social interaction besides other sustainable measures. The document sets out the design elements and milestones that should be followed to obtain the approval for future urban spaces and neighbourhood. [http://www.planning.wa.gov.au/dop_pub_pdf/LN_Text_update_02.pdf](http://www.planning.wa.gov.au/dop_pub_pdf/LN_Text_update_02.pdf)
This rule book is essential at stage three (preparing detailed plan) in the framework. This guide should show the minimum expected measures to give a variety of choices for developers.

In obtaining the approval from the municipality at Stage Four, there is a need to establish a department responsible for sustainable development in the municipality, consisting of experts who are capable of evaluating the planning in relation to sustainability parameters at the design stage. This committee should be responsible for the evaluation of design and for giving suggestions for change before obtaining the final approval. This evaluation could be aided by the introduction of easy-to-use software which enables authorities and developers to readily gauge whether the principles and performance standards are being met.\textsuperscript{22} The software may include the climatic and cultural measures which are the parameters of the design evaluation.

A new layer of legislation may be introduced for funding in the municipality. Before getting the approval, the funding department may propose subsidies or concessions to encourage developers to implement sustainable design. This subsidy, for example, could be for constructing social public open gathering areas and implementing shading strategies. The fund may be calculated as a percentage of the total budget and according to the minimum or maximum implementation of sustainable qualities.

In stage four, the construction stage, a new layer of supervisory committee would need to be established, comprising two supervision teams, the role of which is to adequately supervise the implementation of the approved sustainable plan.\textsuperscript{23} Penalties should be applied if the construction does not follow the approved design. Charges may be implemented such as the payment of a percentage of the construction cost as a fine.

At the fifth stage (the residential units) the design and construction stages are crucial for the success of the legislative framework. For the design stage, site visits should be carried

\textsuperscript{22} A similar approach has been used in USA to improve residential community design where buildings’ performance was assessed under certain design criteria. Selected planning and architectural design criteria have been evaluated by energy simulation tools to assure the best design outcomes (Rashed-Ali 2007).

\textsuperscript{23} Similar action is implemented by the Building Victorian Authority in Australia. The builder is obliged to obtain a report stating that the building is constructed under the sustainability measures, \url{http://www.vba.vic.gov.au/_data/assets/pdf_file/0003/20397/PN-55-2014-Residential-Sustainability-Measures.pdf}. 

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out by the architectural office to document any specific observation of the site context, such as the location of windows and doors in neighbouring houses, the dimensions, orientation and condition streets, and any features that may affect cultural or environmental sustainable practice.\textsuperscript{24} At the design stage, each architectural office should, beside the designers, have access to a group of certified experts in the sustainable practice of the region, to ensure that the design is adequately and competently assessed before obtaining the final approval from the municipality.\textsuperscript{25}

In the approval stage at the municipality, a new sustainability committee should be established to evaluate the house design and propose the percentage of subsidies and concessions depending on the level of sustainability measures in the design prior to approval being obtained from the funding department. In the construction stage, several site visits should be carried out by the municipality through two layers of supervision teams, each of which is to assure implementation of the approved socio-cultural and climatic sustainable measures according to the proposed design.\textsuperscript{26}

Implementing this layered legislative framework promises better sustainable practice for future planning (Figure 7.15). In addition it is a step forward that encourages changes in the system with the ambition of achieving a domestic environment that has less reliance on active cooling systems, and a healthy environment with less pollution and high social interaction, which are the targets of this research (Figure 7.16).

It is also important to highlight here that the government plays a primary role in controlling and preserving the natural environment. The urban expansion and construction activities which are destroying the natural environment and wild life must be controlled. Qatif’s urban expansion and the construction of new suburbs should be implemented to the western side of the city which is unused, un-vegetated desert land.

\textsuperscript{24} This is one of the design policies set by city of Perth for residential areas in Perth, Australia to assure best design outcomes. In some residential areas where the new building might block the wind, a wind tunnel test must be done before getting the design approval. \url{http://www.perth.wa.gov.au/planning-development/planning-schemes-and-policies/planning-policies}.

\textsuperscript{25} In Victoria, Australia, a similar approach needs to be undertaken to get the construction approval for residential units. Accredited Residential Thermal Performance Assessor is required to provide a report with rating stars for the building energy performance before getting the final approval. \url{http://www.vba.vic.gov.au/_data/assets/pdf_file/0003/20397/PN-55-2014-Residential-Sustainability-Measures.pdf}.

