The Sustainability Potential of Traditional Architecture in the Arab World-

With Reference to Domestic Buildings in the UAE

by

Maha Sabah Salman Al-Zubaidi

A THESIS

Submitted to the University of Huddersfield

School of Art, Design, & Architecture in partial fulfilment of the requirements for the degree of

DOCTOR OF PHILISOPHY

October 2007

To the Soul of My Father

Who passed away a few months before completion of this dissertation

To the great man who taught me how to appreciate work, knowledge, and life

Acknowledgement

The author wishes to express her thankful appreciations to her supervisors, *Richard Fellows*, *Richard Nicholls*, and Dr. *Magda Sibley* for their guidance and support in the development of this research.

Grateful appreciations to the author's examiners Professor *Cedric Cullingford* and Professor *Brian Edwards* for the time they spent in reading this dissertation and precious comments and deep discussion they offered during the viva.

The author is particularly grateful to Mrs. *Pamela Armitage* and Dr. *Ian Pitchford* for their great support, understanding, and cooperation during her work in the University of Huddersfield.

Special thanks to *Charles Hippisley-Cox*, *Clive Richardson*, and *Al-Tayeb Ibrahim Al-Madih* for their support and useful comments during her stay in Huddersfield. Thankful appreciations to *Ros Hall* - Departmental Secretary, *Sue Pritchard* - Learning Resources Assistance and the secretarial staff at the School of Art, Design, & Architecture and the library and registry office staff in the University of Huddersfield for their cooperation.

Thankful appreciations to the author's dearest friends Dr. *Victoria Hands* and *Marianna Cavada* for their reliability, concern, and support.

The author wishes to express special gratitude to her husband, Architect *Khalid Sabie*, and to her children, *Samar*, *Dina*, and *Ahmed* for their incessant love and patience, continuous support, and constant presence. Special appreciation to the author's dearest mother, her sisters Dr. *Nada* & Dr. *Layla*, her brother *Ahmed* and to their children for their love and care all her life time.

The Sustainability Potential of Traditional Architecture in the Arab world-
With Reference to Domestic Buildings in the UAE

PhD dissertation
by

Maha Sabah Salman Al-Zubaidi

Abstract:

This research is advocated to investigate sustainability potential in traditional architecture in the Arab World through developing Sustainability Assessment Method (SAM) appropriate to the natural environment and social values in the region.

Problem of this research is the need to formulate a set of guidelines for planning policies and design decisions for contemporary architecture, especially domestic buildings with regard to the potential of sustainability evident in traditional architecture in the Arab World.

The research aims to estimate the sustainability potential of traditional architecture in the Arab world, with particular reference to domestic buildings in the United Arab Emirates. To fulfill that aim, this research is concerned in developing Sustainability Environmental Assessment Method (SEAM) and Sustainability Social Assessment Method (SSAM) appropriate for the UAE and the Arab World by investigating existing sustainability assessment methods.

This research methodology used Comparative Analysis (CA) for ten houses, five traditional and five contemporary, in the UAE using descriptive, qualitative and spatial analysis for these case studies. Two of these case studies were chosen, one each from the traditional and contemporary categories, to be tested in the empirical part of this study. The two chosen case studies were assessed using the proposed SEAM and SSAM to investigate environmental and social sustainability performance of traditional and contemporary houses and to test appropriateness of the proposed SEAM and SSAM.

The research was divided into three parts. The first part aimed to build the theoretical background for sustainability and sustainable architecture review. This part consisted of the introduction and three chapters. The first chapter discussed sustainability as a concept and philosophy of worldwide concern and environment and sustainability dilemma in the Arab world. The second chapter investigated the sustainability potential in Islam and Islamic legislations, and how they were demonstrated in architecture, especially the traditional houses in the Arab World with reference to the UAE. Exploring natural and cultural

background of the UAE and architecture development during the 20th century was discussed in the third chapter to formulate the theoretical frame for the research context.

The second part, consisting of three chapters, was dedicated to formulate environmental & social sustainability assessment Methods. Investigating the sustainability environmental and social assessment methods to develop Sustainability Environmental Assessment Method (SEAM) and Sustainability Social Assessment Method (SSAM) was discussed in chapters four and five. Environmental and social sustainability dimensions in traditional and contemporary domestic buildings in the UAE were investigated in chapter six using the proposed SEAM and SSAM.

The third part was dedicated for planning the research methodology & case study model, testing, and developing the Sustainability Assessment Methods. In chapter seven the research methodology, which is the Comparative Analysis (CA) was discussed. This chapter explained the objectives of the CA, methods of data collection, and methods of data analysis. Chapter eight focused on testing and crystallising the proposed Sustainably Assessment Method (SAM). This chapter introduced a modification of the proposed Sustainability Assessment Methods based on the findings of testing the SAM.

Conclusions of the research and discussing major findings were illustrated at chapter nine. This chapter also discussed limitations of the research and pointed the research contribution to knowledge. Finally, the research set sustainable building checklist, formulated several recommendations, and suggested further studies to enrich the subject.

Table of Contents

Part 1: Theoretical Background

Part 2: Formulation of Sustainability Assessment Method

Part 3: Testing Sustainability Assessment Method

List of Figures

List of Charts

List of Tables

Glossary of Abbreviations

AM	Assessment Method
BA	Beneficiary Analysis
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment Method
CAMRE	Council of Arab Ministers Responsible for the Environment
CGSDI	Consultative Group on Sustainable Development Indicators
DCCP	Dubai Cooling Chiller Plant
DE	Diversified Economies
DEFRA	Department for Environment, Food & Rural Affairs
EAM	Environmental Assessment Method
EEG	Emirates Environmental Group
Emirates GBC	Emirates Green Building Council
GCC	the Cooperation Council for the Arab States of the Gulf countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates)
ESCWA	Economic and Social Commission for Western Asia
GDP	Gross Domestic Products
GHG	Green House Gases
IAQ	Indoor Air Quality
IEEE	Institute of Electrical and Electronics Engineers
IUCN	International Union for the Conservation of Nature
LAS	League of Arab States
LEED	Leadership in Energy & Environment Design
MOP	Mixed Oil Producers
NEPA	National Environmental Policy Act
NGO	Non-government Organisation
OECD	Organization for Economic Cooperation and Development
PP	Primary Producers
RES	Renewable Energy Sources
RUE	Rationale Use of Energy
SAM	Sustainability Assessment Method
SCA	Social Compatibility Analysis
SEAM	Sustainability Environmental Assessment Method
SIA	Social Impact Assessment
SSAM	Sustainability Social Assessment Method
SEEDA	South East England Development Agency

UNCED	United Nations Commission on Environment and Development
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USGBC	United States Green Building Council
WCED	World Commission on Environment and Development

Glossary of Arabic Terminologies

Ain	Spring or fountain
Amanah	trusteeship
Amud	Column
Arish	Type of traditional houses in the Gulf region. It is usually built in the desert regions with palm frond that served people in hot climate
Ayah (pl. *Ayat*)	verse
Bab	Door
Bab-al-Kabir	Main Door
Bab-al-hosh	Door to Courtyard
Bab-al-Maskaan	Door to Family Quarters
Bab-al-Saghir	Private Door
Badgir (*Barjeel*)	Wind Tower (see also *Malkaf*)
Badkash - RE	Wall type wind scoop (see also *Masqut)*
Baghchih -NA	Garden (see also *Hadiqa)*
Bait (pl. *buyut*)	House; residence; living unit
Bakhkhar	Platform for drying dates (also Date storage)
Balcony/Verandah	See *Liwan*
Barasti	See *Arish*
Barzah	See *Majlis*
Biyaá	Environment
Buheira	Lagoon, pond, lake
Chaah	Well
Chandal	Type of wood used as beams in roofs
Da'an	Palm frond
Dallah	Coffee Pot
Darar or dharar	What an individual benefits from at the expense of damaging others
Darish	Summer Quarter
Darisha	Window (see also *Shubbak*)
Dehrez	Main entrance Lobby in the traditional house
Dikkeh	Platform for outdoor sleeping
Dirar or dhirar	Harm, damage, prejudice or actions that damage others without benefiting from the acting party
Dwiriya	Service wing, kitchen (Semi-Private)
Dywania	A public space where men meet
Eid	Muslim feast after *Ramadan* and after *Hajj(pilgrimage)*
Eid Al-Adha	Muslim feast after *Ramadan*

Eid Al-Fitr	Muslim feast after *Hajj (pilgrimage)*
Erdewaz	Type of stone used for facing in traditional architecture
Falaj	A traditional way to pull groundwater especially in mountain regions
Fareej	Lane, alley or passageway
Farkhah see Rawzanah	The small door within the big entrance door
Finaa' (pl. *Afniyah*)	Courtyard; an open space around or within a building
Frash	Sleeping mats
Frieze/Corniche	A decorative horizontal edge define the joint between walls and roof
Ghurfah	Room in the roof, used in hot periods, with walls opened from the top to provide natural ventilation along with air pullers
Ghurleh	Roof Frame
Guss	Mud mixture made as blocks
Hadiqa	Garden
Hdith (pl. *ahadith*)	Tradition or reported saying of the Prophet Mohammed (PBUH)
Hajj	Muslim pilgrimage to Mecca
Halal (opp*. Haraa'm*)	The permitted actions or sayings set by God to Muslims
Haara	House, quarter
Hammam	Bathroom
Haraa'm (opp. *Halal*)	The prohibited actions or sayings set by God to Muslims
Haram	Family Wing
Harim	Women's Quarters
Hawiyah	Courtyard (see also Hosh, Minsera)
Hijra	Immigration of the Prophet Mohammed(PBUH) from Mecca to Al-Madinah
Hijri date	The date Moslems use since immigration of the Prophet Mohammed (PBUH) from Mecca to Al-Madinah
Hosh	Courtyard, enclosure, enclosed area (see also Hawiyah, Minsera)
Hudjrah	Sleeping Room
Iwan	See *liwan*
Jadumi	Sleeping space or room (part of the master bedroom)
Jarid	Roof Deck
Jisr	Bridge (also Girder)
Kabat	*Cabint*
Kabishkan	Screened mezzanine women's reception usually overlooking male reception
Kareen	Type of traditional houses in the Gulf Region. It is considered of winter house and mostly built in mountains is built of permanent materials t as mud in coastal regions and stone in mountains.

Kashur	A local term for coral stone with the implication of something rough
Katiba	Iron bars on windows
Katula	Lookout above street door
Khaimah	See *Arish*
Khimah	Tent
Kharkhara/	Culvert as a vertical pipe in the external walls for waste water from upper baths or toilets
Kouba	Women’s room
Kowar	Oven or stove for cooking put in the kitchen or sometimes in the courtyard
Kowshan	Lobby
Kuwar	Portable Oven
Liwan	covered semi-open passageway or space surrounding the courtyard
Mabayn	Passage connecting male female quarters
Madhafa	Guest’s Wing
Madbaseh	Date syrup room
Magaz	Indirect or offset entry
Mahallahs	Neighbourhoods (see also *Fareej*)
Makhzan	Upper room
Majlis	Male reception room located at the front of the house and towards the main entrance, it also means sitting area
Malkaf	Wind Tower
Makhzan	See *Kareen*
Mangroove	Palm matting in roof construction
Maqsura	Bay window with wooden lattice screen to provide privacy without impeding the flow of air
Maridor	Bay window
Masabeh	Small ventilation openings in traditional houses that allow light and breeze to pass through, usually at the upper part of the wall
Masaif	Summer house
Mashait	Winter house
Mashrabiya	Wooden Grill or Screen
Maskan	Family Room
Masqut	Wall type wind scoop
Matbakh	Kitchen
Mawqed	Cooking stand of clay
Merzab or Mezrab	Gutter
Minsera	Courtyard (see also hosh, hawiyah)
Mirwah	Women’s living room and reception hall

Mostarab	Toilet (see also *Qateeaah*)
Neem-sirdab,	A space around the courtyard dropped down by (1.00-1, 20) m used in traditional houses in Iraq, which means (half-basement)
Parasti	Palm-frond house, see *Arish*
Qa'a	Main hall of the house usually reserved for male guests.
Qalab	Brick form
Qandil	Date Store
Qateeaah	Toilet
Quran	The Holy Book of Moslems; it is the basic source of Islamic teachings and jurisprudence as it is the word of God
Rawshan	Upper floor rooms or bay window with adjustable louvers placed in sliding wooden panels to provide privacy while allowing breeze to flow
Rawshanah	Small niche in the walls; used for windows also
Rawzanah see Farkhah	The small door within the big entrance door
Ramadan	Muslim Holy month of fasting
Sabat	See *Liwan*
Sahn	A open space or courtyard
Sakinah	Calmness and quietness
Sanajil	Room with bay windows
Sarooj	Blend of red clay and manure used as mortar bond
Sas	Foundation
Shari'ah	The sacred, revealed law of Islam
Sherbak	Wooden Partition
Shubbak	Window (see also *Darisha*)
Sikka	Lane, alley or passageway
Sirdab	Basement
Stable	Animal shelter
Sunnah	The model behaviour of the Prophet, the practice he endorsed and the precedents he set; the Prophet's traditions, sayings and deeds
Suq	Market or shopping area
Surah (pl. *suwar*)	A chapter in the Holy Quran
Tawaa'	The well where family gets water, it is usually located in the courtyard
Tidumi	Dayroom or sitting space (part of the master bedroom)
Tofah	Partition wall
Ummah	the nation of Muslims who accept the principals of Islam regardless of any radical, social, geographic, or other differences

Urf	Custom; Action or belief in which persons persist with the concurrence of the reasoning power and which their natural disposition agrees to accept as right
Warish	Parapet or lattice screens around roofs in traditional houses
Wudhu	Prayer ablution; washing some body parts before praying as hands, face, and feet
Zariba	Stable
Zaweiah	A religious building where Muslims is dictated to praying and worship
Zaweyah	Bathing room in traditional houses
Zawiah	Small mosque or a place for prayer
Zuqaq (pl. *aziqqah*)	Lane, alley or passageway

Introduction

During the last two or three decades, when so much publicity was given to our doubtful future on this planet, thinking of nature and concern about environment became an important issue all over the world. Rapid developments in different fields: industry, transportation, communication, and construction, caused radical environmental changes. This affected atmosphere components and the vegetation cover, which may change the balance of environment causing natural resources depletion. Architecture plays an important role in this earth environmental crisis due to the great amount of consumed resources and waste and emissions released.

Sustainable development, based on the definition of the World Commission on Environment and Development (WCED), is to meet the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987, P.9). This definition refers to the significance of changing the way we live and build to respect environment through efficient use of natural and renewable resources without damaging the nature or affecting the environment.

In the past, when the building envelope was the main element man used to protect himself from a harsh climate, he had to depend on passive energy and natural resources, such as sun, wind and earth. Passive energy involves the use of natural energy sources for environmental, healthy, and economical reasons in our buildings. Traditional architecture, in the Arab world, represents a living witness for the suitability of this architecture to the local environment, which incorporated the essence of sustainable architecture.

This research is concerned on identifying the sustainability potential inherent within one type of traditional architecture: the house, where the family spends most of its time for living and doing private activities. The house was the oasis of the family in the middle of the hot desert climate that characterizes most of the Arab world region. The accommodation of the house with the ambient environment was achieved using natural resources in sustainable approaches. There was an efficient interaction between architecture and natural resources as sun, wind, high seasonal & daily temperature fluctuation, site topography, available building materials and cultural values.

Statement of the Problem

The research investigated houses in the Gulf region, where the climate is considered tropical and desert, with reference to the United Arab Emirates as the case study, because its traditional & contemporary architecture is representative of the Gulf architecture in typology & criteria.

Traditional architecture in the UAE was based on modifying ambient environment to protect the occupants. Protection was needed from dense solar radiation, extreme temperatures, high humidity and dusty winds. The potential of sustainability in the architecture, especially houses, in this region emerged through modifying and getting adapted to environmental factors, in order to create a comfortable internal microclimate.

Climate was a major factor in the formation of traditional architecture, where several responses to climatic conditions can be found: court yard houses and Arish (houses built of palm tree leaves) in the coast districts and some oases. Tents were the traditional home and shelter for the Bedouins in the desert, and stone houses with pitched roofs in the mountains.

This study will deal with the architecture of the coast district in the UAE, especially Dubai and Sharjah. These two cities were chosen as models because both of the cities have rich traditional & modern architecture, while Abu Dhabi (the capital) is mostly a modern city and only few buildings were preserved individually as the Fort Palace (built in 1763) and some buildings in Delma island. The other Emirates: Al-Fujaira, Ajman, Ras Al-Khaima, and Aum Al-Quian are still simple cities and do not have modern architecture compared with contemporary buildings in Dubai and Sharjah.

This research relies on the integration of both theoretical and empirical investigations. At the theoretical level, a documentary analysis of secondary data employed to investigate the context of the research problem and build a basis for the identification of the potential for sustainability. The documentary analysis was used also in examining the appropriateness of several sustainability assessment indicators as a framework to assess the sustainability potential in the traditional and contemporary architecture in the UAE. These can be used as the theoretical basis for developing the Sustainability Assessment Method (SAM). At the empirical level, a Comparative Analysis (CA) of different houses in the UAE, traditional & contemporary, was carried out. Through the CA, three techniques were used; a descriptive analysis for the case study houses, a quantative (statistical) analysis, and spatial analysis for each case study. The CA aims to investigate environmental & social sustainability potential in traditional and contemporary houses in the UAE. It also aims to examine the applicability of the proposed Sustainability Environmental Assessment Method (SEAM) and Sustainability Social Assessment Method (SSAM).

Developing Sustainability Assessment Method aimed to examine the sustainability potential in architecture in the Arab World. This required deep investigation for the concept of sustainability, in general, and the criteria of sustainability assessment methods, in particular. This research concentrated on environmental and social sustainability on one type of buildings; the house. Thus, developing SAM was based on these dimensions with reference to houses.

Conclusions of this research were drawn at three levels. The major finding is the development and testing of a Sustainability Assessment Method (SAM), environmental and social, for examining the sustainability potential in traditional and contemporary architecture. Through this research, the potential of sustainability in the Arab world was identified. The research demonstrated that the government policies and building legislations have an apparent role in the crisis evolution. It was concluded that Sustainability Assessment Method represented an appropriate way to evaluate the sustainability performance of the buildings in the region. Formulation of sustainable assessment methods, environmental, social, and economical, requires efforts of many experts and specialists in different aspects. The Environmental and Social Sustainable Assessment Method, proposed in this research, is appropriate to be used for contemporary architecture in the region, yet it might need further input from different specialists. Thus, the research proposed further researches to investigate issues that were beyond the limits of this research. The research suggests a number of recommendations for the designers, municipalities & local authorities, schools of architecture, developers and decision makers.

Research Aims

- To estimate the sustainable potential of traditional architecture in the Arab world, with particular reference to the United Arab Emirates housing.
- To identify sustainability principles in Islam and how they were demonstrated in traditional houses design in the Arab World.
- To investigate existing sustainability assessment methods in order to develop sustainability environmental and social assessment methods appropriate for the UAE and the Arab World.
- To formulate a set of guidelines to provide a basis for planning and design decisions for new housing with regard to the potential for sustainability evident in traditional architecture.

Research Objectives

- To explore and understand the meaning of the term" sustainability" and the issues surrounding it by examining sustainability criteria.
- To analyze traditional and contemporary housing in terms of plan, form, building materials, construction, environmental performance, and in particular social sustainability.
- To assess the sustainability potential of traditional and contemporary housing.
- To formulate guidelines found in the above exploration and analysis for use in contemporary housing design for the region.

Research Question

Can the potential for sustainability present in traditional housing in the United Arab Emirates be used to formulate guidelines for modern housing development?

Research Hypothesis

- Traditional houses in the United Arab Emirates are more sustainable and are more appropriate for the ambient environment than their contemporary counterparts are.
- It is possible to develop a sustainability assessment method to examine the sustainability potential in traditional & contemporary architecture.

Refinement and modification

The testing of the resulting guidelines relating to new proposals for the design of housing with a sustainable component would form the final process to determine the validity of the hypothesis.

Scope of Research

This research includes three levels of investigation. The first level focuses on the historical background, which aims to define both the constant and changing factors and their influence on traditional architecture in the aspects of socio-economic, environmental and culture. The second level investigates the current situation in contemporary architecture and the reasons behind transformations in the environmental, social, and economical sustainability. The third level investigates the future prospects and the need to develop approaches and suggestions for addressing the sustainability in architecture in the Arab World. Figure 1 shows a structural diagram of these Levels.

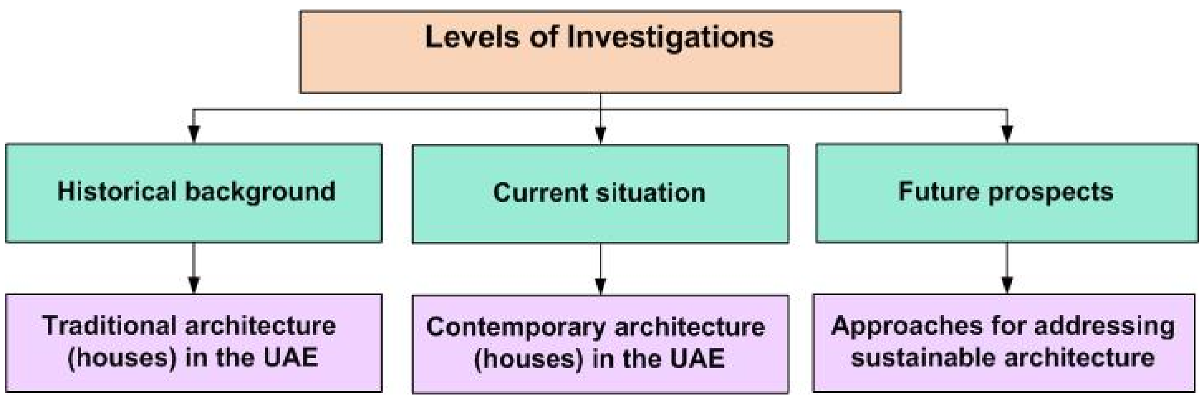


Figure 1: Structural Diagram of the Levels of investigation

(Source: the author)

To build a clear basis for dealing with this research and answering the research question, this research requires a review of the relevant literature on sustainability, sustainable buildings, sustainability assessment methods, traditional architecture and contemporary architecture, and environmental issues in the UAE. The scope of this research embraces the main themes that enable us to test the research hypotheses and achieve its objectives. These themes are:

- **The traditional architecture in the Arab world with reference to the UAE**: issues raised in this research cannot be discussed unless investigating the context of the research problem, which is the traditional and contemporary architecture in the UAE, with special reference to houses. The investigation includes identification of the features of architectural sustainability, environmental conditions, and social values and the occupants' style of living.
- **The available assessment methods**: sustainable assessment methods as indicators to enable policy makers to integrate their decision-making on projects, plans, policies and programs so that they are consistent with sustainability principles is investigated on two levels. The first level is the appropriateness of sustainability assessments to be applied to buildings in the Arab world. The second level is setting guidelines for development policies and building legislations that implement dimensions of sustainability in the built environment.
- **The proposed Sustainability Assessment Method (SAM)**: dealing with this theme is carried out on two levels; firstly, development of the SAM, and secondly, testing the developed SAM. Two kinds of sustainability assessment methods is developed to assess environmental and social sustainability dimensions; one is Sustainability Environmental Assessment Method (SEAM), the other is Sustainability Social Assessment Method (SSAM). Testing the proposed SAM aims to investigate its appropriateness to evaluate the traditional and contemporary buildings through assessing sustainability potential of these buildings. In addition, the testing process intends to examining and refining the proposed SAM itself.

Reasons for Choosing the UAE

Over the period since its federation on December 2, 1971, the United Arab Emirates has witnessed dramatic changes as the revenues from its oil and gas production have been put to good use in the building of a modern infrastructure, while its population has grown by over ten fold. That process of change has taken place against a backdrop of social stability and political continuity that is all the more remarkable because of the upheavals and conflicts that have affected other parts of the Arabian Gulf region (Al Abed & Hellyer, 2001, P.6).

These changes occurred alongside with the oil discovery in the region, economic prosperity, drastic income growth, and transformation of lifestyle. A lot of social values and cultural standards were affected as well as architecture and cities both qualitatively and quantitatively.

The UAE may not be the biggest Gulf country in the area or have the most resources, yet it has become a model for the region and the Arab world. The accelerating steps that have been taken place since the 1970s and the un-preceded development policies, especially in Dubai, have made the country a focal point for many countries especially in the Arab world.

A lot has been written about the UAE: the economic prosperity, luxurious lifestyle, well-planned cities, pioneering buildings, wonderful malls and shopping centres, and leading development policies. Many books, articles, and researches have been accomplished by locals and foreigners in different aspects; mostly on economical success, social changes, and traditional architecture of this country. Nevertheless, analytical studies of architecture in the UAE, especially the contemporary, are rarely to be found.

During the author’s stay in the UAE, she was fascinated with traditional architecture with its barjeels, masonry walls, wide arches, and highly-craft decorations. Its contemporary architecture attracted her with its boldness and uniqueness. Contemporary houses motivated her mind with the way people tried to compromise between their traditional and social values in one hand and the modern lifestyle in another hand. In parallel, author’s interest in sustainability was growing day by day; the more she reads about the subject, the more she recognizes that there is more needed to be known and learnt.

The author’s academic background and her previous studies about Islamic and traditional architecture made her realize the resemblance between principles of traditional architecture, which was built on Islam legislations, and the principles of sustainable architecture. All these issues: sustainability, traditional architecture, and contemporary architecture in the UAE, led to compile the topic of this study.

The Research Methodology

Architecture and the built environment reflect many social and cultural aspects of the society in which it is found. The impact of socio-cultural aspects on architecture is best observed when a society is undergoing major changes. As suggested by Farmer, the impact of culture upon what is built can be seen from several standpoints (Mahgoub, 1997):

- by comparative analysis of the ranges of buildings built by societies
- by considering typological variations of particular type of buildings from one culture to another
- by examining how what is built within a society varies over time
- by noting what is built within a society by subcultures
- by comparing the building output of different peoples building in the same place
- by comparing the use of space between cultures.