\textsuperscript{26} At the construction stage the supervision team should ensure that socio-cultural and climatic measures which were approved in the design stage are adequately implemented. For example, the windows should not interfere with neighbour’s privacy. Also adequate treatments for western openings to avoid overheating should be strictly implemented. Fines may be applied or demolishment of the inappropriate element may be implemented.
Conversely, new green buffer planting should be implemented on free land to the north and west (Figure 7.17).
Figure 7.15: Layers of current and proposed legislative framework in planning and constructing suburbs and residential units in Saudi Arabia to ensure sustainable practice in the Saudi home environment.
Figure 7.16: Simplified diagram of walkable compact residential area with clusters of houses. It shows the hierarchal movement from the private residential unit to the public areas. Each cluster is grouped to form a shared space among neighbouring houses where women can gather and their children can play under their surveillance. Houses are introverted form that allows close arrangement to create narrow shaded pedestrian street. A main pedestrian street is connecting between main activities. The main street is connected with semi-public streets that lead to the residential clusters. Cars are excluded and parking buildings are provided at the periphery. Green areas surround the subdivision with an emphasis on the northern and western peripheral areas to provide separation from the vehicular street and to provide a cooling effect and opportunities for healthy exercise. Vehicular streets are provided on the periphery where public transportation may be provided to connect between this residential area and other residential areas. The mosque is located in a central area to make it convenient for residents to walk to perform their five daily prayers. Neighbourhood green spots are distributed in the subdivision to create social gathering spaces and again to contribute to a cooling effect. Sporting, exercise and recreational areas for both genders are separated and located on the periphery.
This chapter calls for implementing a major shift in the future planning in Saudi Arabia in general and in Qatif in particular. It proposes future planning strategies inspired by the traditional town. It highlights the necessity of implementing shading provisions and plantation to be an extensive feature of the urban form. It proposes a car-free walkable compact form for future urban planning. Connectivity between different urban areas with short shaded walking distance is a major plan strategy to encourage walkability. The chapter also proposes special consideration for women in the future planning as their role has changed. Thus the urban form has to provide public open space for them in private locations. In addition, females’ recreation buildings should be considered in future planning. The chapter also focuses on implementing the introverted courtyard house form as an optimal form for this climatic region and culture. Finally the chapter stresses the role of policy-makers in encouraging the implementation of the proposed strategies. The main role would be exercised by the Ministry of Municipality and Rural Affairs MOMRA, which, it is proposed, should set new planning strategies and building regulations and establish strategies to assure the implementation of the environmental and socio-cultural sustainable practice. This needs to be encouraged through subsidies and strict supervision.
CONCLUSIONS
CONCLUSIONS

In Chapter Two, six research questions were identified, classified into three groups, as follows:

The research posed six questions classified into three groups, as follows:

Group one: understanding the aspects of the traditional home environment

This group asks: How did climate and culture work together to produce the physical configurations of the traditional town in Qatif?

Group two: understanding the deficiencies of the contemporary home environment

This group poses four questions in the light of the traditional town:

1. What are the design deficiencies of the current Saudi home environment that contribute to high energy consumption?
2. What are the design deficiencies of the current Saudi home environment that contribute to the breakdown of communal social interaction?
3. With regard to the issue of energy consumption at the neighbourhood scale, what are the design deficiencies of the current Saudi neighbourhood that contribute to energy consumption and the breakdown of communal social interaction?
4. What are the design deficiencies of the current Saudi house design that contribute to energy consumption?

Group three: implementation principles, for the current and future domestic environment, that aim to create an environment that respects climate and culture and encourages social interaction, with the ambition to reduce energy consumption spent on active cooling.

Based on the comparative analysis this group asks the question: What are the principles that should underline a social and energy-sustainable domestic environment at the individual, neighbourhood and wider scale?
In the following discussion the argument is summarized.

At present Qatif suffers from a lack of sustainable measures in the suburbs. Socio-cultural and environmental responses should be offered by the domestic physical environment planning and design but this does not exist in Qatif’s residential area. Analysis reveals that the gridiron plan form configuration, in its current condition in Qatif, produces significant heat build-up in the residential area and allows for minimal social interaction. This neglect of the interrelated socio-cultural and environmental considerations by planners has resulted in total isolation of residents from interaction with the natural environment, thus imposing an excessive reliance on mechanical cooling as a consequence.

The streets are inadequately planned with regard to climatic response and facilitation of social interaction for the following reasons. As shown in Chapter Five, the current local streets in Qatif are unnecessarily very wide. The ratio between streets’ width to building height is excessive, resulting in the buildings becoming ineffective in casting shade on the street. Thus, streets have become heat sinks as they are exposed to direct solar radiation most of the day. In addition, streets in Qatif’s suburbs lack a shaded, safe pedestrian network. This has caused residents to walk in the street, competing with cars, which has resulted in a reduction in physical activities and social interaction. Another problem with the present situation of Qatif’s streets is that cars have been given free access throughout the street layout. The streets therefore lack social hierarchy as they are all considered to be ‘public’ streets where strangers are expected at any time. This, in turn, reduces the feeling of safety on the suburban level, and impacts on the privacy of residents, again reducing pedestrian usage of streets.

Furthermore, the configuration of houses which are arranged in gridiron blocks in accordance with building regulations has caused them to be in total isolation from the surrounding environment. As discussed in Chapter Five, the house box form contrasts sharply with the traditional courtyard house (analysed in Chapter Four) with regard to both climatic and cultural aspects. Firstly, the current house cube form in Qatif is totally exposed to the weather conditions, sitting in the middle of the lot surrounded by setbacks imposed by building regulations. This arrangement has resulted in windows being exposed
to neighbours, creating a major cultural problem in that they have lost their function as a passive cooling element that may be manipulated to ameliorate weather conditions. The consequence of this exposure to the gaze of neighbours means that these windows will not be opened to allow air access. Thus they remain closed, resulting in a reliance on mechanical cooling. Another problem arising as a result of this arrangement is that, the setback is also overlooked by neighbours. Thus it ceases to be private space, unlike open space in the traditional houses, with their cultural dimension of preserving the family privacy, especially females. In the contemporary Qatifi house, setbacks are not efficiently utilised for the family activities, which is in stark contrast to the courtyard in the traditional house where the family would utilise the space in complete privacy, as discussed in Chapter Four.

In response to all these identified socio-cultural and environmental inadequacies of the present-day residential area in Qatif, this thesis has set out comprehensive design guidelines in two directions: firstly, the proposed retrofitting of the current suburbs and secondly design guidelines for future residential planning, both of which would improve the micro-climate and increase social interaction. If utilised, they would increase sustainability standards by creating climatically modified provisions that reduce heat, increase physical activities and maximise socialising between the community members.

With regard to the current suburbs in Qatif, the modifications proposed in Chapter Six were inspired by an understanding of the urban configuration and house forms of the traditional town and their socio-cultural and climatic responses, presented in Chapter Four. These proposed modifications work on three levels: neighbourhood streets, parks and the relationship of houses to the street and to allotment boundaries. With regard to the street this thesis proposes changes aimed at reducing the tarmacked area, restricting vehicle access, increasing walkability and providing social gathering space with a close proximity to houses. Forms of street modification have been proposed which may be implemented under certain conditions. They have been classified as: linear, cul-de-sac, street with reduced width, and pedestrian street.
Consideration of females’ privacy while using outdoor spaces in relation to parks was one of the main issues highlighted in Chapter Six. Thus, an element inspired by the traditional house configurations was proposed: a unit that provides shade allows breeze and acts as a semi-private outdoor space for females. The proposed modifications at the level of the individual house aim at reducing reliance on mechanical cooling by increasing passive cooling, achieved by solving the cultural conflict created by the form of the modern house. Thus proposed changes focus upon the areas which lack appropriate climatic and cultural responses. These modifications work on three levels: setbacks, windows and roof. Proposed modifications to the setback zone are intended to create outdoor space for the family by providing shaded areas which the family could use with complete privacy. Solutions have been created, such as extension of the existing fence and provision of shaded elements in the front setback. In addition, an entrance room has been proposed as a social gathering area that adds to the territorial depth of the residential area.

Proposals for retrofitting of windows address a concern for providing occupants with freedom to open the window in order to achieve passive cooling. Thus, the solutions comprise forms such as mashrabiya, louvres and bridging shade that can give privacy while having the window opened. Finally, the roof modifications are aimed at utilising the roof as an outdoor space within the house boundaries that can be used by the family. The solutions are based upon a concern for creating a variety of possible spaces that enable residents to tolerate the weather conditions. Thus, a hierarchy of climate modifying spaces have been proposed, ranging from spaces exposed to full sun, partial sun and fully shaded.

In Chapter Seven, the thesis has set out proposed future planning principles. These principles are the result of lessons learned from the analysis of, and comparison between the traditional town and the current suburbs in Qatif. This chapter highlights the need for re-thinking the way the suburbs are planned. It is a call for creating a future culturally and environmentally sustainable Saudi domestic environment which has less reliance on mechanical cooling. In this chapter it is argued that the problem of excessive consumption of fossil fuel resulting from reliance upon mechanical air-conditioning is a direct result of the inappropriate urban form which does not respect either socio-cultural or climatic
Conclusions

requirements. Thus, the thesis emphasises the need to create a neighbourhood form that offers shaded walkable spaces in the residential area to encourage social interaction.

The chapter proposes a clustered urban form that has a hierarchy of spaces. Residents need to circulate through a defined hierarchy of streets and spaces where they transition from public to semi-public to semi-private and then to private areas. The hierarchy could be achieved by grouping the houses to generate communal semi-private shared area. In addition, clear main public pedestrian streets should be assigned to connect the main residential areas with the main activities areas; secondary streets that connect with different groups of housing and public spaces should branch from the public pedestrian streets.

However, pedestrian networks will not be used unless they are also comfortable. Thus, shading has to be a main feature integrated in the urban planning and design. The pedestrian network should be shaded either by buildings or by the provision of shading elements or plants. The provision of green areas that are integrated with the building forms and pedestrian networks, and which are well distributed in the urban plan, is an important factor that must be implemented to overcome the environmental impact resulting from the large loss of farming land in Qatif.

At the domestic scale, the chapter proposes the courtyard house as an optimal form that works effectively with climatic and cultural needs. Although the use of this form would not mean ceasing to use mechanical cooling, it would nevertheless encourage reducing the reliance on mechanical cooling by allowing for passive cooling while respecting cultural concerns. This might create what could be called a hybrid design which combines both mechanical cooling and passive cooling through the given options facilitated by the form.