The strategy of this study is to examine the development of what is being built within a society over a period and its relationship to the social and cultural aspects, as evident in the case of the United Arab Emirates. This research focuses on environmental, social and cultural aspects influencing architecture through a comparison between architecture before and after the discovery of oil in the region as a reflection of other aspects of society from the sustainability standpoint.

This research methodology will carry out quantitative and qualitative analysis for ten houses, five traditional and five contemporary, in the UAE using Comparative Analysis CA. Through descriptive, qualitative and spatial analysis for these case studies, two of these will be chosen, one each from the traditional and contemporary categories, to be tested in the empirical part of this study.

The two chosen case studies will be assessed using the proposed SEAM and SSAM to investigate environmental and social sustainability performance of traditional and contemporary houses and to test appropriateness of the proposed SEAM and SSAM.

This research relies on the integration of both theoretical and empirical investigations. Investigations are divided into three levels: Theoretical level, empirical level, and developing the assessment method.

The theoretical level: A documentary analysis of secondary data is used. Documentary analysis means content analysis of the relevant documents that include books, journals, magazines, archival data, and field survey and observations. The documentary analysis aims to:

- investigate the context of the research problem
- build a basis for the identification of the features of the sustainability that will be determined through complementary field investigations

- examine appropriateness of the Sustainability Assessment Method to evaluate the building sustainable performance
- construct a theoretical basis for developing the Sustainability Assessment Method (SAM).

The empirical level: Comparative analysis of two traditional and contemporary case study houses, chosen out of ten, will be carried out. Through the Comparative Analysis, three techniques will be employed to collect primary data. These techniques are; systematic analysis of the architectural drawings, quantitative analysis to the houses statistics, and a direct observation. The architectural analysis and houses statistics analysis aim at:

- examination the main comparison criteria
- investigating different building responses to the same criteria (factors)
- examination the appropriateness of the proposed SAM criteria to express the codes that each of traditional and contemporary housing responded to in assessing the sustainability (as part of the SAM testing).

Figure 2 shows a conceptual framework of the empirical investigation, while figure 4 shows a framework of the research and procedure of investigation.

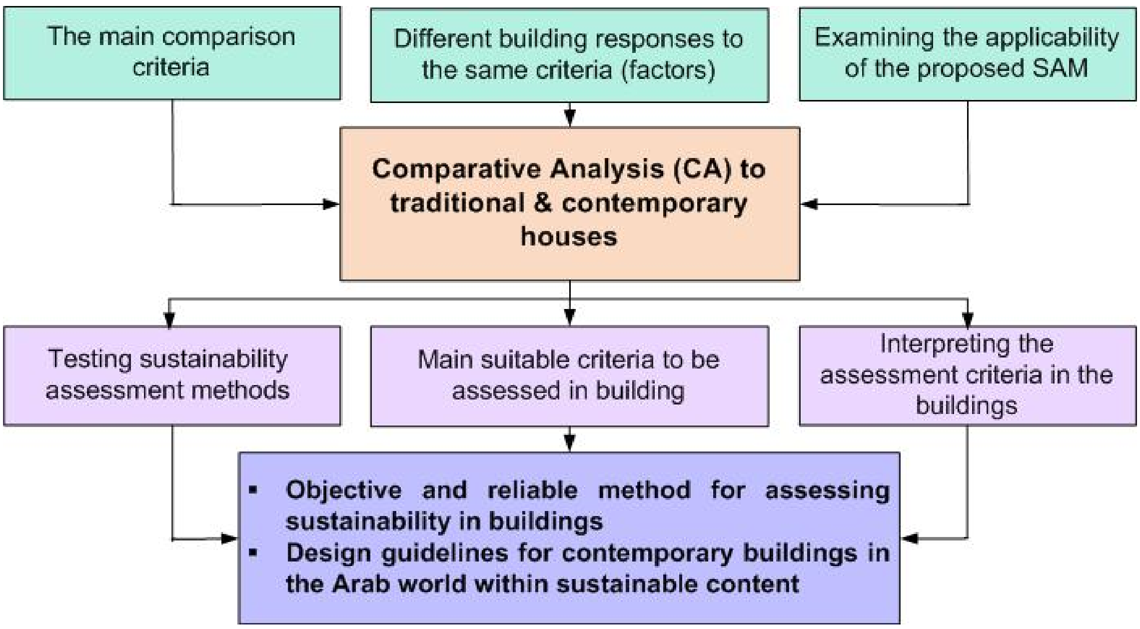


Figure 2- The conceptual framework of the empirical investigation

(Source: the author)

Developing the Sustainability Assessment Method (SAM): The process will be carried out through two stages:

Stage one (the proposed SAM): In this stage, the preliminary framework of the proposed Sustainability Assessment Method is formulated through a theoretical investigation. This stage includes:

- Setting principles of the proposed SAM.
- Identify criteria that express the SAM principles (assessment criteria)
- Setting the SAM rating system and evaluation criteria

Stage two (the final SAM): This stage includes:

- Testing the proposed SAM is carried out at two levels. The first is to test the reliability and objectivity of the SAM through examining appropriateness of the proposed assessment criteria to express the professional and public codes. The second level is to test applicability of the proposed SAM and explain ways of interpreting the assessment criteria in buildings through its application on two case study houses.
- Refining and crystallising the tested SAM in its final form.

Figure. 3 shows a structural diagram of developing the SAM

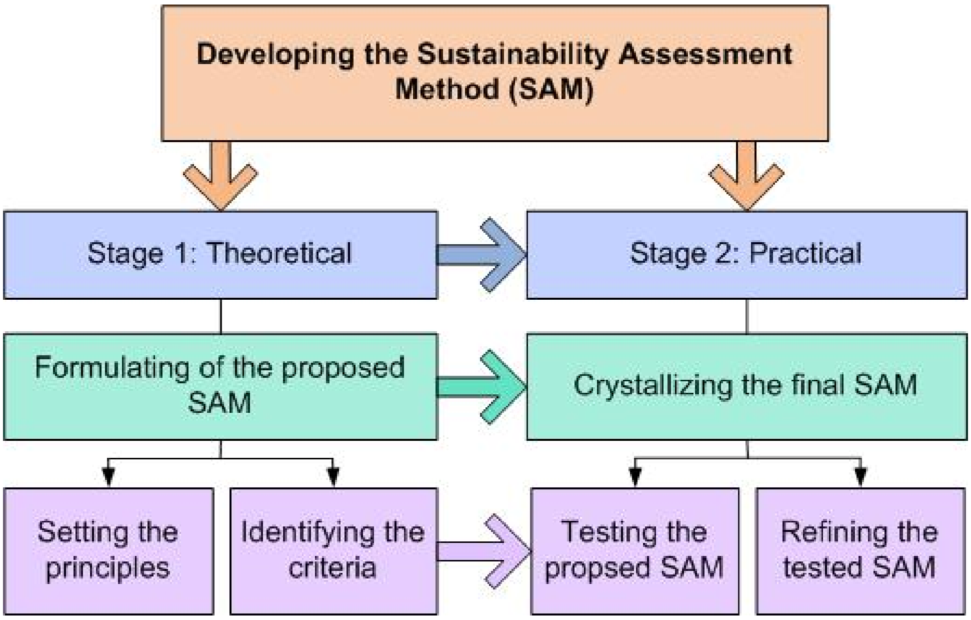


Figure 3- Structural diagram of developing the Sustainability Assessment Method

(Source: the author)

Figure 4 demonstrates framework of the research and procedures of investigation by illustrating components of constructing the research problem and procedures to formulate the final findings.

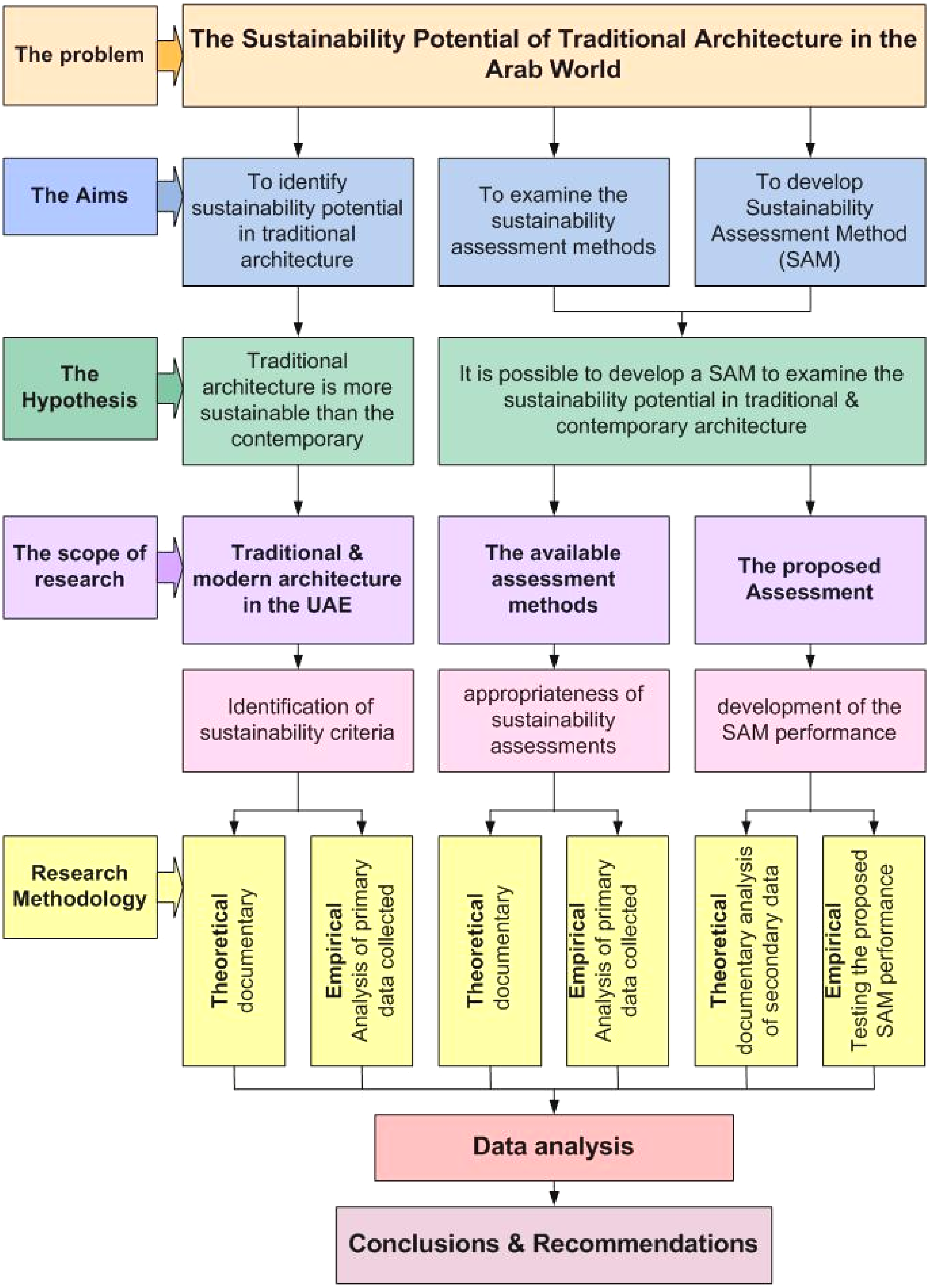


Figure 4 -The research framework and procedure of investigation

(Source: the author)

Research Organization

The research is divided into three parts. The first part aims to build the theoretical background for sustainability and sustainable architecture review. This part consists of three chapters discussing the evolution of sustainability, principles of sustainable architecture, sustainability dilemma in the Arab world, sustainability principles in Islam and how they were interpreted in traditional architecture, and architecture development in the UAE. The second part, consisting of three chapters, was dedicated to formulate Environmental & Social Sustainability Assessment Methods that were used to investigate domestic buildings in the UAE. The third part is dedicated for planning the research methodology & case study model, testing, and developing the Sustainability Assessment Methods throughout two chapters. Through discussion and analysis, the final findings are formulated in the ninth chapter for conclusions and recommendations - Figure.5.

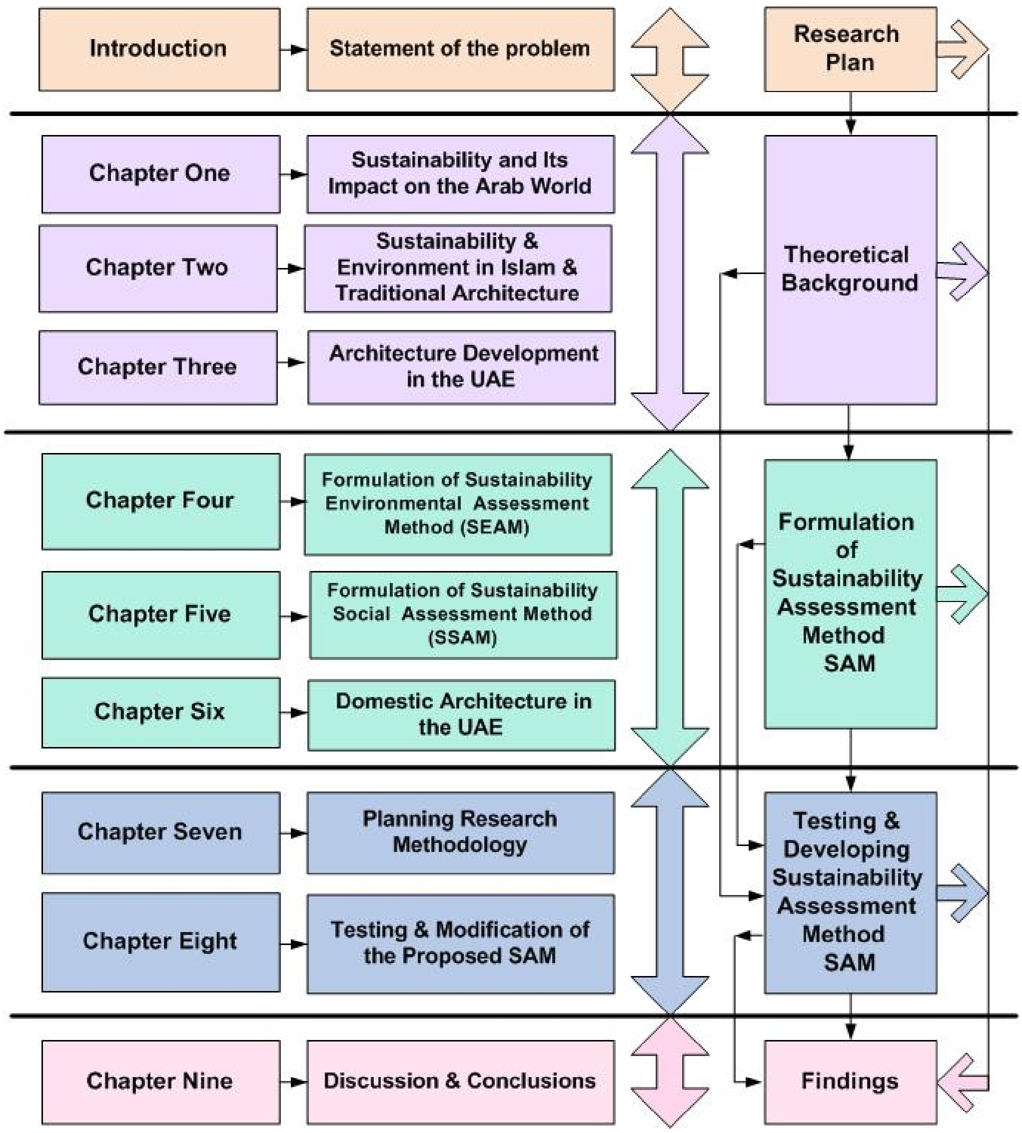


Figure 5- Research Organization Layout

(Source: the author)

Chapters Layout

Introduction & the literature review: illustrates research problem, its aims, objectives and hypotheses. It reviews the literature on sustainability, Islamic architecture, traditional architecture, contemporary architecture and environmental issues in the UAE.

Chapter 1: investigates sustainability as a concept and philosophy of worldwide concern for the last decades and the environmental and sustainability dilemma in the Arab world.

Chapter 2: This chapter investigates the sustainability potential in Islam and Islamic legislations and how they were demonstrated in architecture, especially the traditional house design in the Arab world with reference to the UAE.

Chapter 3: The chapter investigates the natural and cultural background of the UAE and architecture development during the 20th century. It traces roots of modernization during the first half of the 20th century pursuing the architectural boom the country witnessed since declaration of federation in 1971.

Chapter 4: This chapter investigates the sustainability environmental assessment methods through examining existing environmental assessment methods and analysing the main indicators of these methods to create a basis for formulation sustainability environmental assessment method (SEAM).

Chapter 5: This chapter investigates the sustainability social assessment methods through examining existing social assessment methods and analysing the main indicators of these methods to create a basis for formulation Sustainability Social Assessment Method (SSAM).

Chapter 6: Investigates the domestic architecture in the UAE, traditional and contemporary, and degree of houses' response to environmental conditions and social values. Houses analysis is held according to environmental and social sustainability criteria that were discussed in chapters four and five to assist in testing the proposed SEAM and SSAM through Comparative Analysis for two chosen case study houses in chapter eight.

Chapter 7: discusses the research methodology, which is the Comparative Analysis (CA) of ten houses, five traditional and five contemporary, in UAE. This chapter explains objectives of choosing the CA, methods of data collection, and methods of data analysis. The chapter also determines analysis features that will be a basis for the comparison process in addition to identifying characteristics of the chosen case studies.

Chapter 8: focuses on testing and crystallising the proposed Sustainably Assessment Method (SAM). It includes evaluation method according to the indicators of the SAM. The testing process includes also the application of the proposed SAM on the model case study houses. This chapter introduces modification of the proposed SAM based on findings of testing the SAM.

Chapter 9: summarises conclusions of the research and discusses the major findings and points out its recommendations. Figure 6 shows chapters break down and the main issues discussed in each chapter within the main three parts of this research.

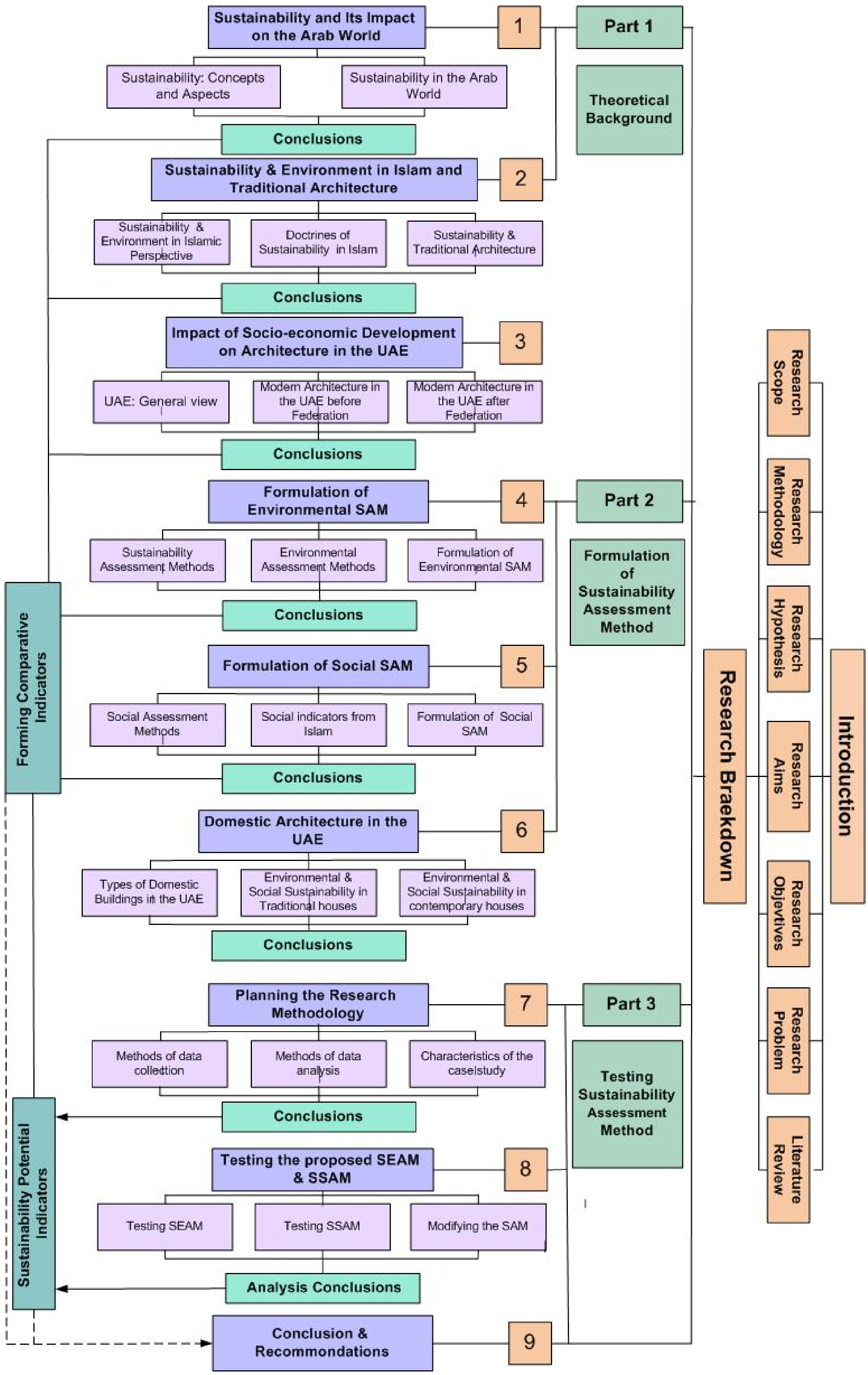


Figure 6- The Research Chapters Breakdown

(Source: the author)

Literature review

The aim of investigating literature review is to look into issues of sustainability in traditional and contemporary architecture considering its importance and value to the future architectural trends. This will be achieved by carrying out a literature review study in this area.

Traditions can be seen as a creative process through which people, as active agents, interpret past knowledge and experience to face the challenges and demands of the present (Asquith & Vellinga, 2006, P.7).

Tradition is that part of culture that is transmitted from one generation to the next one. To some extent, a society's identity is based on its traditional heritage. This is the reason for which many societies place a great value on heritage. In the Arab world, tradition is not a single layer of past cultural manifestation; rather, it is multilayered complex. Tradition is not the theoretical part of one's heritage or the wishful claim of renewal of old grandeur and past glories. It is instead, the hard task of not only recognizing but also creatively transforming those values that have accumulated over centuries, and through this process incorporating contemporary values that did not exist before (Kultermann, 1999, P. 4).

Traditional architecture offers the greatest potential for the development of a viable contemporary regionalism of consistent high quality, capable of providing for many building types, both old and new. The potential diversity from the sheer richness of the heritage diversified over centuries of continuous development (Abel, 2000. P. 171).

The Need for Studying Traditional Architecture in the Arab World

In 1931, Adolph Loos wrote that the lesson to be learned from the architecture of "peasants" was not necessarily its forms but the way in which form was a direct response to function. This thought was shared by Frank Lloyd Wright who described traditional architecture as (Oliver, 2003, P.13):

> "*Folk buildings growing in response to actual needs, fitted into environment by people who knew no better than to fit them to it with native feeling. Wright expressed the opinion that traditional architecture was superior to self-conscious academic attempts to use a historical style in generating architecture".*

Le Corbusier considered traditional architecture ideal in compromising social and physical needs by describing traditional architecture*:*

> *"…..having attained perfection in serving human needs and harmonizing with the environment*".

In his book "*Architecture without Architects*", Rudofsky commented, *"There is much to learn from architecture before it became an expert's art*". The physical configuration of the environment around us is just one aspect of our perception and experience of the environment. We should look for the social and cultural meanings of architecture in the daily life experiences of community and people in order to understand their experience with architecture and environments. Many studies related traditional architecture to natural and cultural environment of the location and region. Kennedy (2004, P. 224) defines traditional architecture: *"an architecture style that develops from the particular climate and social conditions of a place*". Paul Oliver (1997, P. xxi), in his book "*Encyclopaedia of Vernacular Architecture*", confirms this by emphasizing on the interrelation between traditional architecture and the society:

> *"It is particular characteristics of traditional architecture that each tradition is intimately related to social and economic imperatives; it has developed to meet specific needs within each cultural milieu. Seen in the context of hamlet, village or town, the larger frame of the social structure has bearing on the spatial organization of settlements. Families may require proximity to kinsfolk and clan members or to the sites associated with ancestors. Exogamous marriage, inheritance rights and other specifics of custom and tradition can affect location and settlement growth. Within the dwelling, customary norms in organization and utilizing space may persist through generations, requiring places for working and sleeping, or for the preparation and cooking of food. Often they are gender or hierarchically differentiated, changing rarely and only as societies change".*

The traditional architecture contains many values of how people lived in this area and translates their requirements in a unique character. Therefore, these lessons should be studied, handled, preserved, and enhanced in modern planning policies and building practice (Bukhash, 2001, P.35). Hinrichs (1987, P. 139) believes that re-evaluating and analyzing traditional architecture support the interrelation between policy makers and the society

> "*Care must be exercised however to insure that traditional architecture qualities are carefully analyzed and appreciated"* (Hinrichs, 1987, P.312). He also confirms that : "*A re-evaluation traditional systems in the Arab World would not only help policy makers regain their self-respect and identity, but also realign them with their own people and equip them better to be of service*".

In the Arab World, traditional architecture has great potential as a source to inform contemporary architecture. Derek Thomas (2002, P.148) asserts that:

> "T*raditional architecture offers timeless precedents from which contemporary architecture could well draw inspiration. It is significant that in the sphere of*

sustainability, Arab world countries have revisited traditional typologies to reveal identity to contemporary architecture “.

This growing concern towards heritage and traditional architecture is part of a more general concern for preserving the historical buildings, because these buildings, as Rashad Bukhash (2001, P.13) considers, are historic documents and traces of early forms of art, therefore, it is important that their integrity be preserved and that the restored object should be authentic

Traditional architecture is of great potentiality to modern. Farmer (1996, P.12) asserts that by saying:

“*As the late twentieth-century people, though, limitations of traditional cultures in helping us to know what to do are evident*”.

Accordingly, as Khalid Asfour (1998A, P. 60), an architect and academic, believes that we may learn a lot from the past where the natural world was the guiding design principle in the Arabian Peninsula. Examples survive of comfortable living environments answering human, social, cultural and climatic needs. Decorative and design features were concerned with privacy, security and temperature control. Courtyards and colonnades were both important, the former providing shelter from sun and wind, the latter ventilation and indirect light to living areas; and both offering security and all-important privacy. Doors, columns, capitals, roof parapets, shutters, windows, screens and wind-towers became the motifs of regional architecture. He calls for more study into traditional architecture in the Arab World from different standpoints to produce more region relevant architecture to the society (Asfour, 1998B):

“*Arab architectural history has to be reinvented for architects, to generate design issues relevant to the practice. Architecture students should be encouraged to imagine traditional mind sets and to read the logic of historical buildings in a variety of ways*”.

Marwan Ghandoour (1998, PP.151-152) agrees with this opinion adding that traditional architecture is as important as the ancient history in the Arab World:

“Arabs should re-read their history; they should re-read not only their distant *history, but also their recent history that has contributed to the formation of the contemporary Arab mind. The distant history, which is referred to, is the history before the colonization and “modernization” of the Arab world. This distance history is the era where the traditional architecture nourished and developed “.* Yet Ghandoour thinks that:” *Reinterpreting tradition is a historical and global issue, but nonetheless remains part of a number of issues architects have to address. Even* *if some solutions could be found in local tradition, they can also be found in other traditions and in different contemporary approaches".*

It is usually traditional buildings that are particularly instructive-both the vernacular of the local region and that of comparable biomes, those regions elsewhere on the earth with similar climate, vegetation and geology. Buildings of the past or other cultures are not to be copied slavishly, but rather studied so that their lessons and design devices might be reinterpreted to suit current construction technologies and lifestyles. The Arabic architect Rasem Badran (1998), finds that architecture should flourish from its environment; this is evident in traditional architecture that related between sustainability dimensions, society, environment, and economy. In this aspect, he declares:

"*Architecture is concerned with culture, society and economics as well as the surrounding environment. The interaction of all these aspects is vital in defining the characteristics of a place".* The essence of Islamic architecture for Badran is that it " *is 'human', answering the needs of the community without neglecting the individual".* Badran views the architect's role as being intended to "*propagate a continuous discourse that investigates and excavates deeply into the secrets of the place in order to explore its own tools and media of expression*".

Traditional Architecture, Sustainability & Islam

Buchanan (2005, P.14) believes that green sustainable design has much to learn from the past, although there is nothing regressive about this either. In his opinion, most major cultural epochs, such as that beginning with the renaissance, are born in part from a rediscovery and reinterpretation of history. Just as the quest for sustainability is making us more receptive to the wisdom of other and earlier cultures, so green design can learn much from the buildings of the past. In this aspect Boake (1996) wonders, if traditional architecture is based upon time tested traditional building techniques, why is it necessary, now, to reinvent vernacular based attributes to achieve sustainable design.

As long as human kind has been building, people have creatively used materials available in their immediate surroundings and constructed shelter with their own hands. In many ways traditional societies have been the true leaders of sustainable development over time. Inhabitants who are native to a particular place draw their food and water from their surroundings, understanding that their survival requires them to maintain equilibrium with the cycles of life around them. Klinker (2004, P.6, 7) emphasis that traditional architecture has the essence of sustainability to be the link to more environment-respected buildings:

> ”… *in seeking sustainable solutions to growth that ensure our society’s continued survival, we must respect the natural laws of environmental balance. A reconsideration of traditional architecture can provide a vital link to the future development of viable ecological building solutions to fit a range of urban and rural needs. Accessing the current knowledge of traditional builders is a key component in that link*”.

In some cases, an anti-modern environmentalism dominates, in which traditional vernacular is employed much more literally; in others, a preoccupation with new technologies and materials predominate. Susannah Hagan (1998, PP. 107-115) asserts that modern architecture is less ethical towards environment versus traditional:

> “*As will become apparent, within the new materialist remit of environmental ethics, those who tend to be dismissed architecturally the architects following tradition most closely – are held by some within environmental design to be the most ethical, while those pushing the technology envelope are condemned as the least ethica*l”.

Therefore, we may see the re-establishing of more richly layered relationships between inside and outside, which inevitably discover, extend, and rework traditional types and patterns in a process of continuity and change. This is essential to the creation of environments which are sustaining for individuals and societies and which are sustainable environmentally and culturally and enable us to dwell in and with rather than outside against the environment (Stonehouse, 1998, P.130).

Many studies have been prepared about traditional architecture in the Arab World; most of these studies related between Islam and traditional architecture because it was the region where Islam began, flourished and spread in many countries in Asia, Africa and parts of Europe that formulated the Islamic World. These studies discussed role of Islamic legislations on forming urban planning and architectural product of the region that responded to environmental conditions and social needs. This is due to role of Islam in shaping Moslems life, As Hisham Mortada (2003, P. xix, xx) refers:

> “*The tradition of Islam embodies many principles of social organization and behaviour. These principals have been established by this tradition to make the life of believers corresponded to its objectives and message. Following these principals, as early Moslem societies did, creates harmoniums social and physical environments. Built environment was shaped by the beliefs and actions of the inhabitants who adhered to a traditional Islamic way of life”*.

Suha Ozkan (2002, P.86), Secretary General of the Aga Khan Award for Architecture, in his reference to the Middle East region's cultural background and contemporary evolution, concludes that:

> "*There are examples of architecture conversant with the values of Islam, and that the region has been fertile ground for the development of some of the finest expressions of contemporary architecture*".

Besides its social and cultural content, Islamic architecture, as Seyyed Hossein Nasr (1978, P.13) claims, was a model for utilizing natural resources,:

> "*Islamic architecture remained faithful to simple building materials and employed the elemental forces of nature such as light and wind for its sources of energy. It brought nature into the city through the recreation of the calm, harmony, and peace of virgin nature within the courtyards of the mosque or the home*".

Various studies were advocated to environment and sustainability in Islam asserting how Islam called for environment conservation and economy in resource consumption; these studies were supported with parts of *Quran and Hadith.* However, the direct link between sustainability, Islam, and architecture was not deeply studied within holistic view of sustainability.

Relating sustainability principals and Islam were discussed in several studies; mostly on environment conservation in Islamic prospective (Bagader & Others, 1993; De Chatel, 2003; Wersal, 1995; Faruqui & Others, 2001). These studies refer the principles of environment conservation to the Quranic teachings and the concepts of *tawhid* (unity), *khalifa* (stewardship) and *amanah* (trust).

Francesca De Chatel (2003) considers Prophet Mohammed (PBUH) as an "environmentalist" and a pioneer in the domain of conservation, sustainable development and resource management. She thinks that a closer reading of the *Hadith*, the body of work that recounts significant events in the Prophet's life, reveals that he was a staunch advocate of environmental protection:

> *"The idea of the Prophet Mohammed as a pioneer of environmentalism will initially strike many as strange: indeed, the term "environment" and related concepts like "ecology", "environmental awareness" and "sustainability", are modern-day inventions, terms that were formulated in the face of the growing concerns about the contemporary state of the natural world around us".*

Some believe that Islamic architecture is a manifestation of sustainability. At the end of his book (*Traditional Islamic Principles of Built Environment*), and in the closing statement under the title (sustainable living: re-thinking Islam), Hisham Mortada (2003, P157) concludes:

> "*Most of the traditional Islamic principles that have been discusses in this book, can be identified in the mission of sustainability. Indeed, advocates of sustainability admit that traditional cultures and ideologies embody ideas and principles on which sustainable living should be based. They claim that sustainable living satisfies our needs today, without diminishing the prospects of future generations to do the same. As the Qur'an and sunnah did some 1,400 years ago, the contemporary movement of sustainable living asks for a balance in the consumption of resources so others can benefit from them in the future. Sustainable living also demands a reduction in the impact of transportation on humans and the environment. It propagates the importance of using materials in continuous cycles and constantly reliable sources of energy as well as bringing people together to enrich the qualities of being human*".

Few studies tried to relate sustainability principals to traditional architecture. Mahgoub (1997) connects between the three dimensions of sustainability: environment, society, and economy and the principals of traditional architecture. He thinks that traditional architecture is more sustainable that the modern:

> *"Sustainability was manifested in traditional architecture, in different aspects, while modern architecture neglected natural resources and ambient environment, which led to the absence of sustainability in contemporary architecture".*

The essence of sustainability in traditional architecture was not due the way of building alone; it was a style of life. Predecessors built to get adapted to ambient environment with no intention to change or control it. Sustainability principals were manifested through wise utilizing of natural resources (Al Zubaidi, 2004, P.245).

Eman Assad (2006) identified seven aspects as sustainability principals in traditional architecture: respect of site and local environment, respect the inhabitant's way of living, local building materials, building materials with less embodied energy, energy conservation, creation of long-life buildings, recycling, and desert plantation.

Although traditional architecture in the Arab World was a distinguished example of sustainability that became the most common subject that has been written about in the past thirty years; perhaps nowhere is sustainability more problematic than in this region, as Jim Antonio (May 1998) from the Architectural Review declares:

> *"…where an abundance of wealth and energy, with few of the restraints found in other regions such as Europe, has resulted in an urban environment that relies almost entirely on artificial support, with little reference to past life-styles which were so well adapted to natural phenomena".*

In his speech at the "Sustainable Architecture and Construction for the Middle East" that was held in Abu Dhabi/UAE in 30-31March1998, John Gummer, the environmentalist and former British Secretary of State for the Environment emphasized (Antoniou, May 1998):

> "…*buildings of low quality cannot provide the ingredients of sustainability*". In addition to technology, other mechanisms need to be found to use energy efficiently. His view is that: "…*sustainability is not an extra cost but a way of improving opportunities*".

Architecture in the United Arab Emirates

United Arab Emirates is characterized by the richness of its architectural and urban heritage owing to the forms and architectural sites it contains, its values, ideas and philosophies. These forms and sites require study and analysis to develop the vocabulary they offer (Bukhash, 2001, P.14).

Parallel with the development that has taken place in the United Arab emirates since 1971, there has been an explosion in academic research on the country, as scholars both from within the UAE and abroad have studied a wide range of aspects of the state, including not only its recent history and development, but also its past and the nature of country itself (Al Abed & Hellyer, 2001, P.6). Yet studies related to contemporary architecture in the UAE remained rare; mostly were descriptive and didn't analyze economical, social and cultural aspects as main motivator for architecture as a cultural product.

The contemporary architecture in the UAE and Arab World is usually voided in researching and analysis by ridding it of any intellectual credibility and limiting its understanding in negative attributes only: \`image cloning', \`lack of inquisitive consciousness', \`passionate move' and \`little thinking. Beyond accelerating steps of modernity versus traditional architecture lies what, Khalid Asfour (1998A, P.52), called 'the dark side of the equation', attacking the way in which 'cutting and pasting' has been used in the UAE as well as in the Arab world - imposing Western building types without considering their impact on the local culture and environment. He also believed that 'direct copying of the past is as absurd as copying from the West'.

Relying on imported building styles in the UAE and the Arab World may be referred to lack of trust in the traditional methods as they are symbols of poverty and retardation. The successful implementation of Western ideas depends on the assumption fostered in people in the Arab world that western methods are more appropriate (superior) to their own. Perhaps the most insidious affect has been their loss of self respect & identity. The problem, as Ghandoour (1998, P.151) defines:

> *" is not only an absenting of the present, but a belief that such an intellectual act is possible. Such an attitude, which visualizes traditional architecture as an absolute condition, reduces the understanding of buildings to their form. It fails to recognize that the current Arab built environment is suffering from bastardization of their traditional architecture through extensive misinterpretations and formal experimentations with traditional forms carried out by architects from all parts of the world currently building in Arab countries. These representations and interpretations are the outcome of the contemporary rereading of tradition*".

Conclusions

Traditional architecture offers timeless precedents from which contemporary architecture could well draw inspiration. It is significant that in the sphere of sustainability, Arab world countries have revisited traditional typologies to reveal identity to contemporary architecture (Thomas, 2002, P.148). Recognition and acknowledgement of tradition can take the form of interpreting the essence, in meaning and function, of certain elements of architectural heritage and abstracting them in modern designs. It can also take the form of reusing, or recreating, some of these architectural elements in a contemporary design to convey a traditional image.

According to reviewing the relevant references, it is concluded that in spite of the abundance literature review about sustainability in the world, a little has been written about how to implement sustainability principles in architecture in the Arab world or how to develop sustainability assessment methods specific to the region. This directed the researcher to go deeply in this issue. Scarcity of scientific literature review about architecture in UAE, the researcher's interest in the architecture of this country, and the emerging awareness towards sustainability in UAE; these three issues were the main reasons for choosing this topic and UAE as the case study of this research.

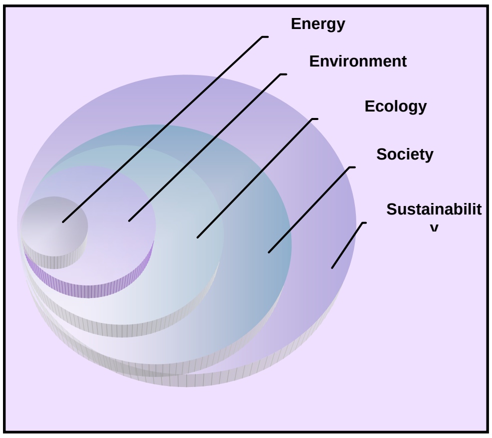
This research is unique and may contribute to literature is achieved in different levels: issues discussed (sustainability, traditional houses, and contemporary houses in UAE), the research methodology (developing SAM) and comparative analysis criteria (using the developed SAM). The main research contribution is developing Sustainability Environmental and Social Assessment Method specific to the region and appropriate to local environment and analysing traditional and contemporary houses in the UAE from environmental and social sustainability standpoint.

Throughout attaining the research aims, many issues were raised and several aspects were investigated utilizing systematic methodology that went along chapters in this research. Theoretical investigations, in most chapters, were demonstrated with figures, tables, and charts that enable other researchers to get a better understanding of the discussed issues and analysed data.

Part One
Theoretical Background

Chapter 1
Sustainability & Its Impact on the Arab World

Main Headings



- 1.1. Sustainability: Concepts and Aspects
- 1.2. Sustainability in the Arab World

Chapter One: Sustainability and Its Impact on the Arab World

Introduction

The past few decades have witnessed a proliferation of protests against a variety of global and local events, such as global warming, flooding, food, agricultural crises and globalization. These have brought together disparate activists from developed and developing countries. All these issues come within the remit of debates on sustainability. This guide outlines the need and parameters for integrating of sustainability in the way we live, act and build. There is a growing interest in the concept of sustainability and sustainable development worldwide. Sustainability is a planning perspective that accounts for economic, social and environmental goals, including impacts that are indirect, difficult to measure, and distant in time and space.

This chapter aims to build a theoretical background about sustainability and its influence on architecture with special reference to the Arab World. This chapter investigates the sustainability concept and philosophies as a worldwide concern for the last decades, through discussion its definitions, goals and dimensions. Then the environment & sustainability dilemma specific to the Arab World is studied by discussing issues such as shortage of fresh water and desertification, expanded urbanisation, air pollution, and consumption of resources and energy consumption. Discussing these issues is crucial to realize sustainability and environment dilemma in the Arab World, which give reason for the need of this research.

1.1. Sustainability: Concepts and Aspects

Rapid developments in different fields: industry, transportation, communication and construction have caused environmental and visual pollution. This affected the atmosphere and in living vegetation and life in its forms. This may change the balance of natural environment and human future on earth. These issues have brought together disparate activists from developed and developing countries. All these issues come within the remit of debates on *sustainability*.

Sustainability became the “Buzzword” or as Lele (1991, P. 607) describes “watchword” for international aid agencies, the jargon of development planners, the theme of conference and learned papers, and the slogan of development and environmental activists. No wonder that the present climate of urgency to find solutions to the now unavoidably obvious repercussions of years of long-term abuse of the environment, *sustainability* has become not only an attractive and fashionable phrase, but also a “*comfort word*” that is prone to being viewed with suspicion (Steele, 1997, P. ix). *Sustainability*, as Bell and Morse (1999, P.3) think, is widely used nowadays as a way to get support or justify policy:

> "*Few development interventions or research initiatives these days can successfully attract funding unless the words "Sustainability" or "Sustainable" appear somewhere in the proposal to the funding agency. Indeed, if one listens to speeches by politicians or reads articles by economists, policy-makers or scientists the word sustainable appears with a remarkable regularity*"

Nevertheless, "*sustainability"* as a concept is becoming more important everyday. The overuse of the word "*sustainability*" abused the meaning of the word the same way as humans abused environment. Investigating the subject needs understanding the essence of sustainability as a way of living not just high-priority issues included in government policies and development strategies.

1.1.1. Sustainability Historical Review

The word *"sustainable*" has roots in Latin; "*sustain"* means, "to hold up" or "to support from below". Oxford Wordpower Dictionary defines "*sustain"* as to keep something alive or healthy, to cause something to continue for a long period of time (Oxford Wordpower, 2006, P.781). If we apply the word meaning to modern use of *"sustainability"* to keep the earth, it is the duty of its inhabitants, present and future, to support a community from below. Certain places, through the peculiar combination of physical, cultural, and, perhaps, spiritual characteristics, inspire people to care for their community. These are the places, where "*sustainability"* has the best chance of taking hold (www.sustainablemeasures.com – Last accessed 25-10-2004).)

For centuries, people lived depending on available resources utilizing natural energy sources to build, cultivate, and produce. The turn-point in humanity civilization was the Industrial Revolution that has been under way for two centuries. Its foundation was a shift in sources of energy from wood to fossil fuels, a shift that set the stage for a massive expansion in economic activity. Indeed, its distinguishing feature is the harnessing of vast amounts of fossil energy for economic purposes.

While the Agricultural Revolution, as Lester Brown (2001, PP. 56–57) identifies, transformed the earth's surface, the Industrial Revolution is transforming the earth's atmosphere. The additional productivity the Industrial Revolution made possible, unleashed enormous creative energies. It also gave birth to new lifestyles and to the most environmentally destructive era in human history, setting the world firmly on a course of eventual economic decline. As Brown believes, nowadays we live The Environmental Revolution that resembles the

Industrial Revolution in that each is dependent on the shift to a new energy source. Moreover, like both earlier revolutions, the Environmental Revolution will affect the entire world. There are differences in scale, timing, and origin among the three revolutions. Unlike the other two, the Environmental Revolution must be compressed into a matter of decades. The other revolutions were driven by new discoveries, by advances in technology, whereas this revolution is being driven more by our instinct for survival.

In spite of industrial revolution the advantages and two centuries of industrial development that have made life better for many people in ways that would have been unimaginable even a generation ago, it has also brought increasing damage to the physical systems and social fabric on which our well-being depends (www.sustainable-development.gov.uk – Last accessed 21-10-2004).

The modern concept of environmental sustainability goes back to the post- World War II period, when a utopian view of technology-driven economic growth gave way to a perception that the quality of the environment was linked closely to economic development. Interest grew sharply during the environmental movements of the 1960s, when popular books such as "*Silent Spring*" by Rachel Carson (1962) and The "*Population Bomb*" by Paul R. Ehrlich (1968) raised public awareness (www.answers.com/topic/sustainable-architecture - Last accessed 30-03-2007).

In the 1960s, the concept of sustainability enhanced, as a response to concern about environmental degradation resulting from poor resource management. As the environment became increasingly important as a world issue, sustainability was adopted as a common political goal. In 1960, the Organisation for Economic Cooperation and Development (OECD) was created to promote policies that would achieve "the highest sustainable economic growth and employment in Member countries in order to stimulate employment and increase living standards" (Global Sustainability, 2001, P. 4). Since 1960s until date, several events, conferences, and summits have been held; this demonstrated "sustainability" as a prospective strategy to conserve environment and planets' resources.

1.1.1.1. Earth Day & Stockholm Conference

Earth Day in June 1970 was a drastic event, the first consensus to arise out of the growing concerns that began to be voiced in the socially conscious 1960s with ecology as a rallying cry. A report entitled "*Limits to Growth*", published by the "Club of Rome" in 1972, focused on the idea of progress and , most particularly, on the fact that global industrial activity was increasing exponentially, predicting drastic consequences if such growth were not altered.

The main conclusion of the report was" *under the assumption of no major change in the present system, population and industrial growth will certainly stop within the next century, at the latest*." This early evaluation from the 1970s is much too pessimistic looked at from a present point of view and cannot be sustained in this drastic way anymore. However, it contributed to creating an atmosphere of awareness of future environmental problems that people would face in the years to come (C·A·P, 2005).

The basic environmental issues rose on the first Earth day and the report "Limits to Growth" as population growth, air and water pollution, greenhouse effect and Ozone- depleting gases and climatic changes was a significant philosophical shift towards the concept of sustainability rather than ecology (Steele, 1997, PP.1, 2). In the same year 1972, the United Nations held the first international Conference on the Human Environment in Stockholm, which brought together industrialized and developing nations to discuss the right of all humans to a healthy and productive environment. The conference resulted in an action plan with detailed recommendations to national governments on how to influence human impact on the environment. From this event, the United Nations environment Program, located in Nairobi, Kenya, was developed (C·A·P, 2005). Stockholm Conference asserted the importance of facing environment crisis. The world began to be conscious about environmental issues that cannot be solved separately from social and economical problems. (www.worldlife.org- Last accessed 20-11-2004).

1.1.1.2. Brandt Commission

In the 1970s, the debate was raised about doubtful future due environmental challenges. A more effective initiative was the independent "Brandt Commission" that held its first meeting in Gymnick, Germany on December 9, 1978. After several meetings, a report of the findings "*North-South: a Program for Survival*" was published in 1980, followed by an addendum published in 1983 (Steele, 1997, P.3). The release concentrated on the relation and negotiation between Developed and Developing countries (as called North and South) and the tragic situation of dependency by the developing world. However, the report did initiate awareness of the need for global consensus and coordination on environmental policy opening the door for the increasing focus on the search for rapprochement between economics and ecology that was to follow (Ibid, P.4).

In 1980, the International Union for the Conservation of Nature (IUCN) released the "*World Conservation Strategy*". The strategy defines the "*main agents of habitat destruction and environmental degradation as poverty, population pressure, social inequity and the terms of trade*". In this release, the word "*sustainability*" was first used in connection with the environment and was inextricably linked to development. Sustainable development was defined as the maintenance of essential ecological processes and life support systems, including those of humans (IUCN/UNEP/WWF, 1980, P. 8). However, *World Conservation Strategy* had a limited impact on governmental policies (Steele, 1997, P.2)

1.1.1.3. Brundtland Commission

The World Commission on Environment and Development (WCED) was founded in the late 1980s by the United Nations as a strategic means of compromise between the growth and non-growth factions. The commission report "*Our Common Future"*, also known as the Brundtland Commission (after the then prime minister of Norway, Gro Harlem Brundtland) was issued in 1987. The report contained a definition of sustainable development that has current widespread influence: "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1987, P 8.)

1.1.1.4. Earth Summit

The Brundtland Commission's work provided the basis for the United Nations Conference on Environment and Development (UNCED) in Serrado Mar, near Rio de Janeiro, Brazil in late spring 1992 with the presence of more than 100 world leaders. Also known as the Earth Summit, the conference witnessed an unprecedented international meeting of delegations from 178 countries and representatives of more than 1,000 NGOs. The summit's purpose was to develop a global consensus on measures needed to balance development pressures against an increasingly imperilled global environment, which is considered the most important agreement related to WCED (C.A.P., 2005).

The summit proceedings was published as "*Agenda 21*", named after the century. It is a complex document with 40 separate sections addressing different areas of concern. The main subjects were the quality of life and earth, efficient use of earth's resources, the protection of global comments, management of human settlements, management of waste, and sustainable economic growth (Steele, 1997, P.9). Agenda 21 was adopted by more than 178 states. It covers topics on virtually everything regarded important for a sustainable future, ranging from agriculture to biodiversity to hazardous waste to eco-tourism. The agenda calls for environment conservation and rational use of natural resources tending towards renewable resources as land water, and energy (C.A.P., 2005).

1.1.1.5. Kyoto Protocol

The Kyoto Protocol is an agreement negotiated as an amendment to the United Nations Framework Convention on Climate Change (UNFCCC), which was adopted at the Earth Summit in Rio de Janeiro in 1992, assigning mandatory emission limitations for the reduction of greenhouse gas emissions to the signatory nations. The convention was held in 1997 in Kyoto Japan. Countries that ratify this protocol commit to reduce their emissions of carbon dioxide and five other greenhouse gases (methane, nitrous oxide, sulphur hexafluoride, HFCs and PECs), or engage in emissions trading if they maintain or increase emissions of these gases. According to the protocol, industrialised countries were to reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990. National limitations range from 8% reductions for the European Union and some others to 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland.

The Kyoto Protocol now covers more than 160 countries globally and over 55% of global greenhouse gas (GHG) emissions. The treaty was negotiated in December 11, 1997; it opened for signature on March 16 1998, and closed on March15 1999. The agreement came into force on February 16, 2005 following ratification by Russia on November 18, 2004. As of December 2006, 169 countries and other governmental entities have ratified the agreement (www.en.wikipedia.org – Last accessed 20-04-2007).

1.1.1.6. World Summit on Sustainable Development

The Johannesburg Summit 2002 brought together tens of thousands of participants, including heads of State and Government, national delegates and leaders from non-governmental organizations (NGOs), businesses and other major groups. The conference was to focus the world's attention and direct action toward meeting difficult challenges, including improving people's lives and conserving our natural resources in a world that is growing in population, with ever-increasing demands for food, water, shelter, sanitation, energy, health services and economic security. Ten years later the Rio, the Johannesburg Summit presented an opportunity for Leaders to adopt concrete steps and identify quantifiable targets for better implementing Agenda 21 (www.un.org/geninfo/bp/enviro.html - Last accessed 20-04-2007).