This research has also highlighted the role of government policies in encouraging sustainable practices between community members. This is the role of the municipality and national authority. A state tax could be levied on unsustainable houses. Also, to create long term independence of fossil fuel the government may fund subsidies for sustainable design and houses with solar energy cells. In addition, the municipality should
integrate the socio-cultural and climatic strategies in the building regulations with the objective of producing a built environment of a better quality which also contributes to the reduction of energy consumption. Finally, a public transportation system should be implemented to reduce reliance on motor vehicle and encourage walkability. The discussion in this chapter also proposes some layers to assure best sustainable practice. Layers are mainly concerned with adequate supervision, involving experts in sustainability who may apply qualitative measures through the introduction of software that can measure the sustainability socio-cultural and climatic performance of a particular design.

If the retrofitting and future planning strategies were implemented, this would result in an overall improvement in the quality of the residential area in many aspects. On the suburban level, the implementation of the proposed modifications of the current neighbourhoods, and the strategies for future suburbs in Qatif would increase walkability and reduce reliance on motor vehicles. These strategies would encourage walkability of the city, an outcome that would improve the health of the population. In addition, air pollution and carbon dioxide caused by cars could be reduced, thus contributing to the reduction of heat on a suburban level. The major result of these strategies would be the reduction of the ambient temperature of air ventilating houses, which has been a main target of this research.

On the domestic level, the strategies developed by this thesis have targeted the occupants’ habitual behaviour. The benefit of the proposed modifications to the current houses and the strategies for future houses is to allow occupants to become accustomed to the idea of the hybrid form. In this sense, the house design must integrate passive and active cooling while respecting the cultural dimension. This would assist in the long-term modification of the pattern of interaction between the occupants and their physical environment. Also, it would create housing configurations that are not isolated from nature but engaged with it. This, in turn, is a critical benefit in an era of energy shortage, as it will assist residents to tolerate the weather by availing themselves of the options provided by the design, especially for the operation of openings which would eventually cause reduction in the reliance on mechanical cooling.
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At a neighbourhood level, retrofitting of the streets will reduce to a functional minimum the large area of asphalt which has contributed to an increase of heat on the suburban level. The proposed retrofitting would create shaded and planted spaces for social interaction in proximity to the residential units, and would reduce access to through traffic of vehicles, thus improving air quality.

Another future benefit of the implementation of the proposals outlined in this research might be that the proposed modifications, especially for the house, could be developed into a performance handbook that documents the elements of retrofitting and the principles for new buildings, listing the benefits of implementable modifications. Such a handbook would be of great value to professions involved in the design and construction of the built environment, in setting out the principles underlying culturally and environmentally sustainable construction. Also, through communication of this research, public awareness may be raised regarding the applications of cultural and climatic elements.

The aim of this research has been to investigate ways in which the current residential area may be modified in response to climatic and socio-cultural needs. It has also aimed at shifting the current thinking with regard to future planning, in the hope of producing, a sustainable residential area of high quality that enhances interaction between the community members, with less reliance on fossil fuel. However, this research may be taken to a further quantitative step by virtually simulating the effect of each of the strategies on reducing temperature on a street level and a house level. Also a long-term economic benefit may be calculated on a house unit scale and on a national benefit scale. On a house unit, for example, what savings would result from implementing the suggested house modification? Whereas on a national scale, what savings would result from the reduction of reliance on fossil fuel if houses were developed with hybrid passive and active cooling systems? In addition, what savings would result from installing solar power cells?

Finally, the future planning for this research has worked diagrammatically on the principles that should be implemented to achieve residential areas with environmental
Conclusions

and cultural sustainable aspects. However, realistic, grounded model planning may be undertaken as a further step to develop the principles highlighted herein.
Appendices
A.1 Materials Preparation pre-construction

The field work started with explanations from Mr Algheryafi. He illustrated local materials used for construction and how they were prepared. It is as follows:

As this area is an oasis area known for its agricultural land, full with palm trees farms and located on the Gulf Sea, the houses were built from available local materials. Houses walls were built from coral-stone extracted sea and ceilings were built from palm tree trunks. This was the common practice for thousands of years.

To build a house the process starts with preparing materials and bringing them to the construction site. Firstly, coral-stone and sea mud are extracted from the shallow sea beds from the Gulf Sea. Trained people go to the sea with their small wooden boats and sharp tools to cut and carry the stones in the boats or in the Zabeel carried on their back (Figure A.1.1).

The stones then brought to the shore where they are later will be carried by donkeys to the site. These stones as a raw material will be used to construct the walls without any treatment (Figure A.1.2). The sea mud on the other hand needs to be treated before it is used in the building. It will be carried to an opened area in the farming land and will be left on the ground to dry and crack for few days till it forms a layer with the thickness of 1-5cm (Figure A.1.3). Then the cracked dry mud will be gathered and built as a pyramid and situated on top of wooden structure to be burned for few days or a week (Figure A.1.4). This process is called Alsar preparation. This material will be used later between walls layers and for plastering. The burned material will then be divided to two materials; each has its special qualities and special use. One is the highest quality which is the inner material inside the pyramid it is called the jilb which is used for walls plastering and cast ornamentation (Figure A.1.5). The

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1 Mr Algheryafi is a local school teacher, who is an amateur historian with extensive knowledge of the traditional patterns of inhabitation in Qatif.
other one is the medium quality which is the outer material outside the pyramid it is called the *arabi* used as a cement material between walls layers to construct walls. After the burning process both materials will be grounded till they become a powder. The powder will be mixed later with water to give the muddy material (Figure A.1.6). These two materials last for thousands of years. They are the same material used for pottery which is found in old civilizations (Figure A.1.7). Secondly, people will be chopping palm tree trucks into different shapes and sizes to be used in the walls and ceiling construction (Figure A.1.8).

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**Figure A.1.2:** Wall built of coral stone extracted from the sea  
*Source:* Algheryiafi’s photo collection

**Figure A.1.3:** Sea mud left to dry before the burning process  
*Source:* Algheryiafi’s photo collection

**Figure A.1.4:** *Alsar* preparation by accumulating and burning sea mud to produce two plastering materials of different quality then it will be used later in the house construction.  
*Source:* Algheryiafi’s photos collection

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2 This material is still used now-a-days in the Eastern province in Qatif in pottery in work to make vases, plates and water containers which are sold in the market.
Figure A.1.5: *jilb* material used to casted ornamentations which are used for decoration and ventilation purposes.

*Source: Algheryiafi’s photo collection*

Figure A.1.6: (a) Mixing the mud with water after the burning process. (b) The material after mixing with water.

*Source: Algheryiafi’s photo collection*
Figure A.1.7: Vases made of the earthenware material which was also used to construct walls and ceilings of the traditional house.

Source: Fieldwork 2011

Figure A.1.8: Cutting palm tree trunks for ceiling construction

Source: Algheryiafi’s photo collection
A.2 Wall Construction

The house construction process starts with the walls. They will be built on an exposed levelled ground. Firstly, a trench extending for the length of the wall will be excavated up to 1m deep and up to 70cm width. This trench is the base for the wall foundation. Secondly, the wall construction will start with filling this trench with coarse stones, and the gaps will be filled with small stones. Between each layer, the *arabi* cement prepared previously will be applied after it is mixed with water. The length of rooms walls varies according to the required area but the width does not exceed 3.5m as the tree trunks needed to construct the ceiling usually are not more than 3.5m maximum.

After finishing the wall’s foundation, doors’ locations will be marked. Then stone columns will be constructed in the walls. The columns dimension is about 240 x 65 x 35cm and with about 1m left between columns. These columns strengthen the wall and help to carry the upper floor loads. After that, the wall is constructed from layers of coral stones with mortar *arabi* applied between layers. Also, beams between columns on top of the openings such as windows are considered. Finally the walls will be plastered with the *jilb*. The plaster material acts as a protective coat to protect the wall from moisture and harsh weather conditions.

A.3 Ceiling Construction

To construct ceilings, the process starts with laying a wooden palm tree trunk posts across the width of the room on top of the walls. These posts do not exceed 3.5m, therefore limiting the width of the room. Then a diagonal grid of palm tree trunks will be placed on the supporting beams. After that a mat made of palm tree leafs will be placed on top of the grid. Finally, a layer of mortar and stones is distributed evenly and levelled (Figure A.1.9).

*Figure A.1.9: The wooden ceiling*

*Source: Fieldwork (2011)*
Appendix 1

The same construction process is applied to each floor until the builders reach the level of the roof. The roof is as important as other floors because it is part of the habitable area. The roof is usually utilized by the family as a sleeping area at night in hot summer days. It is divided into unroofed rooms, with wind catchers from one side in each room to get the best of the breeze. Also, there is always an extra roofed room on the roof with windows and door. This room could be used in the morning as a reception room for guests or for studying or napping.
A.2 RETROFITTING EXISTING SUBURB BASED ON A “BASELINE COMMUNITY”

Part One: Baseline Community

Figure A.2. 1: Baseline community in Qatif suburbs.

Figure A.2.2: As indicated in this baseline example, in Qatif’s suburbs, the main activities are disconnected by the dispersed planning. Thus the school, charitable institution, mosque and shops are not connected with footpath at a safe walkable distance from places of residence. In addition there is a lack of green buffer areas that could function as social space. Free car access is the main feature of suburbs in Qatif, which reduces safety, impacts upon pavement access and discourages walkability for daily activity points. The walking distance from house A to the mosque is about 450m which is a convenient walking distance of about 8minutes duration however residents typically prefer to travel by car because of a lack of pedestrian safety and of shaded footpaths.
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Figure A.2.3: (1) Streets do not encourage walkability. They lack shaded pedestrians’ footpaths. This street is oriented east-west, thus it is exposed to sun all day.