All these conferences, meetings, releases and more others, reflect the worldwide concern for the future life on Earth. Definitely, debates and negotiations will go on, yet the most important is the recommendations, policies and strategies that will be set up and applied on reality to achieve sustainable development and save Earth for coming generations.

1.1.2. Sustainability Definitions

The term "*sustainable*" has its own evolution, but some of its immediate nuances are coloured by the political, economic, social, and psychological climate of the here and now and make it particularly prone of dating (Steele, 1997, P.ix). Sustainability emphasizes the integrated nature of human activities and therefore the importance of comprehensive planning that coordinates between sectors, jurisdictions and groups. Sustainability is just one word and yet there exists over 300 definitions. In fact, it has become such a popular word to describe all sorts of situations that when you write about sustainability, you now need to define it (www.griffith.edu.au – Last accessed 30-03-2007).

There is no universally accepted definition of sustainability (Beatley, 1995, P.339). Consequently, sustainability is defined in the ways that suit particular applications. Sustainability has many definitions; all agree on one key point: that however, we use our world and its resources; we should preserve the ability of future generations to do the same (Harrison, Wheeler, & Whitehead, 2004, P.1). Anyhow, the concept of sustainability has been introduced to combine concern for the well-being of the planet with continued growth and human development.

Perhaps the most commonly quoted within the extensive literature on the subject is based on the definition set up by the World Commission on Environment and Development (WCED) or what was known as Brundtland Commission. In the well-known issue "Our Common Future" in 1987, sustainable development is defined as: *"Development that meets needs of the present or current generation, without compromising the ability of future generations to meet their needs and aspirations"* (*WCED*, 1987, P. 8).

This definition of sustainable development, now commonly cited as a definition of sustainability as a whole, presupposes the necessity of development rather than focusing on strategies for the maintenance of current conditions, and consequently concentrates on areas in which development is most important. Subsequent environmental summits (Rio 1992, Johannesburg 2002) have furthered this international agenda of environmental protection through sustainable resource management.

The word "development" in this definition implicates two important aspects of the concept: It is omni disciplinary, it cannot be limited to a number of disciplines or areas, but it is applicable to the whole world, everyone, and everything on it, now and in the future. Secondly, there is no set aim, but the continuation of development is the aim of the development. The definition is based on two concepts:

- *Needs:* comprising of the conditions for maintaining an acceptable life standard for all people.

- *Limits:* of the capacity of the environment to fulfil the needs of the present and the future, determined by the state of technology and social organization.

The needs consist firstly of basic needs such as food, clothing, housing and employment. Secondly, every individual, in every part of the world should have the opportunity to try and to raise his or her life standard above this absolute minimum. The limits consist of natural limitations like finite resources, but also of declining productivity caused by overexploitation of resources, declining quality of water and shrinking of biodiversity (www.arch.hku.hk/research/BEER/sustain.htm - Last accessed 21-10-2004).

Although the Brundtland Commission (WCED) definition has become widely publicized, the term sustainability is not limited to one precise definition. This definition has been repeated verbatim, or modified to suit specific institutional or individual needs.

There has been much criticism of the Brundtland Commission definition and the sustainable development agenda as a whole. The extreme criticism is that sustainable development, when defined vaguely in order to meet the needs of all stakeholders, is a smokescreen behind which business can continue its operations essentially unhindered by environmental concerns, while paying lip service to the needs of future generations.

As Michael Jacobs (1999, P. 24) notes, *"the vagueness of the definition allows business and "development" interests (and their government supporters) to claim that they are in favour of sustainable development when actually they are the perpetrators of un-sustainability*'". Joshi (2002, P. 7.) makes a similar observation, arguing that the focus on development in areas of poverty tends to evade the uncomfortable issue of the need to restrain consumption on the part of the affluent

There is much loose thinking on the subject of sustainability. Politicians are inclined to favour the Brundtland Commission definition. This is dubious objective since the present generation inherited a planet already on global warming track. Even so, we are still far from meeting the Brundtland Commission objectives (Edwards, 1998, p.126).

Writing for the January 2000 edition of The Architectural Review, Slessor (2000, P.17) sensibly observed that the Brundtland Report "*serves as a starting point, but it hardly sufficient as an analytical guide policy directive*". Slessor also articulates the hopes of many practitioners when she argues that 'sustainability should not be seen simply as a corrective force, but as anew mandate for architecture'. The starting point of agreement, as Ian and James Heartfield (2001, P.6) asserts, is that no one wants to endanger life on earth, or to develop in unsustainable way.

Sustainability is not a nostalgic trend that leads us back to the old techniques and traditional life style. Sustainability has to follow the physical and technological aspects, transforming the way we use our land, water, mineral and energy resources through a better understanding of environmental systems and using new technologies (www.dest.gov.au/priorities - Last accessed 21-10-2004). Aware that Brundtland Commission definition and its subheadings (and those of the other priorities) gave greater prominence to science and technology than the social sciences and humanities.

Many social science and humanities scholars have viewed the sustainability priority as the one that could be most applicable to their own work, if it could be re-evaluated in order to include social and cultural as well as environmental elements. For example, the National Academy of the Humanities, in their response to the priorities, noted, *"What constitutes environmental sustainability is ultimately a social and political question as much as a scientific one. In fact, moving towards an environmentally sustainable world will depend not only on our knowledge of ecosystems and resources but even more on our ability to initiate, advocate and absorb radical shifts in desired lifestyles, values and technology … We believe that the existing priority goals need to be re-drafted to acknowledge the fundamental human origins of environmental problems".* (National Academy of the Humanities, P.13).

William Ruckelshaus (C.A.P., 2005) relates between economical developments and environment conservation: "*Sustainability is the emerging doctrine that economic growth and development must take place, and be maintained over time, within the limits set by ecology in the broadest sense. This is achieved by the interrelations of human beings and their works, the biosphere and the physical and chemical laws that govern it ... It follows that environmental protection and economic development are complementary rather than antagonistic processes*."

At a global level, sustainable development may mean, among other things, the prudent use of fossil fuels that is, with present use, not sustainable. At the household level, it must imply the ability to afford a reasonable standard of living and to do this without adversely affecting the future (Best Practice Energy Efficiency, 1996, P.4). Communities in the third millennium will have to live in equilibrium with their surroundings. Nevertheless, this need not mean abandoning our traditional homes and communities in favour of the futuristic, high-tech living of popular science fiction (Building a Sustainable Future, P.5).

Sustainable development, as a conceptual context, involves finding ways to combine social, economic and environmental goals. It will involve action from all sectors of society, from government to business, communities and individuals (Best Practice Energy Efficiency,2005, P.6). Several issues related to human being life are implemented within sustainability - Figure 1.1.

To demonstrate the multi aspects of sustainability, new terms and expressions emerged in an attempt to embrace the multi-dimensional context of sustainability. One of these expressions is “triple bottom line” that was developed by environmentalist and economist John Elkington in 1997 and has fast become an international commonplace to describe a mode of corporate reporting that encompasses environmental and social as well as economic concerns. The term is now also used widely in discussions of sustainability. Elkington’s expression crystallised the increasingly widespread view that it is not possible to achieve a desired level of ecological or social or economic sustainability (separately), without achieving at least a basic level of all three forms of sustainability, simultaneously’ (Elkington, 1999, P. 75).

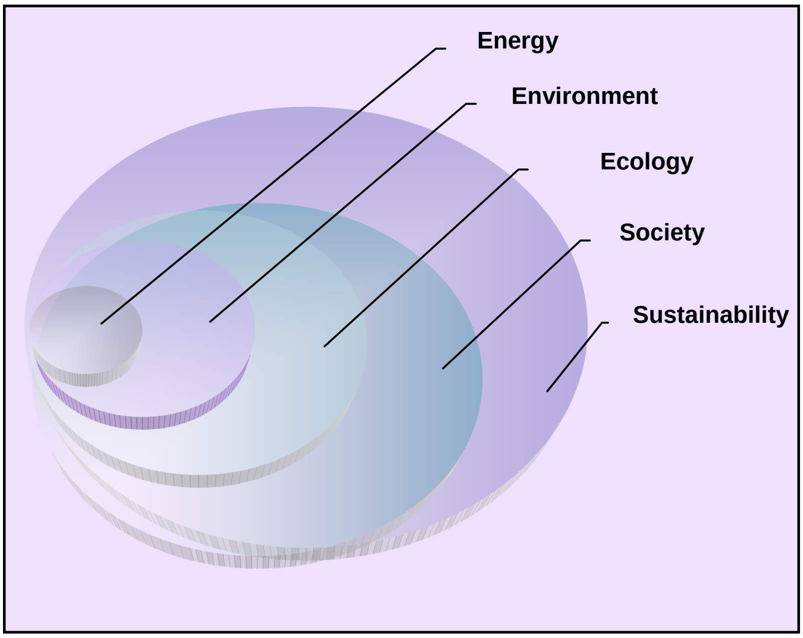


Figure 1.1. - Concept diagram of sustainable development

(Source: the author based on Edwards & Turrent, 2000)

Various writers have suggested that sustainability is inherently a contested concept, and that the way in which arguments over definition and the relative importance of various elements of sustainability are played out in academic discourse is a reflection of the overall contestation of these issues within society. If we think deeply in sustainability definitions, we find that they all have something in common; they refer to the improvements of the way we live and build, with more respect to environment through efficient use of natural and renewable resources without damaging the nature or affecting the environment.

However, the argument is not about *sustainability* definitions, the trend that it takes, or the effectual words used. It is, as Phillip Sutton (2000) states, "*sustainability is not "about" the integration of ecological, social and economic issues, nor is it "about" widespread consultation nor is it "about" improving quality of life. It is about maintaining or sustaining something. To understand the concept … you need to identify the focus of … concer*n". The idea of sustainability is to ensure that our actions and decisions today do not inhibit the opportunities of future generations. This means making sure that our efforts work with our Earth's ecological systems rather than in opposition to them.

1.1.3. Sustainability Dimensions

Sustainability is a broader term and encompasses economic, social and environmental concerns of development. Sustainability does not require a loss in the quality of life, but does require a change in mind-set, a change in values toward less consumptive lifestyles. These changes must embrace global interdependence, environmental stewardship, social responsibility, and economic viability (www.fac.unc.edu/eag/Definitions.htm - Last accessed 21-10-2004).

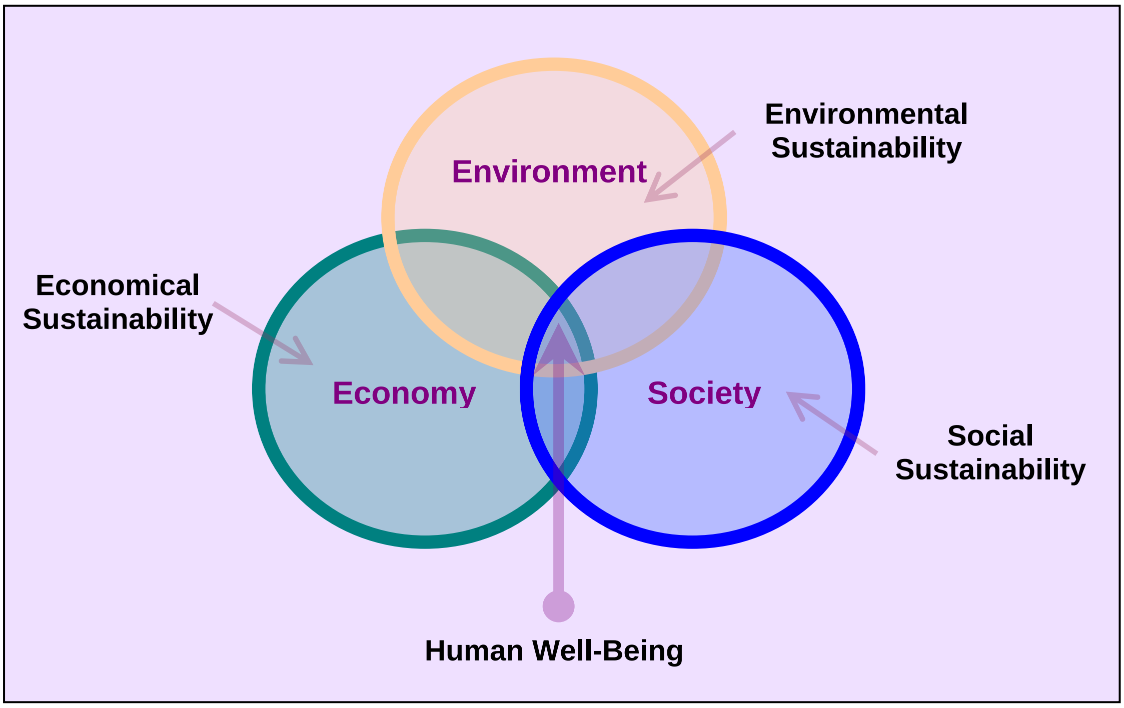


Figure 1.2-Intergration of sustainability dimensions for human wellbeing
(Source: the author)

Environmental sustainability, together with economic growth and social cohesion form the components of sustainable development that targets human wellbeing – Figure 1.2. In discussing sustainability, both social and environmental, it is important to understand that both of them require a system of economic activity with which it is compatible. A system that is not destructive of either the ecological web of life or the social web of life of which we are a part, and upon which we depend for our health, well-being and quality of life. Thus, any discussion of socially sustainable communities must include a discussion of the physical design of the community and the economic system of the community (Hancock, 1993).

1.1.3.1. Environmental Dimensions

Environmental sustainability is a long-term maintenance of ecosystem components and functions for future generations (www.entrix.com/resources/glossary.aspx – Last accessed 19-04-2007). Environmental sustainability is the ability to maintain the qualities that are valued in the physical environment. its goal is to sustain: human life, the capabilities that the natural environment has to maintain the living conditions for people and other species, reliance on renewable resources, functioning of society, and accepted quality of life for all people conserving liveability and beauty of the environment (www.ces.vic.gov.au – Last accessed 20-04-2007).

Environmental sustainability programs include actions to reduce the use of physical resources, the adoption of a recycling approach, the use of renewable rather than depletable resources, the redesign of production processes and products to eliminate the production of toxic materials, and the protection and restoration of natural habitats and environments valued for their liveability or beauty (www.ces.vic.gov.au – Last accessed 20-04-2007). Environmental sustainability is related to the environment. It deals with the natural and the built environment. A sustainable approach towards the environment considers both natural and built environment important parts of the context that we live in.

However, Environmental sustainability dimensions can be framed in these areas: resource efficiency, energy efficiency, site conservation, environment conservation, indoor air quality, water treatment, and waste management. Achieving environmental sustainability requires carefully balancing human development activities while maintaining a stable environment that predictably and regularly provides resources (Melnick; McNeely; Navarro; Schmidt-Traub, & Sears, 2005, P.1). Achieving environmental sustainability requires dramatic changes in the ways societies and citizens manage biodiversity and the processes of production and consumption. Direct investments in environmental management and structural changes are required at local, national, regional, and global levels to address the underlying causes of environmental problems (Ibid, 2005, P.13).

1.1.3.2. Social Dimensions

For a community to function and be sustainable, the basic needs of its residents must be met. A socially sustainable community must have the ability to maintain and build on its own resources and have the resiliency to prevent and/or address problems in the future.

There are two types or levels of resources in the community that are available to build social sustainability (and, indeed, economic and environmental sustainability) - individual or human capacity, and social or community capacity. A community is composed of people as well as the places where they live; it is as much a social environment as a physical environment. Thus, communities must not only be environmentally sustainable, they must also be socially sustainable (Hancock, 1993).

Individual or human capacity refers to the attributes and resources that individuals can contribute to their own well-being and to the well-being of the community as a whole. Such resources include education, skills, health, values and leadership. Social or community capacity is defined as the relationships, and networks and norms that facilitate collective action taken to improve upon quality of life and to ensure that such improvements are sustainable. To be effective and sustainable, both these individual and community resources need to be developed and used within the convex (Vancouver City Council, 2005, P.3).

Social sustainability encompasses three components: basic needs such as housing and sufficient income that must be met before capacity can develop; individual or human capacity or opportunity for learning and self-development; and social or community capacity for the development of community organizations, networks that foster interaction. The above components are underpinned by four guiding principles: equity, social inclusion and interaction, security, and adaptability (Vancouver City Council, 2005, P.4).

Trevor Hancock (1993), in his argument about social sustainability development, suggests social sustainability dimensions as follows:

- meets basic needs for food, shelter, education, work, income and safe living and working conditions;
- is equitable, ensuring that the benefits of development are distributed fairly across society;
- enhances, or at least does not impair, the physical, mental and social well-being of the population;
- promotes education, creativity and the development of human potential for the whole population;
- preserves society cultural and biological heritage, thus strengthening its sense of connectedness to its history and environment;

- promotes conviviality, with people living together harmoniously and in mutual support of each other;
- is democratic, promoting citizen participation and involvement, and
- is liveable, linking "the form of the city's public places and city dwellers' social, emotional and physical well-being"

Living in appropriate environment is an essential issue of social sustainability. The United Nation's Istanbul Declaration (1996) expresses the great human agenda for the present age as "economic development, social development & environmental protection". The Declaration sets out the expectation that it is needed to provide shelter for all in sustainable human settlements in an urbanizing world. Providing shelter refers that, each human being has the right in housing affordability - where housing costs leave a household with enough income to meet other basic needs such as food, clothing, transport, medical care and education (Fox, 2000, P.27).

Sustainability social dimensions are mostly related to human being "Quality of Life" that preserves the society "Cultural Identity" providing "Satiability" for inhabitants' physical and psychological needs. Social sustainable community encourages "Empowerment" of society members' capabilities within a community that enjoys "Safety" and "Equity" for all people.

1.1.3.1. Economical Dimensions

Within sustainability approaches, the economy should be oriented towards environment conservation and social prosperity. Elkington (1999, P. 75) relates between economy and environment as a new approach for economy: "*the sustainability agenda, long understood as an attempt to harmonise the traditional financial bottom line with emerging thinking about the environmental bottom line, is turning out to be much more complicated than some early business enthusiasts imagined*'.

To build a sustainable future, the mechanisms of our economies should be changed. It would be impossible, of course, to simply step on the brakes of current economy. Consumption and production patterns came to prominence in the international debate on sustainable development at the 1992 UN Conference on Environment and Development (UNCED). Since then, change in these patterns is evaluated regularly by UN-ESA (www.cap-lmu.de/index.php - Last accessed 22-04-2007)

The world trend towards sustainable economy is associated with the rational use of resources or as called sustainable consumption. The Oslo Symposium in 1994 proposed a working definition of sustainable consumption as "…*the use of goods and services that* *respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardise the needs of future generations*" (www.iisd.ca/consume/oslo004.html- Last accessed 22-04-2007).

Economical sustainability is more related to growth, development, productivity, and decreasing resources input (materials & energy). Industrialization and population explosions are challenges to social and economic sustainability. Economics must change to quantify intangibles and common property resources (air, waters, oceans, etc.). Environmental and social costs must be internalized through new policies and valuation techniques (www.dbc.uci.edu/~sustain/state/chapter1.htm - Last accessed 30-03-2007).

1.1.4. Sustainability and Built Environment

With the beginning of the third millennium, statistics of the Gaia Atlas of cities, predicted that 22 cities, all over the world, will have a population of over 10 million, with three of these cities over 20 million, where 70-80% of world's population live in concentrated urban centres (Battle & McCarthy, 2001, P.88).

Human settlements in urban centres perform the major sources of resource consumption and waste production in the world. The Habitat II Conference in Istanbul in 1996, organised by the United Nations Centre for Human settlements, made a great deal of the fact that cities, more often than not, are considered places where problems are concentrated (Fox, 2000, P.26). The drift to cities by the human population puts pressure on housing land, water and energy supplies, and sewage and waste capacity. The year 2000 marked the first time in human history that the urban population exceeded the rural one. Of a global population of 6.2 billion, a greater number of people now live in cities than the countryside (Edwards, 2005, P.8).

To assess human settlements' effect on earth resources, a method was set up for measuring and analysing resource consumption and waste output compared to the renewable capacity of nature; it is called the "Ecological Footprint". It represents the amount of productive land area needed to produce the resources (food, energy and materials) and to absorb the wastes produced by an individual, population, or activity, given prevailing technology and resource management. This area is expressed in global hectares; a global hectare is a hectare with world-average ability to produce resources and absorb wastes (Living Planet Report, 2006, P.38).

A country's Ecological Footprint is determined by its population, the amount consumed by its average resident, and the resource intensity used in providing the goods and services consumed. It includes the area required to meet people's consumption from cropland (food, animal feed, fibre, and oil); grassland and pasture (grazing of animals for meat, hides, wool, and milk); fishing grounds (fish and seafood); and forest (wood, wood fibre, pulp, and fuel wood). It also estimates the area required to absorb the CO_2 released when fossil fuels are burned (Living Planet Report, 2006, P.16). Since 1980, the average per capita ecological footprint has decreased as many processes (especially crop production) have become more efficient. If the ecological footprint exceeds the available productive land, the resource use is considered unsustainable. Globally, the available ecologically productive land area included in the Ecological Footprint analysis is 1.89 hectares for each person – Chart 1.1 (WWF, 2006).

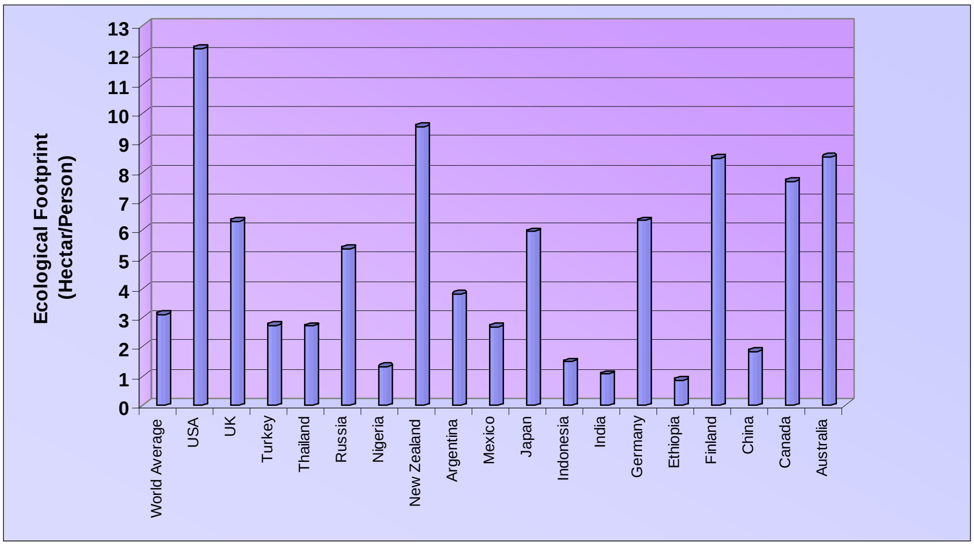


Chart 1.1 - Ecological Footprint for some countries

(Source: the author based on Living Planet Report, 2006)

The footprint takes into account fossil fuel use, cropland, forests, nuclear and hydroelectric power, fisheries and buildings. Countries with a high per capita GDP have a high global footprint as they also have a high level of fossil fuel consumption. Some European countries including Denmark, Netherlands, Austria, the United Kingdom, and Finland have taken steps to reduce their per capita global footprint (WWF, 2006).

The key benefits of the ecological footprint are that: it provides an aggregated indicator of environmental impact; it is easily communicated and readily-understood; and it allows for sustainability benchmarking (Roaf, Fuentes, & Thomas, 2003, P.282). Since the late 1980s, we have been in overshoot; the Ecological Footprint has exceeded the Earth's bio-capacity – as of 2003 by about 25 % - Chart 1.2. Effectively, the Earth's regenerative capacity can no longer keep up with demand; people are turning resources into waste faster than nature can turn waste back into resources (Living Planet Report, 2006, P.2).

Agenda 21 calls for sustainable management of human settlements, referring to the need for adequate environmental infrastructure and changes in the construction industry. This section discussed environmental issues of the built environment and the present structure of the construction industry. It noted the destructive capacity of built environment, which it identifies as: “a major source of environmental damage through the degradation of fragile ecological zones, damages to natural resources, chemical pollution, and the use of building materials, which are harmful to human health” (Steele, 1997, P.13).

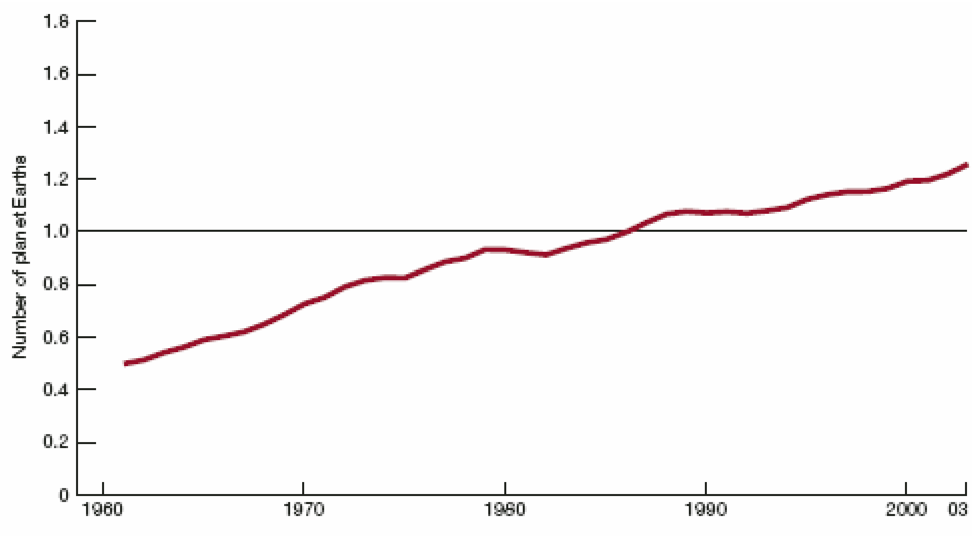


Chart 1.2 – Humanity’s Ecological Footprint, 1961–2003

(Source: Living Planet Report, 2006)

The world’s ecosystems are already under great stress, and society needs to adapt a strategy that brings improvement to living conditions without global disaster. Quality of life can be maintained, but only through the adoption of the four R’s- reduce, reuse, recycle, and recover. Environmentalists have long advocated the three R’s, but the fourth, recover, was added more recently because so much of the human habitat needs to be repaired and recovered from contamination (Edwards, 2005, P.134). Sustainable development seeks towards diminishing Ecological Footprint of the built environment whether for cities at the urban scale or buildings on the architecture scale.

1.1.5.1. Sustainability and Architecture

The Earth Pledge asserts the crucial role architecture plays to achieve sustainability and conserve environment and resources; “*Architecture presents a unique challenge in the field of sustainability. Construction projects typically consume large amounts of materials, produce tons of waste, and often involve weighing the preservation of buildings that have historical* *significance against the desire for the development of newer, more modern designs.*" (www.earthpledge.org – Last accessed 23 -11-2003). The Rocky Mountain Institute defines sustainability in architecture as a conceptual content not just an architectural style or building appearance, "*Sustainable design is more of a philosophy of building than a prescriptive building style. Sustainable buildings do not have any particular look or style*" (www.arch.hku.hk/research/BEER/sustain.htm - Last accessed 21-10-2004).

Using "*Sustainable Architecture*" in the modern literature does not mean that building sustainably was not known before. Traditional architecture is a manifestation of sustainability. The essence of sustainability was evident in predecessors' buildings because they built in harmony with nature, cultural background, and social values of the society. Traditional buildings, as Brian Edwards (2005, P.162) identifies, represents a resource for sustainable design principles because they are made of locally available materials, employ local, mainly renewable, sources for energy, and adopt construction practices that favour recycling and respect for nature. It is essential to learn from traditional architecture because it is naturally sustainable. In this aspect Gissen (2003, P.6) asserts:" *We might look to buildings in the past for ideas about how to build in the future. Indeed, before the advent of air-conditioning and other technologies, we now take for granted, architects and builders had to no choice but to build sustainably*".

Sustainability is by nature "architecture". To achieve it, the design issues should be associated with ambient environment resources. More fully, the underlying influence(s) of political, economic and social issues must be address comprising the cultural and spiritual background in which the desire to achieve sustainability in itself reflects such a significant value shift (Koester, 1995, P.34).

The building and construction sector is vital to the economy, as it is diversified and covers several fields that are interrelated with the various sectors of economy. This sector represents about 10% of the gross world product, provides 7% of the work opportunities, (CAMRE, 2005, P.3).

Some commentators estimate that one-tenth of the global economy is devoted to construction, operating and equipping housing projects and office buildings (Thomas, 2002, P.166.). Such demand devours about 3 billion tons of raw materials each year. Buildings & construction sector consume about 40% of the energy and 50% of material recourses taken from nature are building related which means that 40 % of the materials flow entering world economy is consumed in building (Roodman & Lenssen, 1995, P.5).

As mentioned, building sector consume a great deal of energy. About 50% of all energy used worldwide goes into buildings, with two-thirds of that used in housing sector (Paschich, & Zimmerman, 2001, P.15). In the United States, for instance, buildings account for about one-third of the energy consumed. Of this one-third, heating and cooling systems use 60 %, while lights and appliances use the other 40%. Manufacturing and transporting building materials require additional energy (www.buildsustainably.org – Last accessed 30-03-2007). In UK, building sector accounted for 45% of the total UK primary consumption; 64% of this energy is used in housing (Nicholls, 2002, PP. 1, 2).The energy consumed for housing sector increases in hot region countries, as in the Gulf region. In Saudi Arabia, energy consumed in housing is 70% of total energy, 66% of this energy is used for air-conditioning (Sawat, 2004, P.10). In the UAE, 32% of total energy is consumed in housing, 70% of this energy is used for air-conditioning (UAE, Yearbook, 2006, P.190).

The main issue is not just the amount of energy consumed in buildings; the most significant is the source of energy. Most of the buildings, especially houses, depend on fossil fuel, directly or indirectly, for building operation. Everyday the world consumes about 74 million barrels of crude oil. To date, we have used around half of the total estimated oil reserves globally and it is though that within a few years we will reach the peak of global oil production, after which time conventional oil production will decline (Roaf, Fuentes, & Thomas, 2003, P.2). The oil companies estimate that reserves will be exhausted within about 40 years (Smith, 2002, P. 73).

Environment conservation and renewable energy resources are crucial goals of sustainable architecture. The environmental damage caused by CO_2 released during energy use, combined with the more basic issue of cost has made energy conservation, as Richard Nicholls (2002, P.2) asserts, the central theme of sustainable architecture. However, sustainable architecture goes far beyond energy conservation, which drew attention in late 1960s and 1970s following a worldwide oil shortage. Sustainability emphasizes the relationship of built environment to local geography, microclimates, and indigenous materials (Paschich, & Zimmerman, 2001, P.10).

Construction is no longer a mere establishment of a group of buildings and a division of land into streets, factories and buildings. Building sustainably must be an integrated, coherent and harmonious package in all its economic, social, cultural and urban aspects. At the same time, it means preserving the general framework that suits the environment, its boundaries and its capacity to absorb the building and construction processes. In other words, sustainable built environment is a balance between achieving the objectives of a better life for people without wasting the rights of the coming generations (CAMRE, 2005, P.29).

1.1.4.2. Evolution of Sustainability Concept in Modern Architecture

The roots of sustainability and environment movement in modern architecture can be traced back to the 19th century. John Ruskin, William Morris, and Richard Lethaby all in their different ways questioned the assumption that industrialisation would satisfy humankind's physical and spiritual needs (Edwards & de Plessis, 2001, P.9).

The industrial revolution provided modern materials such as steel and glass that helped to erect new types of buildings and paved the way for new construction systems and wide spans roofing. During the 20th century, architecture witnessed drastic changes in materials, construction systems along with economical and social development that new technologies afford. Modern high-rise buildings with big glass facades provided comfortable indoor environment, regardless the climate, with the virtue of artificial air-conditioning and cheap fossil fuel affordability. This trend became the international style all over the world, neglecting traditional ways of building and passive cooling and heating systems that utilised natural resources.

During the first half of the 20th century, some architects, as Hassan Fathy in Egypt and Frank Lloyd Wright in USA, called for building in harmony with nature utilising natural resources and corresponding to ambient environment. Fathy and Wright took a different approach: both sought use local materials and crafts in an endeavour to produce a modern architecture out of regional building traditions. In the process, they introduced us to the idea that social sustainability and ecological design were closely related (Edwards & du Plessis, 2001, P.10).

Despite wide acceptance of the international style of building all over the world, a number of economical and ecological crises in the 1960s and 1970s led to re-examination of energy use in building and rediscovery of passive strategies. The coincided with a popular environmental movement reflected in best-selling books such as "*Silent Spring*" by Rachel Carson (1962) and public demonstrations such as the First Earth Day in 1970. Public concern about environmental issues only grew with the oil crisis in 1973 (Gissen, 2003, P.13).

Thinking of nature and concern about environment became an important issue all over the world. Environment, for architects and engineers was not be related to what they build only; it became more comprehensive to include energy conservation practices within our planet system. In the 1980s, Wells describes the architects' trend towards environmental issues in the 1960s and 1970s by saying: " *During the last two or three decades, when so much publicity was given to our doubtful future on this planet, nearly all architects and engineers came to think of themselves as environmentalists"* (Wells, 1982, P. 71.).

During 1970s and 1980s, several buildings were constructed with a new desire for energy efficiency, with luminous, well-ventilated, prefabricated large-scale buildings. Most of these buildings were in Europe where energy prices were high. One of the most environmentally progressive British projects was the Willis Faber and Dumas headquarters by Foster and Partners in 1977, which has been cited as a pivotal building in recent development of sustainable architecture (Gissen, 2000, P.14).

This attitude was widely spread all over the world. Architects were keen to design buildings environmentally sensitive utilising passive energy resources and energy efficient systems and materials. Issues as occupants' health, indoor air quality, toxic effect of materials and renewable energy resources became vital in architecture practice. Since the 1990s, the issues of sustainability became a worldwide interest; architecture trends approached more towards sustainability as a conceptual content environmentally, socially, and economically.

At the beginning of the 21st century, architects are expected to be ever more creative, while being mindful of impact of their buildings designs on the ecological systems of the planet (Heartfield, 2001, P.6). Community architecture often ignored the power of design and technology to solve human problems. However, sustainability brings the two camps together: it not only reinvigorates architecture, it gives fresh moral validity to the creation of human settlements providing a new ethical basis for the architectural profession (Edwards, 2005, P.10).

Sustainability became the moral imperative of the age for architects, insists Paul Hyett, president of the Royal Institute of British Architects (RIBA). It is at the level of personal behaviour that Paul Hyett wants to apply sustainability asking; if sustainable design is not a Moral Imperative, What is? Hyett agrees that sustainability is a mandate for architecture, adopting that approach that Phill Macnaghten recommends to relate sustainable development to everyday life. It is through mundane demand management that architects are encouraged to foster a sense of environmental responsibility, to overcome the remoteness of global issues to local reality (Heartfield, 2001, PP.6, 7).

Sustainability, as a broader term that encompasses economic, social and environmental concerns of development, entails new solutions and innovative ideas in dealing with natural resources are most wanted, with cooperation of different specialties; architects, engineers, town planners, researchers along with economists, politicians and decision makers, to focus on environment friend technologies especially in building and city planning.

1.1.4.3. Sustainable Architecture Definitions and Principles

The main goal of sustainable architecture is to create optimum relationships between people and their environments. It aims to find architectural solutions that guarantee the well-being and coexistence of human being, built environment and natural environment (Kim & Rigdon, 1998A, P.8). More specifically, sustainable buildings should have the absolute minimal impact on the local, regional, and global environments.

The definition of sustainable architecture has since become as varied as the architects, ecologists, developers, and environmentalists who practise it. These definitions tend mostly to environmental sustainability rather than other dimensions: social and economical.

Thomas Fisher, in 1993 edition in Progressive Architecture, described sustainable architecture more specifically as that which "*conserves energy, uses renewable or recyclable materials, reduces dependence on fossil fuels, and attempts to create more intimately scaled buildings and communities*". Bill Mollison elaborated United Nation's long-range criteria , saying "*the aim of sustainable architecture is to create systems that are ecologically–sound and economically viable , which provide for their needs, do not exploit or pollute and are therefore sustainable in the long term*" (Paschich & Zimmerman, 2001, P.12).

Sustainable Architecture is an approach to architectural design that emphasizes the place of buildings within both local ecosystems and the global environment. Sustainable architecture seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development space (www.answers.com/topic/sustainable-architecture - Last accessed 30-03-2007).

Sustainable architecture, from environment dimension, is defined as "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles". Thus, sustainably designed buildings aim to lessen their impact on our environment through energy and resource efficiency. It includes the following principles: minimizing non-renewable resource consumption, enhancing the natural environment, and eliminating or minimizing the use of toxins.

According to an OECD project, "Sustainable buildings" can be defined as:" *those buildings that have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting.* Other definitions look to sustainable architecture within sustainability dimensions. Sustainable architecture may be defined as "*building practices, which strive for integral quality (including economic, social and environmental performance) in a very broad way.*

Thus, the rational use of natural resources and appropriate management of the building stock will contribute to saving scarce resources, reducing energy consumption (energy conservation), and improving environmental quality". Sustainable building involves considering the entire life cycle of buildings, taking environmental quality, functional quality, energy efficiency, and future values into account. The OECD project has identified five objectives for sustainable buildings (www.arch.hku.hk/research/BEER/sustain.htm - Last accessed 30-03-2007):

- Resource Efficiency
- Energy Efficiency (including Greenhouse Gas Emissions Reduction)
- Pollution Prevention (including Indoor Air Quality and Noise Abatement)
- Harmonization with Environment (including Environmental Assessment)
- Integrated and Systemic Approaches (including Environmental Management System)

During a building's existence, it affects the local and global environments via a series of interconnected human activities and natural processes. To obtain the concept of sustainability design along building lifetime, Kim and Rigdon (1998A, P.9) proposed three principles of sustainable architecture:

- Economy of Resources: is concerned with the reduction, reuse, and recycling of the natural resources that are input to a building.
- Life Cycle Design: provides a methodology for analyzing the building process and its impact on the environment.
- Human Design: focuses on the interactions between humans and the natural world.

These principles can provide a broad awareness of the environmental impact, both local and global, of architectural consumption.

Social aspect is an important factor that has been left of the sustainable architecture too often in the past, especially in housing agenda. Edwards & Turrent (2000, P.20) recognized social sustainability importance in housing by saying "*Sustainability should encompass not just the fabric of the buildings-although that is important- but also the "people factor". Housing is sustainable if everyone has the opportunity of access to a home that is decent if it promotes social cohesion, well being and self-dependence*". In this aspect, they emphasize the social dimension of sustainable architecture along with environmental dimension and resources conservation. Sustainability as a process must address five distinct areas:

- The conservation of natural resources (land, energy, water).
- The sensible reuse on manufactured resources
- Maintenance of ecosystems and their regenerative potential
- Equity between generations, people and classes
- Provision of health, safety, and security.

Designing within sustainability holistic dimensions, as Edwards (2005, P.3) identifies, is a complex concept for architects. A large part of designing sustainably is to do with addressing global warming through energy conservation and using techniques such as life-cycle assessment to maintain a balance between capital cost and long-term asset value. However, sustainable architecture is about creating spaces that are healthy, economically viable and sensitive to social needs. It is concerned with respecting natural systems and learning from ecological processes. Nevertheless, this is the challenge of architecture as an effective major to demonstrate sustainability goals and preserve Earth resources.

Given that all human actions alter the systems we live in, the challenge of sustainability is a complex issue. It includes looking at how we attain the resources we use, using them in a way to get the most from them, and eliminating the idea of “waste” from our vocabulary. There is no way to know with certainty how complex ecological systems will react to our influence, but there is an undeniable responsibility to act with the best of our knowledge (www.buildsustainably.org – Last accessed 30-03-2007).

Conceptually, sustainability is not all about energy conservation, renewable resources, or building materials. Sustainability is a life style, a way of living and society cultural identity. Sustainable development is not about government policies and regional strategies; it is to be oriented towards people wellbeing whom supposed to be part of the process not just a target for these policies. Human being everyday activities are the essence of sustainability, the way they live, act, build, work, produce, plant, and travel. Sustainability is not a term to be understood; it is a life to be practised.

1.2. Sustainability & Environment in the Arab World

The Arab countries as a group are popularly referred to as the “Arab World”. The term “Arab World” is a political designation rather than an economic grouping; consists of twenty-two countries stretching from Mauritania in the west to Oman in the east with a total population estimated as 323 million (Wikipedia encyclopaedia, 2006). As a political grouping, the term finds its expression in the League of Arab States (LAS) that was established in 1945. A lot of economic diversity characterizes the Arab World. Arab countries are grouped into four broad categories: mixed oil producers (MOP) including Algeria, Libya and Iraq; Gulf Cooperation Council (GCC) including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and UAE; diversified economies (DE) including Egypt, Jordan, Morocco, Lebanon, Syria, and Tunisia; and, primary producers (PP) including Comoros, Mauritania, Sudan, Djibouti and Yemen (Ali, 2001, PP.2, 3).

Besides its strategic location, the Arab World is effective as a main source of energy; the Arab countries hold 61% of the world oil reserves, and 26 % of the world gas reserves. They produce nearly 30 % of the oil production, and 11 % of the world gas production. The energy sector has been playing a crucial role in the socioeconomic development of the Arab countries. It is characterized by a huge oil and gas sector and a large electric power sector dominated by thermal power generation. The oil and gas sector represents the largest economic component in most of the Arab countries especially in the Gulf region. Together, the GCC countries account for about 45% of the world's proven oil reserves and 25 % of crude oil exports (Saudi Arabia is the largest world oil exporter), and possess at least 17 % of the proven global natural gas reserves (LAS & ESCWA, 2005, P.3). This strategic commodity plays a significant role in economic growth and development policies towards environmental and sustainability issues in the Arab world.

1.2.1. Environment and Sustainability Dilemma in the Arab World

Environmental and sustainability issues face many predicaments in the Arab World. Different studies agree that Arab countries are in significant environmental trouble compared to the rest of the world. According to Esty, Levy, & Winston (2003, P. 237), Arab countries are, on average, 11 points less than other countries on Prescott-Allen's "Environmental Wellbeing Index" (which ranges from 20 to 72) and 178 points lower than other countries on the Consultative Group on Sustainable Development Indicators (CGSDI) (which ranges from 87 to 763).

The Arab Region Roundtable on Harnessing Science, Technology and Innovation for Sustainability that was held in Dubai 2005 identified some of the high priority issues for sustainable development in the Arab World are:

- gender equity;
- education and capacity building in science and technology;
- environmental issues - fresh water, desertification, dry land biodiversity and coastal zones;
- Alternative and renewable sources of energy (www.sustainabilityscience.org - Last accessed 11-02-2007)

Generally, environment and sustainability dilemma in the Arab World can be identified in several issues such as shortage of fresh water and desertification, expanded urbanisation, air pollution, and high consumption pressure and energy consumption. All these issues are reflected clearly in the low sustainability indicators for the Arab countries.

1.2.1.1. Shortage of Fresh Water and Desertification

Shortage of water resources in the Arab World is a strategic and security issue as well as a developmental issue. The Arab world has 5% of the world population but only 1% of the available global water resources and only 70% of the population now has safe drinking water. More importantly, most of these water resources are not controlled by the Arab countries. Adaptation to shortage of water is pushing Arab countries to abandon agriculture, as the economic value of water in agriculture is less than its value in industry or for domestic use. Thus, the Arab world is considered the most dependent on food imports (Krayem, Nehme, & Abdul Hadi, 2000). Geographically, most of the Arab World lies within arid zones. According to WWF Biome Classification, 57% of the countries that have more than 50% desert are Arab countries, thus desertification is becoming one of the serious environmental problems facing these countries (Environmental Sustainability Index, 2005, P.9) – Table 1.1.

Table 1.1 – Countries that are more than 50% desert
(Source: The author based on Environmental Sustainability Index, 2005)

Rank	Country	ESI	Rank	Country	ESI	Rank	Country	ESI
1	Namibia	56.7	**8**	Niger	45	**15**	Iran	39.8
2	Israel	50.9	**9**	Morocco∗	44.8	**16**	Saudi Arabia∗	37.8
3	Kazakhstan	48.6	**10**	UAE∗	44.6	**17**	Yemen∗	37.3
4	Oman∗	47.9	**11**	Egypt∗	44	**18**	Kuwait∗	36.6
5	Jordan∗	47.8	**12**	Mauritania∗	42.6	**19**	Uzbekistan	34.4
6	Algeria∗	46	**13**	Libya∗	42.3	**20**	Iraq∗	33.6
7	Azerbaijan	45.4	**14**	Pakistan	39.9	**21**	Turkmenistan	33.1

∗ Arab countries

1.2.1.2. Expanded Urbanisation

The Arab world today is marked by the extraordinary expansion of towns and by changes brought about by urbanisation. Of a population of 323 million, about half consists of town dwellers. While these changes indicate a sustained increase in the urban population of the Arab world, they give rise to a process of urbanisation that is far from uniform. In fact, in all the Arab countries, urban population is growing at a higher rate than the national population. This rapid urbanisation is asserted by the United Nations Population Division reports that indicate: on an average, urban areas in the Arab World are growing a percentage point faster than in the rest of the world, especially in the Gulf region (LAS & ESCWA, 2005, P.4). Oil producing countries as Saudi Arabia and Libya have undergone spectacular urban transformations in just a few years, owing to petroleum revenues. The rates of urbanisation in Kuwait, Qatar and the United Arab Emirates are among the highest in the world. Since late 1980s, towns accounted for 90% of the total population (www.unesdoc.unesco.org – Last accessed 12-08-2006).

Some of the poorest countries, such as Comoros, Mauritania, and Somalia, have rates of urbanization in excess of 4 percent per year, which puts tremendous strains on urban water supplies and sanitation. Cairo, the largest Arab city with a population of 10.6 million, has significant air quality and sanitation problems. Casablanca, a city of 3.3 million, properly disposes of only 10% of household waste through sanitary landfills and incineration (Esty, Levy, & Winston, 2003, P.242). Dubai, a city of 1.4 million population, has one of the highest annual per capita domestic waste generation that reached 941 kg compared to 779 kg in the year 1999 and 753 kg in 1998 with 10% annual growth (www.dm.gov.ae – Last accessed 6-02-2007). Generally, UAE has one of the world's highest levels of domestic waste that reached 750 kg/ capita. yr, compared to USA (740 kg/ capita. yr), UK (620 kg/ capita. yr), Canada (380 kg/ capita. yr) Germany (590 kg/ capita. yr), France (510 kg/ capita. yr), Greece (430 kg/ capita. yr) Japan (410 kg/ capita. yr), Turkey (360 kg/ capita. yr) and New Zealand (400 kg/ capita. yr) (www.oecd.org – Last accessed 20-04-2007). These figures are indicators for the environment crisis and unsustainable strategies in the Arab World.

1.2.1.3. Air Pollution

Air pollution is an important issue in the Arab World, although it receives less attention than other issues such as water scarcity. Generally, Arab countries exhibit higher levels of emissions than other countries, particularly of oxides of nitrogen and volatile organic compounds (Esty, Levy, & Winston, 2003, P.239). Since the energy sector in the Arab World is characterized by heavy reliance on fossil fuels, the sector has adverse environmental impacts on air, water and land resources. Total CO_2 emissions from the energy use is estimated at around 900 million tons in 2001, with an average per capita share of 3.1 mt/year, compared to a world average, of 3.87 mt/capita (LAS & ESCWA, 2005, P.4).

The climate change indicators average in the Arab World exceeds world average- Chart 1.3. Kuwait, for instance, has slightly acceded per capita CO2 emission of the United States. The United Arab Emirates CO2 emission is almost approaches United Sates average. These figures are serious indicators if compared to the difference in area, resources, population, and industrial activities between UAE, Kuwait and USA. It is clear that GCC countries have the highest levels of CO2 emission in the Arab World. This is due to the high levels of income/ capita, accelerated rate of industrialization and energy use. If it were not for extremely low-emission countries such as Sudan and Somalia, the Arab countries average on green house gases (GHG) emission would be higher.

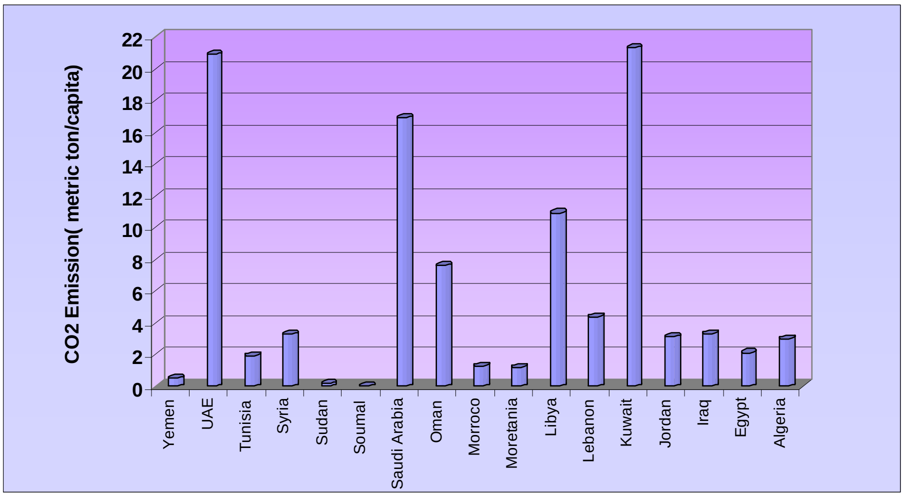


Chart 1.3 – CO_2 Emission average in the Arab countries

(Source: the author based on Environmental Sustainability Index, 2005)

Air pollution affects over 60 million urban inhabitants or about 40% of total urban populations (20% of the total population). Fighting pollution and desertification would cost an estimated USD 58–78 billion in the next decade and is considered essential to development (Krayem, Nehme, & Abdul Hadi, 2000).

1.2.1.4. High Consumption Pressure

One of the environmental problems in the Arab World is the high consumption pressure, especially in the Oil Producing Countries. Moreover, these countries have weak recycling and resource conservation programs, in part because energy has been so inexpensive for many of them (Esty, Levy, & Winston, 2003, P.242). According to World Wildlife Fund statistics, the Arab countries ecological footprint per capita average is 3.76 hectare/capita, which is close to the world average 3.1; yet few Arab Countries, especially the GCC countries, are markedly above this average - Chart 1.4.

Recent issued data shows that the United Arab Emirates has the highest ecological footprint in the world that reached 15.99 hectare/capita (WWF Living Planet Report, 2006). The country took the top spot because its energy consumption is high and emissions are spread among a small population. The country's landscape offers little help. Undulating sand dunes and jagged mountains of bare rock offer precious little greenery to soak up carbon emissions. The plants do double duty distilling fresh water from the Arabian Gulf seawater, an energy-intensive process that accounts for 98% of the fresh water in a country with no rivers and little usable groundwater. Desalination also produces most fresh water in the Gulf countries such as Saudi Arabia, Kuwait, and UAE that also showed high footprints (www.foxnews.com/wires/2007Jan16/0 - Last accessed 21-01-2007).