Figure A.2.4: (2) The lack of footpath provisions disconnects residents from the main activity areas such as the mosque and schools. Based on recent studies residents would typically prefer to travel by car to attend the mosque (Alhajaj 2104).
Micro-climate indicator: urban scale

**Figure A.2.5**: Shade cast by the form is not effective at critical times of the day. Residents need to walk in unshaded streets to perform main activities like shopping; taking children to school or praying in the mosque, thus walking is discouraged. Streets, as the Ecotect micro-climate model and graph in (Figure A.2.6) and (Figure A.2.7) indicates that they are poorly designed and exposed to extensive solar radiation thus contributing to escalated heat levels in the suburb.

**Figure A.2.6**: The western side of the residential block is exposed intensively to solar radiation. Thus if shading is not provided, residents would not be encouraged to walk in the street.
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**Figure A.2.7:** When shade is not implemented around the residential block, the street is exposed to extreme solar radiation.

**Micro-climate indicator: residential scale**

**Figure A.2.8:** For the baseline Community model evaluated here, houses are represented by a box-like form with unshaded facades, a comparable abstraction of the typical house in Qatif.

**Figure A.2.9:** On the hottest day the 21st July, the unprotected façade is exposed to high solar radiation thus a high energy load is required in order to cool the interior to a comfortable level (see Figures A.2.18-A.2.19).
Appendix 2

Part Two: Retrofitting

Figure A.2.10: This diagram demonstrates the strategy outlined in this thesis for retrofitting the current suburbs in Qatif by improving the climatic and social responses. To increase connectivity and walkability, pedestrian footpaths connected to the residential blocks have been added to main streets. A notional resident from house A would walk on a shaded footpath surrounding the residential block then cross the wide street on a clear pedestrian footpath in order to comfortably reach the destination of the mosque. Green social gathering areas are provided for several purposes: Firstly, they reduce vehicles access and eventually increase safety. Secondly, they encourage the use of outdoor space as they create social gathering area for mothers and children. Thirdly, they contribute to lowering heat levels in the residential area.

Figure A.2.11: This diagram demonstrates the strategy outlined in this thesis for retrofitting the current suburbs in Qatif by improving the climatic and social responses. To increase connectivity and walkability, pedestrian footpaths connected to the residential blocks have been added to main streets. A notional resident from house A would walk on a shaded footpath surrounding the residential block then cross the wide street on a clear pedestrian footpath in order to comfortably reach the destination of the mosque. Green social gathering areas are provided for several purposes: Firstly, they reduce vehicles access and eventually increase safety. Secondly, they encourage the use of outdoor space as they create social gathering area for mothers and children. Thirdly, they contribute to lowering heat levels in the residential area.
Figure A.2.12: (1) Shaded footpaths surrounding each block are added to increase walkability. Trees are added in the street of fifteen meters width in order to reduce vehicles speed and in order to provide shade.

Figure A.2.13: (2) In main wide streets, two rows of trees may be added, and a wider footpath may be implemented: a middle row of trees is inserted to reduce street width and a further row is provided on the western side of the block to create a shaded footpath, especially in the afternoon which is a critical time of the day for solar heat exposure. The eastern footpath is provided with overhead shading provisions and bollards have been added to prevent parking over the pavement, thus increasing pedestrians' safety. The provision of avenues of trees is not merely cosmetic, it has been proven that shaded areas under trees are 8°C less than the ambient temperature (Talib 1984).
Appendix 2

Figure A.2.14: Implementing footpaths with shading elements surrounding a residential block helps to cool down the street and provide shaded areas for pedestrians.

Figure A.2.15: If overhead shading was implemented, the footpath would be completely shaded at a critical time of the day in the summer months. Therefore, residents are encouraged to walk to socialise and to perform their daily activities.
Figure A.2.16: (3) Vehicular access is limited to through streets in the suburb by creating green areas for pedestrian social gathering between housing blocks in the suburb. Trees are implemented in order to cast shade and thus to provide a cooling effect. Shaded seating areas are provided to encourage adults to use the outdoor space for socialising.

Figure A.2.17: These diagrams illustrate the implementation of different retrofitting options to increase the climatic and cultural response of the Saudi house in Qatif. The windows are covered so that they can be freely opened for cross ventilation without loss of privacy.
In this model of a typical retrofitted street, differing options have been implemented with respect to culture and climate, in adapting a typical house form in Qatif. The aim is to provide shade, privacy and to give control for occupants over windows to be opened for cross ventilation. If cross ventilation were to be facilitated by the physical form, cooling loads would decrease (see Figures A.2.19- A.2.22). However, as made evident in the climatic data provided in Chapter Three, there are times of the year notably in July and August when humidity is high and wind speed is ineffective, when mechanical cooling would be the optimal option, although here the adaptations would minimise the energy load.