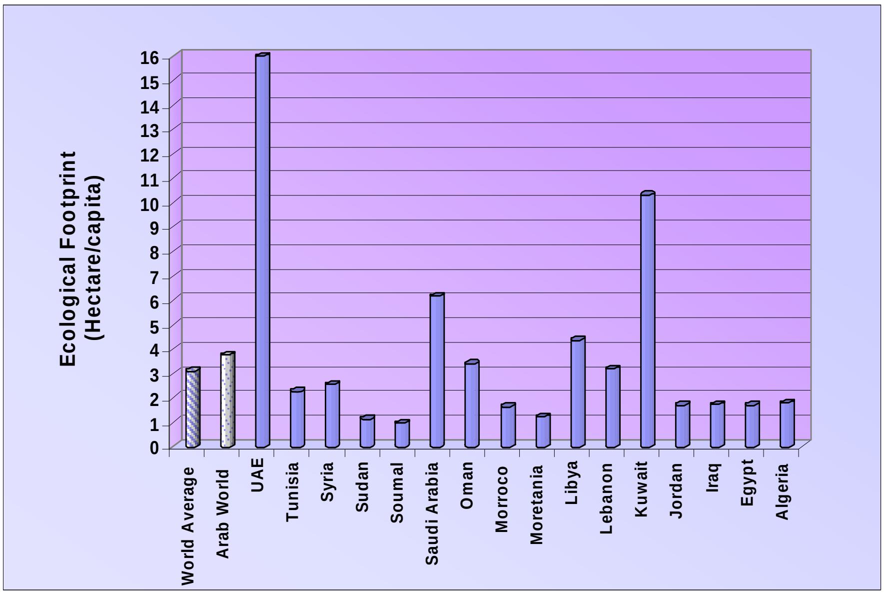


Chart 1.4 - Ecological Footprint for the Arab countries

(Source: the author based on WWF Living Planet Report, 2006)

Energy consumption in the Arab World is higher than the world average, especially in oil-production countries. Correlation between per capita energy consumption and human development indicators of the Arab countries indicates that per capita energy consumption increases in the countries ranked high in the human development scale (LAS & ESCWA, 2005, P.4). The increased energy consumption, practically fossil fuel, is of negative sequences on air pollution, CO_2 emission, and depletion of non-renewable energy resources, oil in particular. According to Environmental Sustainability Index figures - Chart 1.5, it is concluded that oil-producing countries, such as UAE, Iraq, and Saudi Arabia, recorded the highest energy consumption. This consumed energy is mostly fossil fuel, oil and gas.

1.2.1.5. Renewable Energy

The Arab World enjoys tremendous potential for renewable energy resources with 8967 MW of installed hydroelectric capacity and solar resources varying between 1460-3000 KWh/m2/year. Large Hydropower stations exist in Egypt and Iraq, while small hydropower exists in Tunisia, Syria, Algeria, Jordan, Sudan, Lebanon, Mauritania, and Morocco. Wind resources, whether grid connected wind power or stand-alone wind units, are available in several Arab countries mainly in Egypt, Jordan, Syria, Morocco and Mauritania. Solar Energy applications though have not been widely promoted in the region yet, some solar water heaters, and small scale photovoltaic applications are in use in some countries such as

Tunisia, Morocco, Syria, Egypt, and Jordan. Enormous biomass resources in the form of Biogas, agriculture residues, and wood fuel exist in Jordan, Syria, Sudan, Egypt, and Algeria (LAS & ESCWA, 2005, P.3).

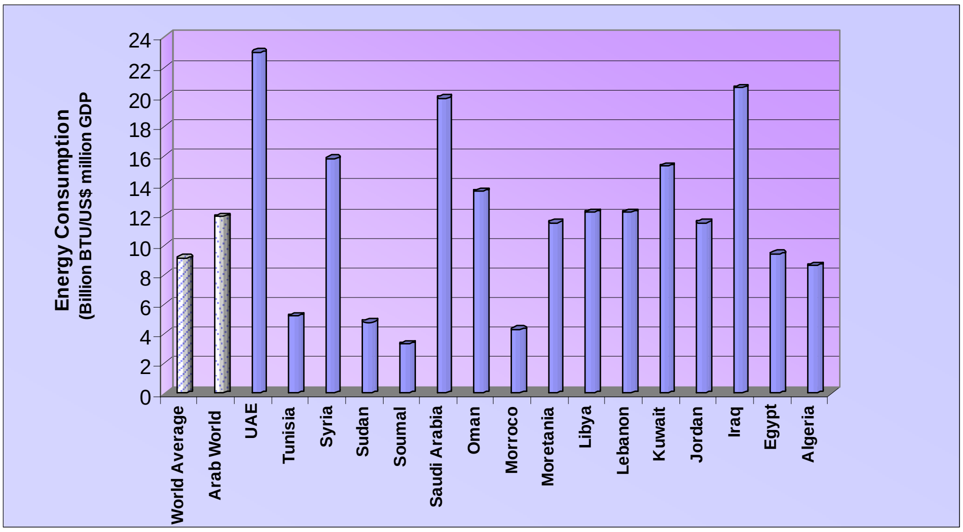


Chart 1.5 – Total energy consumption in the Arab countries

(Source: the author based on Environmental Sustainability Index, 2005)

However, utilising renewable energy resources remain so limited in the Arab World compared to World average, especially in oil-producing countries, while is notable that poor countries such as Sudan depend on renewable energy resources – Table 1.2. Other countries such as Egypt and Morocco got higher percentage in depending on renewable energy resources; this can be referred to limited fossil fuel resources and high population density especially in rural areas.

Prospects of developing renewable resources in Arab countries are very low in the short and medium terms. On the other hand, small oil producing countries or some oil importing countries have higher prospects of renewable energy development in rural and remote areas. Countries such as Egypt, Tunisia, Morocco, Syria have been developing ambitious plans and programs of renewable energy resources for many years. These disparities impose several challenges that should be addressed to achieve sustainable development (LAS & ESCWA, 2005, P.5).

Despite the increase of energy consumption in GCC region, the governments are fully aware that they cannot depend on oil for their income forever, especially in the prevailing situation of price fluctuations, the rapid population and consequently the increasing demand for electricity throughout the region. The GCC countries are currently stating a process of environmental awakening. The governments, the private sector and the public are realizing the inevitability of putting climate changes issues on the top of the list of priorities in the process of economic and social development. As a result, the use and development of RES (Renewable Energy Sources) and RUE (Rationale Use of Energy) could make a significant contribution to improving environmental protection and to guarantying continuing oil supplies in conditions of stability and security in the region (Bertelsmann Foundation, 2002; Gelil IA & Kandil, 2004; Doukas & Others, 2006, P.757).

Table1.2 – Energy consumption & CO2 emission in the Arab World

(Source: the author based on Environmental Sustainability Index, 2005)

Country	**Energy Consumption**	**Renewable Energy**	**CO_2 Emission form fossil fuel**	**CO_2 Emission**	**CO_2 Emission**
	Billion BTU/US$ million GPD	100%	Kg/ person. annual	Metric tons of carbon/capita	Metric tons /million US$ GDP
Algeria	8.6	0.2	0.85	2.96	499.89
Egypt	9.4	7.8	0.51	2.10	498.70
Iraq	20.6	0. 5	0.75	3.29	659.23
Jordan	11.5	0.1	0.82	3.09	540.61
Kuwait	15.3	0.00	6.38	21.33	474.16
Lebanon	12.2	3.1	1.85	4.36	332.42
Libya	12.2	0	2.53	10.92	445.46
Mauritania	11.5	0.6	0.32	1.16	642.69
Morocco	4.3	3.7	0.23	1.26	253.75
Oman	13.6	0.00*	0.00*	7.58	378.21
Saudi Arabia	19.9	0.00*	3.43	16.91	631.76
Somalia	3.3	0.00*	0.00*	0.00	0.00
Sudan	4.8	14.4	0.11	0.17	147.60
Syria	15.8	9.7	0.90	3.27	1152.2
Tunisia	5.2	0.3	0.65	1.93	212.55
UAE	23	0	9.06	20.91	300.48
Yemen	0.00*	0.00*	0.31	0.47	407.46
Arab World Average	**11.9**	**2.5**	**1.8**	**6.35**	**467.95**
World Average	**9.1**	**6.6**	**1.06**	5.14	364.03

* Data is not available

1.2.2. Sustainability Indicators in the Arab World

To identify sustainability level in the Arab World we need some sustainability measuring indicators. While absolute measures of sustainability remain elusive, many aspects of environmental sustainability can be measured at least in relative terms. The Environmental Sustainability Index (ESI) is one sustainability measuring indicator. The ESI benchmarks the ability of nations to protect the environment over the next several decades. It does so by integrating 76 data sets, tracking natural resource endowments, past and present pollution levels, environmental management efforts, and the capacity of a society to improve its environmental performance – into 21 indicators of environmental sustainability. These indicators permit comparison across a range of environmental and sustainability issues. The Environmental Sustainability Index is assed for 146 countries; the higher a country's ESI score, the better positioned it is to maintain favourable environmental conditions into the future (Esty, Levy, Srebotnjak, & de Sherbinin, 2005, P.1).

According to the Environmental Sustainability Index 2005, Finland was the highest-ranking country (score 75.1), while North Korea was the lowest (score 29.2). The ESI ranks the Arab countries slightly more than 10 points below world average (the ESI ranges from 24 to 74). Analysing the Arab World results, demonstrates that all Arab Countries (except Tunisia) has ESI scores less than 50 - Chart 1.6. Compared to 146 ranks, 82% of Arab countries lay in the last fifty ranks (ranking more than 100) except Tunisia (rank 55), Oman (rank 83), Jordan (rank 84), and Algeria (rank 96) –Table 1.3.

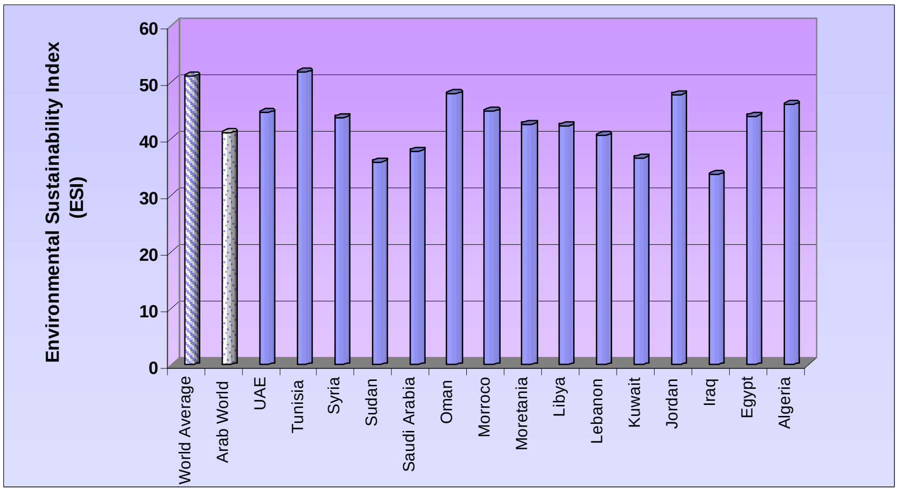


Chart 1.6 – Environmental Sustainability Index (ESI) for the Arab countries

(Source: the author based on Environmental Sustainability Index, 2005)

Arab countries face profound sustainability challenges that will influence their ability to achieve lasting economic, social, and environmental goals (Esty, Levy, & Winston, 2003, P.236). Negligence of the environment in the Arab World has an annual cost, according to many experts, of USD 14 billion or 3% of GDP. Fighting pollution and desertification would cost an estimated USD 58–78 billion in the next decade and is considered essential to development (Krayem, Nehme, & Abdul Hadi, 2000).The Arab world has a critical resource base that must be wisely used if it is to be sustained and to facilitate sustainable development (Environmental Sustainability, 2004). As a conclusion, and depending on the environmental indicators of the Arab World, resources management and development strategies are not likely to be sustainable.

Table 1.3 – ESI & Ecological Footprint in the Arab World

(Source: the author based on Living Planet Report 2006 & Environmental Sustainability Index, 2005)

Country	**Population**	**ESI**	**world rank**	**Ecological Footprint**	**Footprint change per Person** (%)	**Water withdrawals per person**
	millions	-	-	Hectare/capita	1975–2003	‘000 m3/year
Algeria	31.8	46	96	1.79	51	194
Egypt	71.9	44	115	1.7	49	969
Iraq	25.2	33.6	143	1.73	30	1742
Jordan	5.5	47.8	84	1.71	77	190
Kuwait	2.5	36.6	138	10.3	44	180
Lebanon	3.7	40.6	129	3.19	141	384
Libya	5.6	42.3	126	4.36	13	784
Mauritania	2.9	42.6	124	1.22	31	606
Morocco	30.6	44.8	105	1.56	4	419
Saudi Arabia	24.2	37.8	136	6.15	203	736
Oman	3.1	47.9	83	3.39	0.00*	0.00*
Somalia	9.9	0.00*	0.00*	0.97	-38	347
Sudan	33.6	35.9	140	1.14	-6	1135
Syria	17.8	43.8	117	2.55	32	1148
Tunisia	9.8	51.8	55	2.27	38	271
UAE	4.1	44.6	110	15.99	205	2270
Yemen	20.0	37.3	137	0.8	20	343
Arab World Average	**323**	**41**	**-**	**3.76**	55.85	732.375
World Average	**6 301.5**	**51**	**-**	**3.1**	**14**	**618**

* Data are not available

It is notable that the lowest worldwide scores sustainability indicators are found in the Arab World. Even for oil exported countries as UAE, where its economy depends basically on oil that consists about 33% of the national gross income and more the 70% of the country's foreign currency sources (UAE Year Book, 2006, P.118), it is a must to start adapting new economical strategies based on sustainable development in different aspects especially building sector.

Sustainable development in the Arab World must be considered within the broad economic, political, institutional, environmental, cultural and ethical context. Sustainable development in the Arab World, must achieve its aspired objectives, namely the optimal use of its resources and aligned with environment conservation, certain factors must be available; starting from replacing the one-sided way of thinking with a global outlook that keeps into account all the sectors that influence construction (CAMRE. 2005, P.30).

The main challenge ahead for Arab countries lies in finding appropriate mechanisms that, while culturally and politically sensitive to the region, can move towards a governance system for sustainable development, which is highly integrated, multi-sectoral, process oriented and participatory (LAS & ESCWA, 2005, P.9).

Conclusions

There is a growing interest in the concepts of sustainability and sustainable development worldwide. Sustainability is a planning perspective that accounts for economic, social and environmental goals, including impacts that are indirect, difficult to measure, and distant in time and space.

This chapter has investigated sustainability as a concept through discussion of its definitions, dimensions, and principles. The main conclusions of this part can be summarised as follows:

- Sustainability became the most commonly term used all over the world reflecting world’s concerns about coming generations’ future on Earth.
- Resources depletion, population growth, climate change, greenhouse gases, and environment pollution, economical growth, and human well-being are the main issues of sustainability.
- The most commonly sustainability definition is based on Brundtland Commission that published in “Our common future”1987 “Development that meets needs of the present or current generation, without compromising the ability of future generations to meet their needs”.
- Human settlements and built environment perform the major sources of resource consumption and waste production in the world.

- Ecological Footprint in developed countries is higher than in developing countries. This is due to high life standards, luxurious life style, and high rate of consumption.
- Buildings & construction sector consume a great deal of natural resources producing toxic gases and waste.
- Sustainable architecture may play a crucial role in achieving sustainability.
- Sustainability is not all about energy conservation, renewable resources, or building materials. Sustainability is a life style, a way of living and society cultural identity.

Discussing the environment & sustainability dilemma in the Arab World led to these conclusions:

- Environmental and sustainability issues face many predicaments in the Arab World.
- Generally, environment and sustainability dilemma in the Arab World can be identified in several issues such as shortage of fresh water and desertification, expanded urbanisation, air pollution, and high consumption pressure and energy consumption.
- Sustainability Indicators in the Arab World are critical compared to the rest of the world.
- Arab countries face profound sustainability challenges that will influence their ability to achieve lasting economic, social, and environmental goals
- Depending on the environmental indicators of the Arab World, resources management and development strategies are not likely to be sustainable.

Issues discussed in this chapter pointed up importance of sustainability in facing environmental crisis all over the world that may change the balance of natural environment and human future on earth. This chapter also indicates the significant dilemma in sustainability indicators and environmental quality in the Arab world. The illustrated figures and facts justify the need for this research to reconsider development strategies in the Arab World, especially in wealthy countries such as the UAE, which is our case study.

After discussing sustainability dilemma in the Arab World, identifying sustainability principles in Islam will be investigated in chapter two discussing how they were demonstrated in traditional houses design in the Arab World.

Part One

Theoretical Background

Chapter 2

Sustainability & Environment in Islam and Traditional Architecture

Main Headings

- 2.1. Sustainability & Environment in Islamic Perspective
- 2.2.Doctrines of Sustainability & Environment Protection in Islam
- 2.3. Relation between Human being & Environment in Islamic Perspective
- 2.4. Sustainability & Traditional Architecture

Chapter Two: Sustainability & Environment in Islam and Traditional Architecture

Introduction

All Arab countries are part of the Islamic World where Islam played an important role in forming people's life, relations with others, and views of the universe. Discussing environment & sustainability issues in the Arab World necessitates looking into Muslims' view of the environment. This view was intimately shaped according to Islam perspective and it was reflected in traditional architecture in the Arab World.

This chapter aims to investigate the sustainability potential in Islam and Islamic legislations and how they were demonstrated in architecture especially the traditional house design in the Arab world.

To achieve this aim, the scope of environment and sustainability in Islam will be analysed depending on the two fundamental sources of *Shari'a (*the sacred, revealed law of Islam): the Holy Quran and the Prophet Mohammed (PBUH) *Sunnah* or tradition.

2.1 Sustainability & Environment in Islamic Perspective

The word (environment) or (*biyaá*) in Arabic is derived from the root "*bayia*", meaning place or abode. The term is also used to refer, figuratively, to the place where a man chooses to settle, such as his homeland (Yunis, 2001). In spite of environment importance in Islam, the word (*Environment*) has not been stated literally in the Holy Quran or the Prophet *Sunnah*. Yet if we understand environment as: "Earth with its living and nonliving things and the atmosphere surrounding it", we would find that "*Earth, what and who lives on it and what surrounds it*" has been mentioned by this meaning in 199 Ayahs (verses) in different Surahs (chapters) in Quran (Al-Faris, 1990, P.5).

Environment in Islam is the frame where a Muslim lives, works, socializes, and produces; environment is the source of wealth and resources that God has created on earth. In describing some of God's bounties to support human existence on earth, Quran says: ﴿ *Yea, the same that) has made for you the earth (like a carpet) spread out, and has made for you roads (and channels) therein, in order that ye may find guidance (on the way)* ۞ *That sends down (from time to time) rain from the sky in due measure; and We raise to life therewith a land that is dead; even so will ye be raised (from the dead)*﴾ (43 AL-Zukhruf: 10-11).

In the Islamic perspective, the environment is a living entity, the earth is not a mere globe on which man treads and where he behaves as the whim strikes him. The mountains are not dead mounds but living entities that have feelings and emotions (Asseidi, P. 104), for Allah says "*The Seven Heavens and Earth, as well as whoever is in them, glorify Him. Nothing exists unless it hymns His praise; yet you do not understand their glorification. Still He has been Lenient, Forgiving.*" (17 Al Israa: 44), and: "*We gave Judgement and Knowledge; it was Our power that made the hills and the birds celebrate Our praises, with David: it was We Who did (all these things)*". (21 Al Anbiaa: 79).

A common definition of environment is "the milieu or space in which man lives, including the natural and human components that influence him and are influenced by him". Islamic definition of environment is much deeper for it links environment to the Muslim's faith and his belief in oneness of the creator of universe and the source of the Holy Quran. The Quran and the Prophet's *Sunnah* abound with texts that clearly define man's relation to the environment in which he lives. These texts all intimate that Allah created the universe with all its creatures and components and harnessed these to serve man as he attends to the duties of peopling this earth and worshipping Allah. Islam contained the way and the balance that governs the relationship between humankind on the one hand, and between humankind and environment, on the other hand (Yunis, 2003, P.23).

Environment is the vital space of human beings and of all other creatures living on this earth. Allah created the components of environment and set them on a complex course the purpose of which is to help man fulfil his primary mission on earth, namely to settle and people it. Therefore, all the components of life work spontaneously towards fulfilling this goal; thus, any alteration in the essence of one element of the ecological order upsets environment and causes it to lose its capacity to create and sustain life (Yunis, 2003, P.23).

2.2 Relation between Human being & Environment in Islamic Perspective

The Quran and the Prophet's Sunnah abound with texts that clearly define man's relation to the environment in which he lives. The *Quran* is the Holy Book of Muslims; it is the basic source of Islamic teachings and jurisprudence as it is the word of God. The word "Al-Quran" in Arabic literally means, "The book to be read". *Sunnah* is the model behaviour of the Prophet Mohammed (PBUH), the practice he endorsed, the precedents he set, his traditions, sayings and deeds. In Arabic, *Sunnah* literally means the "method" (Mortada, 2003, P. 4).

Islam has set up a responsibility for human being toward the environment. This responsibility evolves from the role of human being as God's *khalifah* (inheritor, vice-regent or steward) on earth. In this regard Quran says: ﴾ Behold, thy Lord said to the angels: *I will create a vicegerent on earth." They said: "Wilt Thou place therein one who will make mischief therein and shed blood? Whilst we do celebrate Thy praise and glorify Thy holy (name)?" He said: "I know what ye know not*.﴿ (2 Al-Baqarah: 30).

Making human being as a *khalifah* is an honour from God to humankind by giving him the mind, wisdom and good judgment to deal with the trusteeship given to him. In this aspect Quran says: ﴾*We have honoured the sons of Adam; provided them with transport on land and sea; given them for sustenance things good and pure; and conferred on them special favours, above a great part of Our Creation*﴿ (17 Al-Israa: 70). Humankind has a great responsibility towards earth and keeping this trusteeship (*amanah*) because the bounties of God are uncountable ﴾ If ye would count up the favours of Allah, never would ye be able to number them; for Allah is Oft-Forgiving, Most Merciful.﴿(16 Al-Nahl: 18), ﴾ *Say: "If the ocean were ink (wherewith to write out) the words of my Lord. Sooner would the ocean be exhausted than would the words of my Lord, even if we added another ocean like it, for its aid* ﴿ (18 Al-Kahf: 109).

The concepts of *khalifah*, stewardship, and trusteeship (*amanah*) emerge from the principles of Islam that manage the relation between human being & environment in Islamic perspective. The Quran explains that humankind holds a privileged position among God's creations on earth: he is chosen as *khalifah*, "vice-regent" and carries the responsibility of caring for God's earthly creations. Each individual is given this task and privilege in the form of God's trust. However, the Quran repeatedly warns believers against arrogance: they are no better than other creatures. ﴾ *No creature is there on earth nor a bird flying with its wings but they are nations like you*﴿ (6 Al-An'am:38); ﴾ *surely the creation of the heavens and the earth is indeed greater than the creation of mankind; yet most mankind know not* ﴿ (40 Gha'afir:57).

As 'nations' like us other creatures too have rights, they too have a 'space' of their own. Humankind has been given the authority but also the moral responsibility to work in harmony with the natural environment. This is the *amanah* or trusteeship humankind has to look after. This is the reason that humankind has to work in partnership with nature instead of the secular viewpoint of man as a predator to nature (www.islamweb.net/ - Last accessed 6-11-2006).

Being a *khalifah*, obligates humankind to work as the main duty on earth to fulfil his needs and develop the environment, ﴾*It is He Who has made the earth manageable for you, so traverse ye through its tracts and enjoy of the Sustenance which He furnishes: but unto Him is the Resurrection.* ﴿ (67 Al-Mulk: 15). Humankind's capability to be a *khalifah* is determined by his ability to build and develop the earth as a commitment from God to people. ﴾ *It is He Who hath produced you from the earth and settled you therein: then ask forgiveness of Him, and turn to Him (in repentance): for my Lord is (always) near, ready to answer.* ﴿ (11 Hud: 61)

Relation between human being and environment in Islam, based on his responsibility toward environment, can be framed within two values: Utilisation or Subjection (*Taskhir*) and Middle way or Moderation (*Wasati'ah*).

2.2.1. Utilisation or Subjection (*Taskhir*):

Utilisation or Subjection refers to the subjugation by Allah of all the components of environment to help man in discharging the task of settling the earth. Quran describes in detail bounties of God to help human supporting himself, construct and build up earth. ﴾*It is Allah Who has created the heavens and the earth and sent down rain from the skies, and with it brought out fruits wherewith to feed you: it is He Who has made the ships subject to you, that they may sail through the sea by His Command; and the rivers (also) has He made subject to you.* ۞ *And He hath made subject to you the sun and the moon, both diligently pursuing their courses: and the Night and the Day hath He (also) made subject to you.*﴿ (14 Ibrahim: 32-33), ﴾*Do ye not see that Allah has subjected to your (use) all things in the heavens and on earth, and has made His bounties flow to you in exceeding measure, (both) seen and unseen? Yet there are among men those who dispute about Allah, without knowledge and without guidance, and without a Book to enlighten them!* ﴿ (31 Luqman: 20)

The earth is made available for human use, without abuse or misuse. The circle of things available for the benefit of humanity is much greater than that of the environment (Abu-Sway, 1998). The human is the most favoured of Gods creation. Allah created everything in existence for the use of humans. Allah has made subservient to humans all animal life, bird life, plant life, water bodies, inanimate objects, and other creations (Wersal, 1995).

These beings are partners to humankind in existence, and they deserve their own respect and have their own positions. They have been created for humankind, and without them, it would not be possible for man to live (Wersal, 1995). Quran illustrates some of what God created that were utilised for the benefit of humankind ﴾ *With it He produces for you corn, olives, date palms, grapes, and every kind of fruit: verily in this is a Sign for those who give* *thought.* ۞ *He has made subject to you the Night and the Day; the Sun and the Moon; and the Stars are in subjection by His Command: verily in this are Signs for men who are wise.* ۞ *And the things on this earth which He has multiplied in varying colours (and qualities): verily in this a Sign for men who celebrate the praises of Allah (in gratitude).* ۞ *It is He Who has made the sea subject, that ye may eat thereof flesh that is fresh and tender, and that ye may extract there from ornaments to wear, and thou seest the ships therein that plough the waves, that ye may seek (thus) of the bounty of Allah and that ye may be grateful.* ﴾ (16 Al-Nahl: 11-14).

The Quran, moreover, makes it clear that the earth is a habitat for human beings and that he is required to dwell on it, work it out and establish a balanced way of life without excesses or deficiencies; his duty is to "*I'mar", build,* or inhabit this earth. To limit the translation of "*I'mar*" to inhabitation will not do justice. The meaning includes spreading and settling all over the earth, inhabiting every liveable quarters, building …etc. In short, it includes every positive activity that would make life on earth prosperous. If an activity diverts humanity from the right path (i.e. against the *Shari'a*), then it cannot be considered as *I'mar (*Abu-Sway, 1998).

2.2.2. Middle way or Moderation (*Wasati'ah*)

Middle way or Moderation here refers to the quality that should mark man's benefiting from Allah's subjugation of the components of environment harnessed for him by Allah to him, true to the moderation and spirit of the middle way that distinguish Islam from all other religions. This moderation springs from the status itself that man holds within the universe. In Islam "man is a master in the universe" and not a "master of the universe" as claimed by Western thinkers (Yunis, 2003, P.29). Human being is integrated into the ecological system. Such integration is not only physical but more importantly, is spiritual (Edwards & du Plessis, 2001, P. 17)

The Quran constantly reminds believers that they are but the guardians of God's creation on earth and that they should never take this creation for granted: ﴿*Consider the water that you drink.* ۞ *Was it you that brought it down from the rain cloud or We?* ۞ *If We had pleased, We could make it bitter*﴾ *(56 Al- Wakiaá: 68-70).*

Islam calls for getting use of God's bounties and earth resources, yet it persists on rational consumption in a middle way. This call for middle distance merges from humankind position in the universe as a steward to earth. Quran states the need for rational consumption as a quality of believers while over spending is a work of devil and the quality of non-believers, ﴿ *Verily! The spendthrifts are brothers of the Shayatin (devils), and the Shaitan (Devil-Satan)* *is ever ungrateful to his Lord* 》 (17 Al-Israá: 27); "*Thus, have We made of you an Ummat justly balanced, that ye might be witnesses over the nations*" (2 Al Baqara: 143). This middle way is what governs, or should govern, man's relationship with environment. Closely associated with moderation is the condemnation of waste and squandering. Allah says "...*And eat and drink, but be not prodigal. Lo! He loveth not the prodigals*" " (7 Al Araf: 31).

Middle way or (Wasati'ah) for which Islam calls is the main aim of sustainability, which represents a balance that accommodates human needs without diminishing the health and productivity of natural systems. This is affirmed by The American Institute of Architects that defines sustainability as "the ability of society to continue functioning into the future without being forced into decline through exhaustion or overloading of the key resources on which that system depends" (Mendler, & Odell, 2000, P.1).

2.3. Doctrines of Sustainability & Environment Protection in Islam

Islam advocates the protection of the environment, though not in name, for the word (Environment) or (biyaá), along with its connotations, evolved in recent times (Abu-Sway, 1998). This is demonstrated in Quran and *Sunnah* calling for protecting environment and its resources for human well-being. Islam cared a lot about environment conservation and protection from pollution and harm making this as part of Muslim's faith. In this aspect, the Prophet Mohammed (PBUH) said, "Faith is more than seventy sections, the best is saying No gods but Allah, and the least removing harm from the road".

De Chatel descries Prophet Mohammed as a "Pioneer of the Environment", as she found in the *Sunnah* a lot of environment conservation indicators either in the Prophet's sayings or in his deeds. In this aspect, she says (De Chatel, 2003):

> "*A closer reading of the Hadith, the body of work that recounts significant events in the Prophet's life, reveals that he was a staunch advocate of environmental protection. One could say he was an "environmentalist avant la lettre", a pioneer in the domain of conservation, sustainable development and resource management, and one who constantly sought to maintain a harmonious balance between man and nature. From all accounts of his life and deeds, we read that the Prophet had a profound respect for fauna and flora, as well as an almost visceral connection to the four elements, earth, water, fire and air.*"

Based on the previous discussion, it is concluded that Islam embodies many sustainability and environment conservation indicators that integrated with the social values and human behaviour of the Muslims society. The concept of environment in the Islamic perception means more than simple enumeration of its components or those of the ecological system; it transcends this to establish a link between these components and the human factor. Islam calls for environment conservation from harm or pollution. ﴿ Do no mischief on the earth, after it hath been set in order, but call on Him with fear and longing (in your hearts): for the Mercy of Allah is (always) near to those who do good. ﴾ (7 Al-A'raf: 56) and ﴿… and do no mischief on the earth after it has been set in order: that will be best for you, if ye have Faith. ﴾ (7 Al-A'raf: 85). God considers people who harm others as committing offence ﴿ And those who annoy believing men and women undeservedly, bear (on themselves) a calumny and a glaring sin. ﴾ (33 Al-Ahzab: 58).

Pollution prevention is one way of environment protection. Pollution is considered one form of corruption ("*fasad"* in Arabic). "*Fasad*" involves physical corruption like disrupting the environmental phenomena and the contents of the universe (water, soil, food) by foolish human interference in the natural balance created by Allah the Almighty, Who did so wisely, perfectly and infallibly to fit the life of all creatures (Ghoneim, 2000).

The fact that to protect environment is considered an act of worshipping does not mean that every component of the environment should be saved. In fact, it is sometimes to the contrary. The Prophet stated that a person who uprooted a tree, which formed an obstacle, in the path of people, ended up in heavens. The Islamic position forms a middle path between human behaviour that has disregard to the environment and those who practically worship the environment or certain parts of it. While the Islamic worldview supports the protection of environment from the greedy behaviour of human beings, it allows room for sustainable development (Abu-Sway, 1998).

Prophet Mohammed (PBUH) was a strong proponent of the sustainable use and cultivation of land and water, proper treatment of animals, plants and birds, and the equal rights of users. In this context, modernity of the Prophet's view of the environment and the concepts he introduced to his followers is particularly striking; certain passages of the *Hadith* could easily be mistaken for discussions about contemporary environmental issues (De Chatel, 2003).

The call to preserve the environment from harm extended to city planning and human settlement. In this aspect, the Arab historian and theorist Ibn Khaldoon, in his "Muqaddamah or Introduction to History", wrote" *it is necessary that harmful things be kept away from the towns by protecting them against inroads by them, and that useful features are introduced and all the convenience are made available in them*" (Mortada, 2003, P. 63). Doctrines of sustainability & environment protection in Islam are diverse; they can be studied from different standpoints. The main doctrines of sustainability & environment protection in Islam may be illustrated as follows:

2.3.1. Resources Conservation

It is impermissible in Islam to abuse one's rights as *khalifa*, because the notion of acting in "good faith" underpins Islamic law. All humankind and all its posterity from generation to generation inherited the planet. Each generation is only the trustee. No one generation has the right to pollute the planet or consume its natural resources in a manner that leaves for posterity only a polluted planet or one seriously denuded of its resources (Weeramantry, 1988, P. 61). In other contexts, the concept of *khalifa* refers to the fact that waves of humanity will continuously succeed each other and inherit planet earth (Ameri, 2001).

Although Islam asks people to benefit from the natural environment for their living needs, it obliged them to maintain it. This is mentioned in Quran and many of the Prophet's *Hadiths* warning Muslims from damaging or abusing environment with all its components: plants, animals, and water. Islam considers all other creatures are nations or communities like us, thus we should not harm them. Quran says ﴿ *There is not a moving (living) creature on earth, nor a bird that flies with its two wings, but are communities like you, we have neglected nothing in the Book, then unto their Lord they (all) shall be gathered*﴾ (6 Al-Ana'am: 38)

The injunction not to harm people's right or property particularly in urban planning is drawn from the concept of "*la dharar wa la dhirar*" or "*neither dharar nor dhirar*". This concept, which is also a Prophetic declaration, is explained as "there would be neither harming nor reciprocating harm, or there is neither injury nor return of injury" (Mortada, 2003, P. 63). This quotation is frequently used as a rule in forming relation between humankind and environment. Humankind activities should not harm environment spontaneously or deliberately.

2.3.2. Environmental Balance

God has not created anything in this universe in vain, without wisdom, value and purpose (Bagader, & others, 1993). All things that God has created in this universe are created in due proportion and measure. Everything created in environment was created in specific quantities and with distinct features that contribute towards guaranteeing a suitable life for man and the other creatures that share this environment with him. God says ﴿ *And the earth We have spread out (like a carpet); set thereon mountains firm and immovable; and produced therein all kinds of things in due balance.* ۞ *And We have provided therein means of subsistence, for you and for those for whose sustenance ye are not responsible.* ۞ *And* *there is not a thing but its (sources and) treasures (inexhaustible) are with Us; but We only send down thereof in due and ascertainable measures*》 (15 Al-Hijr: 19-21), 《*Verily, all things have We created in proportion and measure.* 》 (54 Al-Qamar: 49)

The intention of rational use of resources is to preserve the harmony that is provided in the natural environment. Indeed, Quran stresses the preservation of this harmony and says whatever God has created in this universe was created in due proportion and measure both quantatively and qualitatively (Mortada, 2003, P. 52). Quran says 《 *It is He Who created all things, and ordered them in due proportions*》 (25 Al-Furqan: 2). This balance is evident in each element and component in environment qualitatively and quantatively to do its part in the ecological system as God created. All things in the universe are created to serve the One Lord Who sustains them all by means of one another, and Who controls the miraculous cycles of life and death. 《 *Every single thing is before His sight, in (due) proportion.* 》 (13 Al-Ra'd: 8).

As Allah created man on earth, he decreed that man should preserve this habitat. He gave man the right to invest in it and benefit from it. He enjoined upon man not to cause mischief anywhere. He addresses whoever may think of disturbing the natural balance, the earthly equilibrium, or inflicting injustice (Ghoneim, 2000), 《 *Seek not mischief in the land, for Allah loves not those who do mischief*. 》 (28 Al-Qasas: 77), 《*Then, is it to be expected of you, if ye were put in authority, that ye will do mischief, in the land, and break your ties of kith and kin?*》 (47 Mohammed: 22).

2.3.3. Common Right of Resources

According to Islam, the universe and the creations in it – animals, plants, water, and land – were created for the benefit of humankind. Man is allowed to use the resources but he can never own them. Thus while Islam allows land ownership, it has limitations: for example, an owner can only own land if he uses it; once he ceases to use it, he has to part with his possession (De Chatel, 2003).

Islam has set rules for how human get use of natural resources. Yet it prohibited using these resources selfishly ignoring others' right or affecting posterity to fulfil their own needs. This is the main goal of sustainability《 *O Children of Adam! Wear your beautiful apparel at every time and place of prayer: eat and drink: but waste not by excess, for Allah loveth not the wasters.* 》 (7 Al-A'raf: 31).

According to Shari'a, the utilisation and sustainable use of natural resources and elements is the right and privilege of all people. This right is to a certain degree considered by Islam as an obligation. Both the Quran and *Sunnah* stress this right or benefit in commanding Muslims for example to restore derelict lands and act as good stewards of nature (Mortada, 2003, P.48). In fact, the Quran makes it clear that the relationship between man and nature is a relation of utilisation and development. It says ﴿ *Verily! In the creation of the heavens and the earth; and the alternation of night and day; and the ships which sail through the sea with that which is of use to mankind; and the water (rain) which Allah sends down from the sky and makes the earth alive therewith after its death; and the moving (living) creatures of all kinds that He has scattered therein, and in the veering of winds and clouds which are held between the sky and the earth; are indeed Ayat (proofs) for people of understanding* ﴾ (2 Al-Baqarah: 164).

The relationship between the Muslim and the universe is one of harmonious benefit and use. When Allah takes an oath by some creatures, he draws attention to the fact that man should recognize their value and take care of them (Ghoneim, 2000). Islam incited believers to share the earth's resources. The Prophet said *"Muslims share alike in three things – water, herbage and fire,"* and he considered it a sin to withhold water from the thirsty.

While Islam supports utilising local natural resources and elements, it disapproves of any selfishness associated with this utilisation. God has provided natural resources for the welfare of all people (Mortada, 2003, P.50).

2.3.4. Water Conservation

In the harsh desert environment where the Prophet lived, water was synonymous to life. Water is a gift from God, the source of all life on earth as is testified in the Quran: ﴿ *Do not the Unbelievers see that the heavens and the earth were joined together (as one unit of Creation), before We clove them asunder? We made from water every living thing. Will they not then believe?* ﴾ (21 Al-Anbiyaa: 30)

Islam called for fighting the pollution of the environment starting from within the person himself whom Islam ordains to be clean in soul and body. The Prophet says, "*Be clean for Islam is clean*" and associates purity and cleanness with faith in many of his *Hadiths*, such as "*Cleanness calls for faith, and faith accompanies its partner into heaven*". For the Muslim to be clean in his body, the Islamic *Shari'a* has decreed that he makes his ablutions prior to praying (Yunis, 2001). Keeping environment clean supports the health and efficiency of people, the Prophet emphasises cleanness as a fundamental habit of the Muslim's daily life (Mortada, 2003, 51). The prophet says; "*Cleanness is half of faith*". Islam calls for being clean all the day especially during praying, as Muslim has to do ablution before prayer; Allah says: "*O ye who believe! When ye prepare for prayer, wash your faces, and your hands (and arms) to the elbows; Rub your heads (with water); and (wash) your feet to the ankles.*" (5 Al Maida: 6).

Though Islam calls for cleanness, it forbids the wastage of water and the usage therefore without benefit because it is the secret of life. Saving water and safeguarding its purity were two important issues in Islam because its valuable gift from God and life cannot be imagined without water for drinking or washing or irrigation; ﴿*Consider the water that you drink.* ۞ *Was it you that brought it down from the rain cloud or We?* ۞ *If We had pleased, We could make it bitter*﴾ *(56 Al- Wakiaá: 68-70).*

Concern about the sustainable use of water in Islam led to the creation of *haram* zones near water sources; they are areas often drawn up around wells and water sources to protect the groundwater table from over-pumping. Nevertheless, even when water was abundant, the Prophet advocated thriftiness: thus, he recommended that believers perform *wudhu (Prayer ablution)* no more than three times, even if they were near to a flowing spring or river (De Chatel, 2003). The theologian El-Bukhari added: *"The men of science disapprove of exaggeration and also of exceeding the number of ablutions of the Prophet."* In calling for economy in water consumption, the Prophet said to his colleague Sa'ad Bin Maádh when the Prophet passed by him while Sa'ad was in ablution: "*Don't* improvidence in *water,* Sa'ad *said: Is there any improvidence in water? The Prophet replied: yes, even if you were on a running river*" (www.islamweb.net – last accessed 14-07-2005).

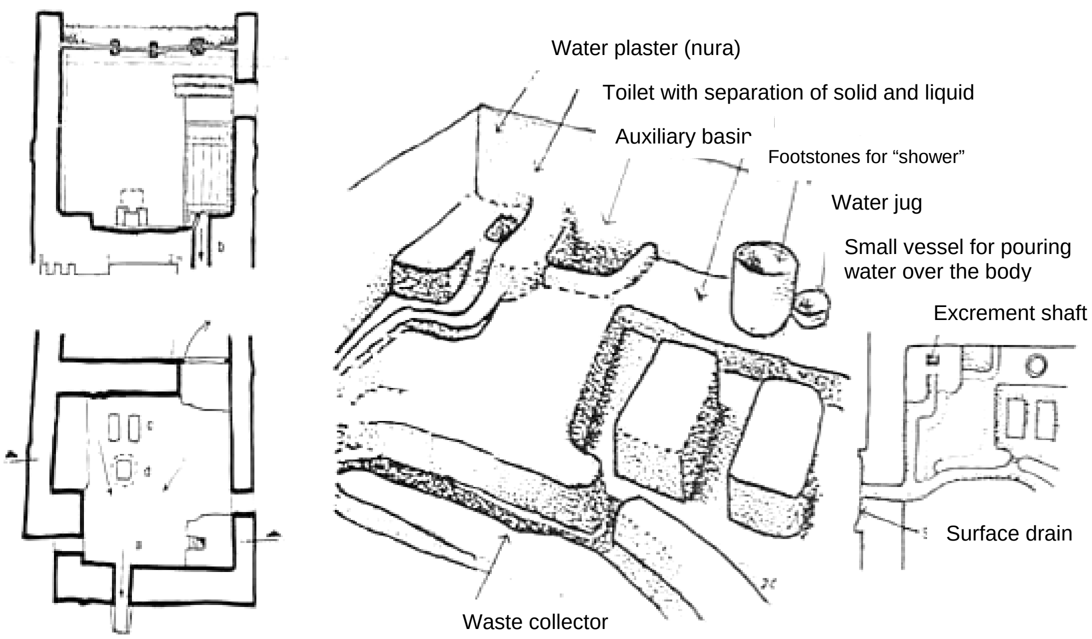


Figure 2.1- Developed sanitation system in traditional architecture- house in Yemen
(Source: Ragette, 2003)

To keep environment and water from harm or pollution, Islam forbade urinating in pools of still water, or otherwise contaminating water bodies. From this, the inference can be drawn that Islam also forbids sewerage and factory outpours to go to waterways or to the ocean as this would pollute the water and threaten marine life (Wersal, 1995).

The Prophet also warned against water pollution by forbidding urination in stagnant water (Bagader & Others, 1993). Shari'a set rules for human defecation and urination by keeping one's privacy and environment reservation by forbidding urinating, pissing or acting excrement in running water or in the view of people (Ragette, 2003, P. 73). Consequently, we find that water supply, drainage, and sanitation systems are so developed in Islamic and traditional architecture where toilets and baths, public or private, were essential elements of city planning and houses design. In spite of limited water resources in many places in the Arab world, the water supply systems and drainage were designed in creative ways to keep cleanness and rational use of water – Figure 2.1

2.3.5. Greenery & Plantation

Plants and vegetation are bounties from God to humankind to support their living on earth. There are many verses in Quran that describe kinds of plants that God created, ﴿ *It is He Who sends down water (rain) from the sky, and with it We bring forth vegetation of all kinds, and out of it We bring forth green stalks, from Which We bring forth thick clustered grain. And out of the date-palm and its spathe come forth clusters of dates hanging low and near, and gardens of grapes, olives and pomegranates, each similar (in kind) yet different (in variety and taste). Look at their fruits when they begin to bear, and the ripeness thereof. Verily! In these things, there are signs for people who believe*﴾ (6 Al-Ana'am: 99).

Islam calls for greenery and plantation conservation; it prohibited cutting down of trees without strong and legitimate reasons or putting garbage under them or in their shadow. This act is encroaching on the bounties of Allah, and encroaching on the beauty of the environment that Allah has created. The Prophet recognized man's responsibility towards natural environment and his role in its development. Thus, he said, *"When doomsday comes, if someone has a palm shoot in his hand, he should plant it,"* (www.hadith.al-islam.com – last accessed 21-07-2005) suggesting that even when all hope is lost for humankind, one should sustain nature's growth. He believed that nature remains a good in itself, even if man does not benefit from it.

Islam considered cultivation and growing plants and tress as a divine work that will be rewarded by God because this is done for other creatures' wellbeing. In this aspect, Prophet Mohammad (PBUH) says "*any Muslim who plants or cultivates vegetation and eats from it, or* *another person, animal or bird, eats from it will receive a reward for it from Allah*". He also said, "*Anyone who plants a tree under which people seek shade or shelter from the sun will have his reward with Allah*" (www.hadith.al-islam.com – last accessed 21-07-2005).

Greenery and Plantation are essential component of the traditional architecture in the Arab World. They are important to the senses of sight and smell, can provide food, invite (indeed, demand) caretaking and thus, act as catalysts for the watering that, through evaporation, can be a major source of internal spaces especially courtyard cooling in hot weather (Reynolds, 2002, P.18). The combination of the sound, smell and sight composed by plantation, along with water, in courtyard create an image of heaven within the hot desert climate that characterise the Arab region – Figure 2.2.

Figure 2.2 – Greenery in Islamic architecture is part of Muslim's view of environment
(Source: Edwards, Sibley, Hakmi & Land, 2006)

Islam also encouraged the sustainable use of fertile lands, The Prophet told his followers of the benefits of making unused land productive: planting a tree, sowing a seed and irrigating dry land were all regarded as charitable deeds. *"Whoever brings dead land to life, that is, cultivates wasteland, for him is a reward therein."* Thus, any person who irrigates a plot of "dead", or desert land becomes its rightful owner (De Chatel, 2003).

Plants and trees outside the building play a vital role when the plants wind is forced to pass through them, thus allowing winds to be cooled and relieved of much of their and dust (Koch-Nielsen, 2002, P.59). The courtyard, with the presence of greenery and plantation along with water surfaces, will create different pressure zones between outside and inside spaces that will help to create natural air movement around and inside the house. Plantation helps also to reduce the glare created by courtyard bare ground especially in sunny climate as in the Arab World.

2.3.6. Air Preservation

Air is created for the perpetuation and preservation of life. It is also clear evidence God's omnipotence, bounty, provision and perfection (Mortada, 2003, P.52). Hence, contaminating the air with smoke is an encroachment on nature, and a threat to the life of humankind and all other living things (Wersal, 1995).

Islam calls for keeping air pure and unpolluted. Thus, Islam forbids chemical and biological products that could, directly and indirectly, damage natural elements. Islam prohibited polluting air with smokes or offensive odours that might hurt others even from simple things as onion or garlic. Consequently, it was not allowed to build factories or mines near residential districts because it might hurt or affect people with odours, gases or smokes.

Protecting the air from pollutants can be deduced from the many *Hadiths* that, at the time of the Prophet discouraged or prohibited activities that result in offensive smells and odours, from taking place in certain public places. Several *Hadiths* prohibit the Muslims from relieving themselves near the rest place under a tree or near their paths. It is clear that there are two associated harms with such behaviour: offensive scenes and smells *(*Abu-Sway, 1998).

Natural ventilation was essential in traditional house design to obtain constant air change within compact urban fabric to keep air quality within living spaces. Utilising courtyard and wind catchers (barjeels) was one of passive cooling strategies that traditional architecture employed to create comfortable indoor climate through evaporative cooling.

2.3.7. Protecting the Human being Against Noise Pollution

Islam took care of the human being and made sure that he should not be subjected to loud and annoying noises to prevent harm to him both physically and psychologically. The *Hadith* states that loud noise is foolish and harmful. In the Quran, Luqman advised his son by saying: ﴾…*and lower thy voice; for the harshest of sounds without doubt is the braying of the ass*.﴿ (31Luqman:19).

Shari'a considered noise as source of harm that should be prevented. This is based on the argument against noise on the legal rule "Let there be no harm or reciprocating harm", and the rule "Preventing evils is better than achieving benefits". The harm resulting from noise is divided into two categories: harm that should be fought, and harm that can be borne. Of the first category is the noise and vibrations resulting from the movement of gates, since they can influence the safety of neighbouring buildings. The second category of harm is the one resulting from sounds that are unpleasant but cause no harm. Jurists differ in their rulings on this category (Yunis, 2001).

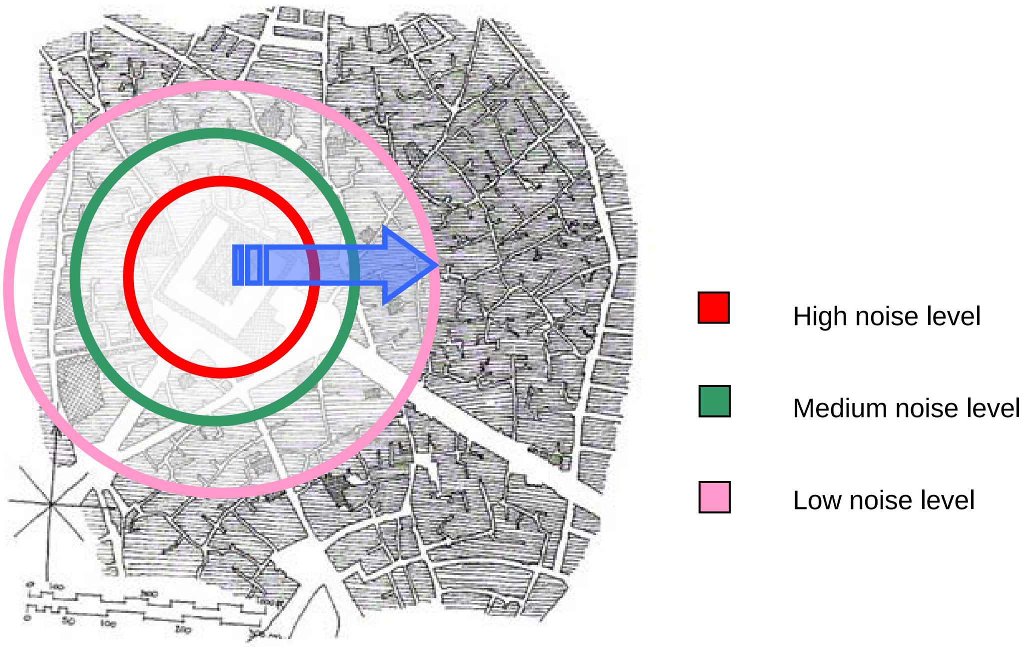


Figure 2.3- Graduation in noise levels in a traditional city in the Arab world
(Source: The author based on Schoeauer, 2000)

The Islamic Shari'a does not allow loud voices in the mosques, even if it is Quran that is recited. The right of the others to pray peacefully or to recite the Quran quietly on their own, during times other than the obligatory prayer, which is performed together, should be respected *(*Abu-Sway, 1998). Accordingly, it is noticed that the mosque, as a public focal point in Islamic city, is surrounded with markets (souq) then the residential sectors. This graduation in siting depends on privacy degree; from public to private and dampening noise levels gradually form the busy city centre to quiet residential districts – Figure 2.3.

2.3.8. Environment Protection from Harm

The care Islam paid to environment is related to its definitions, component, and how to conserve them. This is due to the goal that Islam seeks: good *khilafa* (inheritance or stewardship) of human on earth. Thus, human beings should work within Islam framework to conserve the environment and sustain its resources to keep it as a trusteeship to the coming generations. It is what sustainable development aims to; it is the essence of sustainability. This attitude in Islam approaches to the most common definition of sustainable development, set by the World Commission on Environment and Development, *Sustainable Development that meets needs of the present or current generation, without compromising the ability of future generations to meet their needs and aspirations"* (*WCED*, 1987, P. 8).