The diagram also shows the implementation of a pedestrian footpath with trees and overhead shading elements on the western side of a residential block, which is the side most exposed to the afternoon solar radiation. These implementations would result in about 50% of the footpath being shaded in mid-July, a critical time of the year with high direct solar radiation. The strategies, if implemented, would encourage walkability by creating safe shaded pedestrian areas. As proven by Talib the temperature under trees in this climatic region is 8°C cooler than in areas of full solar exposure (Talib 1984). Therefore, during the hottest months of June, July and August, when the average temperature is between 40-45°C, the temperature under the tree canopy would be around 32-38°C.
To test the effect of lack of cultural concerns and climatic factors in the design of a Saudi house in the climatic region of Qatif, the researcher modelled a simplified, representative local house form based on the data collection in this research.\(^1\) The window is assumed to be closed throughout the year due to cultural concerns, and therefore its opening is restricted (Figure A.2.18).\(^2\)

The analysis shows that cooling loads during the year are very high and a total of 37,166,25 watt hours are needed to maintain the temperature between 18-26°C (Figure A.2.19). The analysis also shows that the highest cooling loads are in the hot season from May until October. July and August recorded the highest cooling loads, so in these two month in particular there is a need for an active cooling system because of the high humidity levels (Table A.2.1).\(^3\) However, a significant reduction in cooling loads has been achieved when implementing a culturally and climatically effective shading of openings. The researcher has added, for the same test model, a shading element that would allow cross ventilation by opening the window and at the same time it gives complete privacy for the family inside the house (Figure A.2.20). Thus, occupants’ freedom to open and close windows has been increased significantly.

The author’s analysis shows that the cooling loads during a year for the modified house have decreased from 3716625 watt hours to 2970751 watt hours (Figure A.2.21). This is a decrease of about 8million watt hours by using culturally and climatically effective shade structures (Table A.2.2).\(^4\) This indicates that implementing simple shading with climatic and cultural consideration

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1 Ecotect software has been used to run the analysis to give a perspective about the building performance under the measurable criteria of the research.
2 See Chapter Five.
3 See Chapter Three for climatic data.
4 Due to software limitations, the reduction may be higher. However, the results show the general performance of the building in this climatic region which is necessary for this research.
Appendix 2

contributes significantly to increasing occupants’ ability to actively adjust natural ventilation, reducing cooling loads and consequently reducing energy consumption.

Figure A.2.21: Test model with climatic and cultural effective shade.

Figure A.2.22: Heating and cooling loads for the ground floor for the test model.
MONTHLY HEATING/COOLING LOADS

Zone: Zone 1 (Ground Floor)
Operation: Weekdays 00-24, Weekends 00-24.
Thermostat Settings: 18.0 - 26.0 C

Max Heating: 400 W at 06:00 on 15th February
Max Cooling: 1819 W at 15:00 on 19th June

<table>
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<th>MONTH</th>
<th>HEATING (Wh)</th>
<th>COOLING (Wh)</th>
<th>TOTAL (Wh)</th>
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Floor Area: 25.000 m²

Table A.2.1: Cooling loads for simplified model that does not respect climatic and cultural factors.
MONTHLY HEATING/COOLING LOADS

Zone: Zone 1 (Ground Floor)

Operation: Weekdays 00-24, Weekends 00-24.
Thermostat Settings: 18.0 - 26.0 C

Max Heating: 324 W at 06:00 on 15th February
Max Cooling: 1369 W at 16:00 on 21st July

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PER M²: 709 118121 118830
Floor Area: 25.000 m²

Table A.2.2: Cooling loads for a simplified model that respects climatic and cultural factors.⁵

⁵ All images and calculations are done by the author.
Appendix 3

The graph shows that a typical contemporary house is not capable of reducing the inside temperature to a level that can be defined as “comfortable”.\(^1\) The modern sealed insulated house on the hottest average day shows a stable hot temperature inside the house during the day. The temperature does not go below 41°C which is about 12°C above the comfort level. This implies that occupants will not feel comfortable inside the house without any means of artificial cooling. Given the fact that under the discussed cultural restriction (in Chapter Five) the windows are not openable in such urban arrangement. Thus passive cooling cannot be implemented and mechanical cooling will be operating to reach comfortable levels.\(^2\)

\(^{1}\) This house was provided to the author by the architectural office in the fieldwork in 2011. See Chapters Two and Five. The author modelled the house digitally and ran the analysis.

\(^{2}\) Ecotect environmental analysis software has been used for hourly temperature calculation, although it has its limitations in not considering cross ventilation, it was sufficient for the modern house analysis to show its performance as the house is tight and windows are not openable due to cultural concerns.
A.4 FUTURE DEVELOPMENT

Figure A.4.1: The proposed future development in Qatif is a sustainable walkable car free suburban form.
Appendix 4

Figure A.4.2: Future development is a car-free walkable area with dense, attached and introverted residential units. Car parking buildings are provided on the periphery to minimise street parking. A main spine connects the residential quarters and provides meeting, gathering and recreational space. Narrow streets are implemented to provide effective shade and maximise air movement during the critical hot summer months. A green belt surrounds the development to create a cooling effect and to filter sandy winds coming from the northern and western direction. Green buffers are distributed in the residential area to create cool social-gathering outdoor space for residents. Courts are also distributed to create meeting points for the residents to encourage social gathering. A convenient walking distance is provided to main activity areas such as the mosque and the maximum walking distance from any residential unit to any destination point is not more than 600m. Thus, the walking distance from house A (top-left corner of plan) to the mosque is about 300m which is around a 6 minute walk, and from house A to the local shops is about 600m which is about a 10 minute walk.

The development is surrounded by vehicular streets. In this proposed future development, public transportation may be provided to enable residents to travel from one suburb to another or to the urban centre, and thus to reduce reliance on cars.
Figure A.4.3: In this proposed future subdivision, the house allotment area is reduced from 500 to 300 square metres, for two reasons. Firstly, reducing the size means lower cooling loads are required. Secondly, it will help to fit more residential units into the suburban area making more sustainable use of infrastructure. The future dense development, which is equal to the baseline community land area at about 200,000 square metres, can accommodate about 30% more residential units (388 residential units compared to the baseline detached community of 230 residential units). This equates to about 26 residential units per hectare for the future development, 18 residential units per hectare for the baseline community.

In addition, the dense form in the proposed development creates shaded outdoor spaces. The attached forms, with their narrow pedestrian streets have created shaded neighbourhood spaces where residents are encouraged by the form to use the outdoor spaces and move around on foot. In this climatic region, the temperature under the shaded areas is expected to be 8°C lower than the ambient temperature, as proven by Talib (see Chapter Three). Shade caused by the attached dense form covers about 35% of the built area, whereas the rest is covered by the green areas, comprising about 40% of the total area. Shaded suburban areas combined with green areas will also create a cooling effect. According to Myrup, this amount of coverage creates a temperature difference of about 6°C (Myrup 1969) whereas the temperature within the green area itself could be 15°C lower than the surrounding areas in the afternoon according to Givoni (Givoni 1991) (see Chapter Seven).
Figure A.4.4: The attached urban form provides shaded outdoor spaces. Trees and shading elements are provided when required to cast shade.

Figure A.4.5: Trees are planted in a wide north-south oriented pedestrian street to provide effective shade which could not be achieved by the urban form configuration. Shaded car-free streets encourage walkability, thus social interaction would be enhanced.

Figure A.4.6: Overhead sun shading has been implemented to northern and western façades to provide adequate shaded footpath for pedestrians at critical times of the day.
Figure A.4.7: Playgrounds of a close proximity from residential units are distributed in the suburban form. They serve as a green buffer and social gathering point. Maximum walking distance is about 10 minutes.

Figure A.4.8: Temporary shading elements may be added to playground areas to protect residents from direct solar radiation while using the outdoor space.
Figure A.4.9: Public social gathering area near the mosque. Heavy tree planting is implemented, shading elements and a variety of seating areas are provided to encourage residents to use the outdoor space.

Figure A.4.10: Local shops for necessities accessed by a covered pedestrian street are located on the periphery, within a reasonable walking distance from any point of the residential area. Walking distance varies from 3-10 minutes.
Appendix 4

Figure A.4.11: Shaded market area oriented north-south in the prevailing wind direction. The approximate location in addition to the micro-climate encourages residents to walk and use the space efficiently.

Figure A.4.12: As shade is a first priority in this climatic region, an attached introverted form has been used to provide adequate shaded facades and shaded courtyards similar to the traditional town (see Chapter Four). According to Olgyay, shade is the most effective strategy to create energy efficient buildings (Olgyay 1963). The residential units have been arranged to protect the western facades as much as possible from the direct solar radiation in the afternoon.

Figure A.4.13: The introverted house form creates a shaded private family outdoor area within the house perimeter which provides for the important social need of Saudi families in Qatif for social gatherings and daily activities. The form also creates a shaded façade, which is an important aspect to help cooling down the exterior surface thus internal cooling loads are reduced eventually (see Figure A.3.14 and Figure A.3.15).
Figure A.4.14: Shade cast by the form on 21st July. The attached introverted form causes shade to be cast on facades and on the courtyard in the afternoon, with a consequential reduction in cooling loads (See Figure A.3.15).

Figure A.4.15: Due to the attached arrangement and the shade caused by the introverted form, the cooling load for one of the rooms is 125507 per square metre (see Table A.3.1) which is lower than the extroverted box form (see Appendix 2). This indicates that the form plays an important role in saving energy consumption. However, some rooms maybe partially exposed to the sun, thus shading structure should be implemented where necessary, especially on western openings to control direct solar exposure and eventually cooling loads.
MONTHLY HEATING/COOLING LOADS

Zone: Zone 1
Operation: Weekdays 00-24, Weekends 00-24.
Thermostat Settings: 18.0 - 26.0 C

Max Heating: 374 W at 06:00 on 15th February
Max Cooling: 2476 W at 17:00 on 19th August

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TOTAL 7964 6526386 6534350

PER M² 153 125507 125661

Floor Area: 52.000 m²

Table A.4.1: Cooling loads for one of the rooms in the courtyard house.¹

¹ All images and calculations are done by the author.
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