The Prophet's environmental philosophy is first holistic: it assumes a fundamental link and interdependency between all natural elements and bases its teachings on the premise that if man abuses or exhausts one element, the natural world as a whole will suffer direct consequences (De Chatel, 2003).

The Quran warns against this plundering of the earth: "*Do no mischief on the earth, after it hath been set in order, but call on Him with fear and longing (in your hearts): for the Mercy of God is (always) near to those who do good"* (7 Al Araf: 56). Mischief on the land and sea is inflicted by man's unwary interference with the natural laws and environmental systems that are ultimately against his own interests. Environmental pollution, which is tantamount to the disruption of natural balance, is the main form of corruption on earth. The natural wealth deposited by Allah for the benefit of humankind has been spoiled. Selfishness and aggression has overcome humankind, as they have become corrupters of earth, the surrounding atmosphere and neighbouring outer space (Ghoneim, 2000). In this aspect, Allah the Almighty says ﴿ *Mischief has appeared on land and sea because of (the meed) that the hands of men have earned*. ۞ T*hat (Allah) may give them a taste of some of their deeds: in order that they may turn back (from Evil)*﴾ (30 Al-Rum: 41)

Being mindful of the needs of current and future generations is an important aspect of piety in Islam. In the words of the *Hadith*, "*Act in your life as though you are living forever and act for the Hereafter as if you are dying tomorrow*" (Izzi Deen, 1990, P.194). The *Hadith* asks people, in effect, to work for and think of future generations as if they were alive and using these very resources. Just as one would not undermine one's own future, a person ought not to rob future generations of their needs (Ameri, 2001). If we compare this philosophy to sustainability definitions and goals, we find an exact matching. Consequently, we conclude that Islam has called for sustainability and environment preservation centuries ago.

2.4. Sustainability in Traditional Architecture

Since the time when humans lived in caves and enjoyed the benefits of stable temperatures and natural ventilation with zero environmental impact, we have been refining our use of resources to provide improved shelter. Until very recently in human history, this refinement occurred within sustainable principles because it was dependent on available resources and technologies. These limitations meant that solutions had to be effective, yet still work with the environment and available materials rather than transforming and dominating them (Battle & McCarthy, 2001, P.15).

Traditional architecture is the result of constrains on resource availability, whether financial or naturally imposed. Historically and without modern means, extraordinary enterprise produced architecture often of the most distinctive character and identity with only limited means available (Thomas, 2002, P. 150).

Jorn Utzon, the famous architect, asserts on how important it is to learn from traditional architecture because it was a product of its era and place. In this aspect, he says (Utzon, 2004, P. 11):

> "*The study of already existing architecture must consist in letting ourselves be spontaneously influenced by it and appreciating the ways in which solutions and details were dependent on the time at which they were created*"

Sustainability was evident in traditional societies and in the way of life. Ambient environment was the source of living, thus predecessors did not use "sustainability" as a principle for living; they carried out the principle in their everyday life. They lived, cultivated, ate, and built sustainably. Interaction with local environment and utilizing natural resources were part of their survival on earth. Hassan Fethy, Sheikh of Arab architects, considers architecture as natural product of the everyday life of the society that produced it. He says, "*Traditional architecture is engaged with extinction due to the connotation that it is part of the old way of life*"" (Fethy, 1973, P.35). Accordingly, society that lives sustainably, builds sustainably.

Traditional architecture in the Arab World was a natural product of interaction between environmental factors (site, geography, topography, and climate) and social and cultural values (religion, traditions, norms, and cultural background). Traditional architecture in the regions where Islam stretched, including the Arab countries, was affected by Islamic values and ideals. Islam was not just a religion for Muslims; it is a way of life. This fact is asserts by Cost (1994, P. V2) believes that the cultural affect of Islam is beyond being just a religion that spread out in certain countries. In this aspect, he says:

> "*Islam appears to rise against a much more complex background than merely the birth-place of the Prophet Mohammed (PBUH), the area from which there came and spread out the new religion and political power. It is cultural background, which, it should be stressed, suggests the existence of a much stronger relationship than was previously supposed between the art of Islamic period and the land in which the new religion originated*."

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

Hotten (2003), a professor in architecture and in his sustainable course, believes that there are six historical principles to achieve sustainable houses. They are siting and design; shade; ventilation; earth shelter, thermal inertia; and air lock entrances. He also thinks that sustainable design can limit the scale of the building and recognizes traditional, vernacular and cultural values.

Analyzing principals of sustainability in traditional architecture is sometimes misunderstood as a romantic nostalgia to the past with its simple and unpolluted vernacular ways of living. On the contrary, sustainability is a call for an adoption of a new way of thinking and acting responsibly towards the surrounding environment and the creation of new environments.

Studying traditional architecture in the Arab World cannot be separated from Islamic values. In the next chapters we will discuss in-depth the issues of sustainability and environment conservation assuring the role of Islam in forming traditional architecture features, in the Arab World, environmentally and socially. Principles of traditional architecture based on sustainability doctrines materialise in the following discussed aspects.

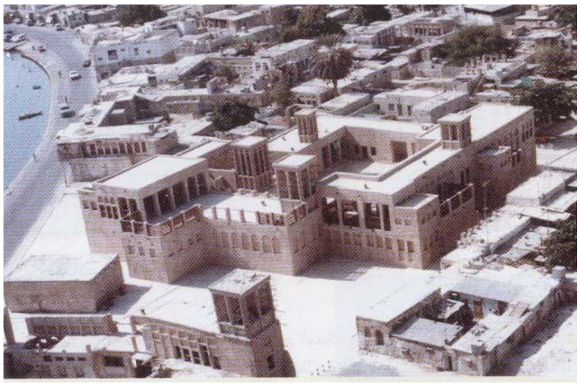
2.4.1 Compact Urban Planning

Social and environmental sustainability integrated to formulate urban fabric of the traditional Arab city. Human settlements nourished and expanded according to society needs and inhabitants' desires within available resources and ambient environment. Residential sectors, with its courtyard houses, consisted most of the traditional city urban fabric. The aerodynamic and thermal aspects of courtyard helped to create a natural airflow and maintain a low temperature inside the house.

The traditional urban fabric of Islamic city was not an external appearance of buildings and streets. Indeed, it was a manifestation of principals of the Islamic social framework and ambient environment. This is why the urban characteristics and conditions of most traditional Islamic cities share great similarities (Mortada, 2003, P. 56).

The extreme annual and diurnal variations and the severe prevailing climate, in most regions in the Arab world, necessitate planning fabric and house forms well adapted to the ambient environment. City planning was the first step for sustainable thinking. This was materialized in planning and buildings features as: compact urban fabric, shaded streets, narrow passageways and unique design houses (Al-Zubaidi, 2002 June, P.5). Urban fabric of the traditional Arab city is compact and the buildings are integrated into one complex structure in which it is hard to distinguish the individual houses, in order to avoid the sharp sunlight during summer and protection against extreme temperatures and sand storms, to minimize the thermal load on the buildings envelopes, especially houses - Figure 2.4.

Sharjah city-UAE
(Source: Al-Azzawi, 2004)



Dubai city-UAE
(Source: Dubai Municipality 2004)

Figure 2.4- Compact urban fabric in a traditional city in the Arab world

The courtyard house is essentially an urban type of dwelling in a traditional city in the Arab World. Because it is introspective, its external walls can be shared with neighbouring houses, and it can be built right up against the public domain. Grouped together, courtyard houses generate a dense urban fabric with a clear separation of public and private open spaces. The relationships of rooms to courtyard, and of the house to its neighbours and to public areas, are a physical expression of man in his various roles as family member, neighbour and citizen. A cluster of courtyard houses has a cellular structure that suggests that man is working in harmony with nature (Macintosh, 1973, P. 7).

2.4.2. Site planning

In selecting a suitable building orientation for a hot climate, where most of the Arab countries exist, the objective aim is to minimize the internal daytime temperature and to produce shaded exterior living space. Building and their continuous outdoor living spaces are oriented in a defensive posture against the wind-borne dust. To plan any site, the position of the sun must be determined for all hours of the day at all seasons as well as the direction of the prevailing winds, especially during the hot season. For the direct rays of the sun, it is sufficient to know the angles of declination and altitude for the summer and winter solstices and the autumnal and vernal equinoxes. In addition, there will be reflection from adjacent buildings and wind shadowing by clusters of buildings, which contribute to specific microclimate for each building location (Hinrichs, 1987, P. 176).

Urban fabric in traditional cities was organic; thus most of the plots were irregular. To obtain the internal courtyard that was the central design for traditional houses, the regular geometric courtyard was the first to be planned. Then passageways and rooms were to be arranged around the courtyard. The irregular parts and undesirable angles were modified by changing the walls depth that may be used as shafts, service areas, niches, cabinets, or fixed furniture- Figure 2.5.

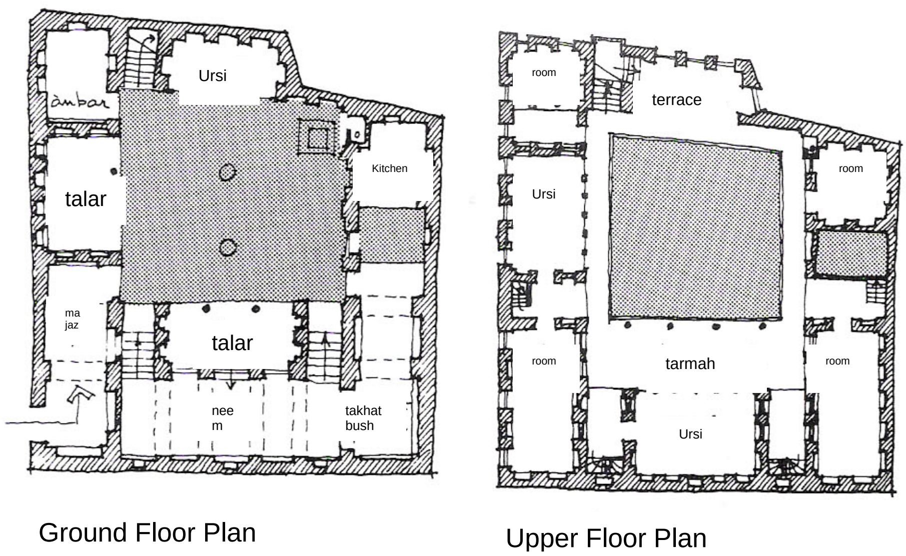


Figure 2.5- Modification of structure to fit to irregular plot in a traditional house in Baghdad

(Source: Schoeauer, 2000)

Organic compact urban fabric with attached buildings provided protection and safety for inhabitants especially within the neighbourhood community. Neighbour rights and privacy were preserved in several planning and design solutions.

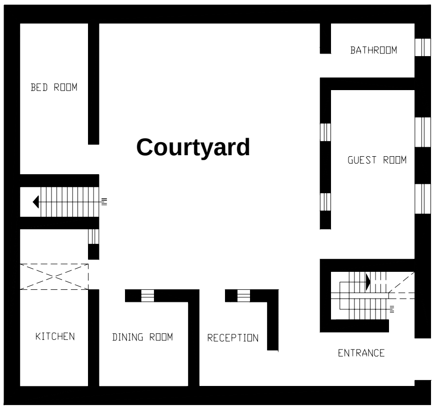
2.4.3. Design philosophy

Traditional house design philosophy is based on attaining two strategies: privacy and protection. These two strategies influenced the house layout, spatial relations, and architectural details. A central interior courtyard onto which all the rooms opened was restricted to family use. Courtyard provided an adequate climatic and social solution; it provided shading and privacy in an open space (Bagnid, 1989, P. 45). Most of daily facilities were located at the courtyard.

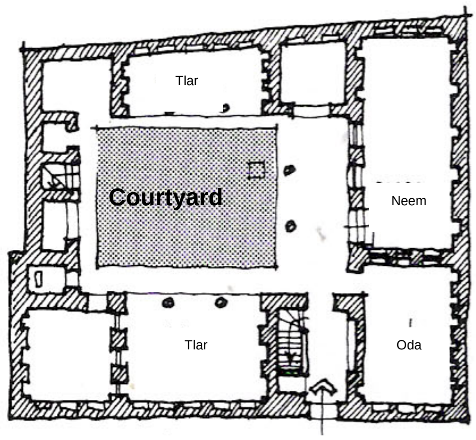
The courtyard represents a constant feature of domestic architecture in most of the Islamic World: it was however, developed in different ways as influenced by existing local traditions, construction materials and environmental factors (Sibley, 2006, P.49) - Figure 2.6.

Courtyard houses have an ancient history in Mesopotamia and Egypt thousands years B.C. Essentially, the courtyard house, which consists of rooms on three or all sides of an open atrium, is associated with Arab culture, but its distribution extended between Sale and Marrakech in Morocco to the West, and India to the east (Oliver, 2003, P.136).

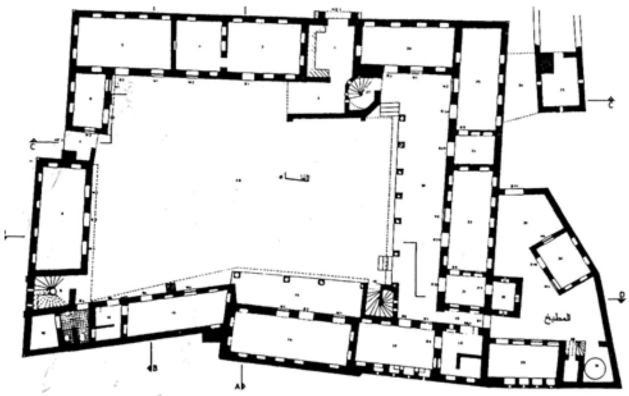
Socially, the courtyard house provided a perfect solution for male and female segregation in Islam. Moreover, It preserve the family, especially women, privacy from intruders' eyes and provided an open space for family and children to act their life freely. Courtyard houses were flexible, thus they could accommodate to family growth and fit to the requirements of extended families.



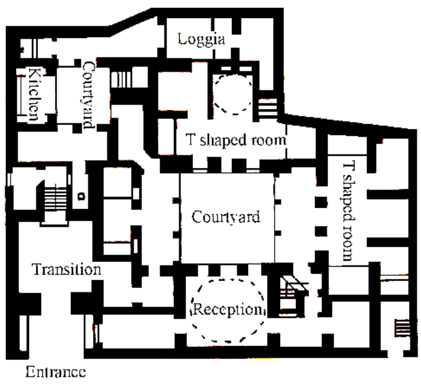
Traditional house in Saudi Arabia
(Source: the author)



Traditional house in Baghdad
(Source: Schoeauer, 2000)



Traditional house in the UAE
(Source: Al-Azzawi, 2004)



Traditional house in Tunisia
(Source: Sibley, 2006)

Figure 2.6- Different plans for traditional courtyard houses in the Arab World

Environmentally, courtyard was a thermal regulator, thus exposure to the sun is to be avoided and courtyards are to be kept small and overshadowed by high walls, wide eaves and foliage (Macintosh, 1973, P.8). In hot areas, where most of the Arab countries locate, courtyard functions in three phases. During the first phase, the cool night air descends into the courtyard and fills the surrounding rooms. Building structure even furniture are cooled at night and remain so until late afternoon. In addition, the courtyard loses heat rapidly by radiation to the clear night sky (Moore, 1993, P.50). During the second phase, at midday, sun strikes the courtyard floor directly. Some of the cool air begins to rise and leaks out of the surrounding rooms. This induces convection currents that may afford further comfort. The courtyard now begins to act as chimney during this time when the outside temperatures are highest – Figure 2.7.

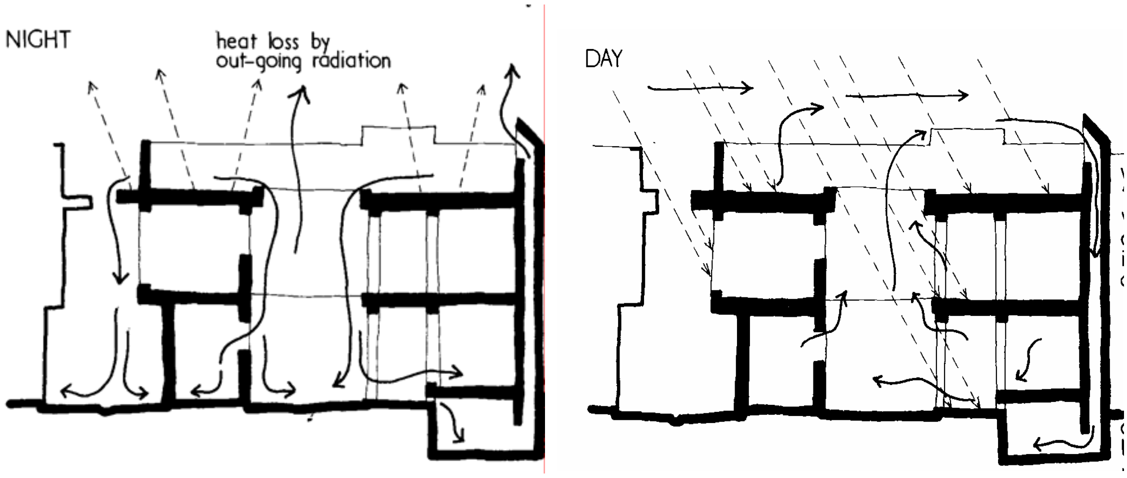


Figure 2.7- Thermal performance of the courtyard in a traditional house

(Source: Ragette, 2003)

During the third phase, the courtyard floor and the inside of the house get warmer and further convection currents are set up by late afternoon. Most of the cool air trapped within the rooms spills out by sunset. During the late afternoon the street, courtyard, and building are further protected by shadows of adjacent structures. As the sun sets in the hot arid zones, the air temperature falls rapidly as the courtyard begins to radiate rapidly to the clear night sky. Cool air begins to descend into the courtyard, completing the cycle (Moore, 1993, P.51).

2.4.4. Building Envelope and Materials

The building envelope of a traditional house forms an effective barrier against the worst extremes of the external climate. It provides a filtering which modifies the climate sufficiently for the internal conditions to be more acceptable (Collier, 1995, P.52).The main function of the house envelope is to resist the transference of heat, reflecting sun rays as much as possible, minimize the heat and solar gain to create cool conditions inside and counteract excessive solar gain (Giovani, 1998, P.120).

Building envelope in traditional architecture was constructed of indigenous building materials that were appropriate of to ambient environment whether in physical properties to climatic conditions or the construction techniques employed by the society that produced this architecture. Oliver (2003, P.133) asserts that by saying:

> "*Building materials selected from natural resources available to different cultures to build their houses can be examined as to the structural properties of materials selected, and the methods employed in using them fro construction. They may also be considered in terms of their climatic suitability and performance, and means by which cultures have utilized their thermal properties, or have devised methods or structures to modify climate"*.

Traditional building materials, such as brick, stone, palm trunks, and wood are usually natural, so they are generally low in embodied energy and toxicity (Kim & Rigdon, 1998b, P. 13). Often, traditional building materials are local and better suited to climatic conditions; thus, they create comfortable internal environment passively and naturally. Traditional building materials obtain potential of sustainability. They are low embodied energy, recyclable, reusable, energy efficient and environmentally sustainable. Undoubtedly, this is, in a way, in compliance with the Islamic principals of encouraging the use of indigenous materials for sustainable living.

Traditional building materials such as such brick and stone were massive. They were good thermal insulators when used as thick walls with minimum external openings. The almost solid elevations provided privacy for family especially for ground floor spaces. External treatments were simple reflecting humility and social equity.

2.4.5. Natural Ventilation

The basis of a significant portion of the contrast in passive and active design lies in the pedagogical relationship of the development of passive strategies from traditional prototypes and practices. Traditional architecture depends on passive design characteristics.

Natural ventilation was one of the passive cooling strategies that traditional architecture employed to create comfortable indoor climate through evaporative cooling. Traditional houses are oriented with respect to prevailing wind. Blank facades are oriented to shield the outdoor living spaces from the hot winds while allowing adequate winter sunlight to penetrate the living zones. Wind movement and humidity also are important and should be considered simultaneously with the direct and indirect effects of the sun. Wind towers, malqafs, barjeels, or badgers are the main natural ventilation features, along with courtyard and air pullers, formulate a complementary natural ventilation system for the house.

In cooler seasons, which air movement is not required, dampers are easily shut and the wind catchers' openings covered. A typical wind tower resembles a chimney, with one end in the ground floor and the other end rising from the roof. The upper part of the tower is divided into several vertical air passageways that germinate in openings in the sides of the tower. Barjeel design differ in the upper side, the cross section of the air passages, the placement and number of the openings and the placement of the tower with respect to structure it cools. Openings in the lower part of the barjeel open into the ground or first floor in the central hall or the family master room. The flow of air through different parts of the building can be controlled by opening or closing the openings grillers upward and downward (Hinrichs, 1987, P. 258).

2.4.6 Thermal Mass Effect (Subterranean Building)

Mass-effect cooling (subterranean building) is one of the sustainable passive energy strategies that had been used in Arab countries for a long time to accommodate to harsh environment. Thermal mass-effect cooling means utilizing mass thermal storage of earth to absorb heat during the warmest part of a periodic temperature cycle and release it later during a cooler part (Golany, 1983, P.53). It can be achieved by: dampening out interior daily temperature swings, delaying daily temperature extremes, ventilating "flushing" the building at night and earth contact to achieve seasonal storage (Moore, 1993, P.209).

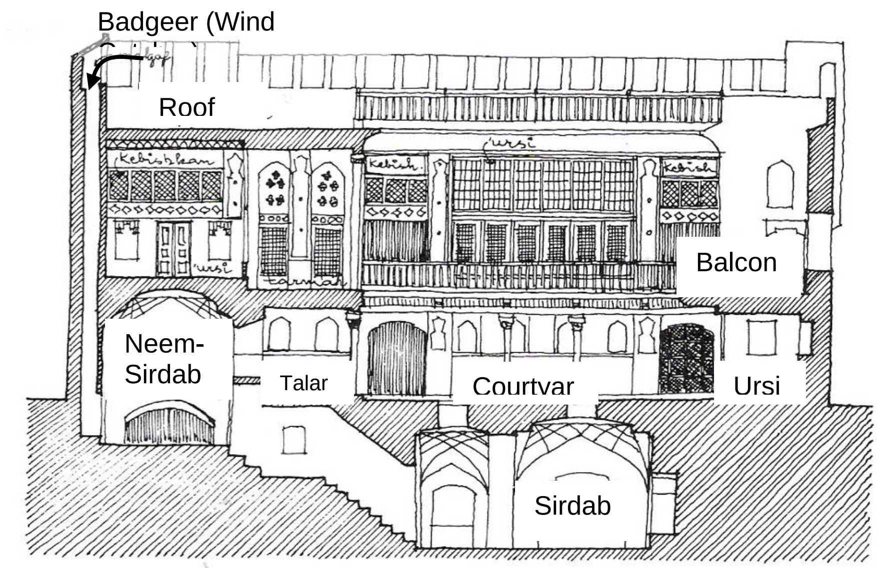


Figure 2.8- Basement as thermal mass effect cooling strategy- traditional house in Baghdad
(Source: Ragette, 2003,)

The basement or "*Sirdab*" is one of the most successful architectural elements that utilize the thermal storage of the earth to provide comfortable indoor climate when the temperature reaches its maximum limit outside. Subterranean air tunnels or stream connected to the basement by a vertical shaft, were used to cool the internal spaces (Fethi, 1988, P.89).

The *Sirdab* had to be ventilated efficiently by using wind catchers "*badger* or *malqaf*", which is a vertical shaft, opens high above the roof level towards the favorable prevailing winds, with another opening at the basement close to the lowest level of the building (Al-Zubaidi, 2002 September, P.9). In Iraq, besides *Sirdab*, rooms around the courtyard are dropped down by (1.00-1, 20) m and have high windows, they are called (*neem-sirdab*), which means (half-basement) (Ragette, 2003, P.64) – Figure 2.8.

Inhabitants adjusted their daily life to obtain comfortable internal environment within affordable natural resources. In the morning time when courtyard is still cool and shaded, inhabitants, especially women and children, used the courtyard for daily activities as cooking, eating, cleaning, and women reception. In the afternoon when outside temperature reaches its maximum, inhabitants stayed in the basement that is much cooler than other spaces in the house. This is due to time lag because of mass effect and natural ventilation from the wind catcher. Mass-effect cooling (subterranean building) is a sustainable passive energy strategy that utilizes natural resources. Yet it affected family life system that was flexible to accommodate to natural environment within social values that were accepted by everyone.

According to the issues raised in this chapter, it was found that sustainability is present in traditional architecture spontaneously. Our predecessors built sustainably; it was the way they accommodated to the harsh ambient environment. Sustainability was not implemented deliberately; it was spontaneous yet it was not random or incidental, it was based over deep investigation and evolved over years of trial and error getting use of available natural resources. Sustainability environmental and social dimensions in traditional architecture will be discussed thoroughly in chapter six with special refer to domestic buildings in the UAE.

Conclusions

Issues discussed in this chapter declare that Islam presents a comprehensive approach to dealing with environment aiming to preserve environment and protect it from pollution. The Holy Quran and the *Sunnah* contain a number of conditions and instructions that govern man's behaviour with regard to the environment. Discussing sustainability and environment in the Islamic perspective led to these conclusions:

- Islam draws the attention to the reality of the environmental balance and urges people to preserve this balance. In its main sources: the Quran and the Sunnah, Islam has warned against the pollution and damage man will inflict upon the environment.

- Environment philosophy in Islam relates environment to Muslims' belief and urges him to preserve environment from harm linking the protection of environment to the essence of the Islamic faith.
- Islam considers human being as stewardship on earth (khalifah) as his duty is to look after this amanah (trusteeship).
- Relation between human being and environment, with all it resources, is based on two values: Utilisation or Subjection (Taskhir) and Middle way or Moderation (Wasati'ah).
- The right to utilize and harness natural resources, which God has granted man, necessarily involves an obligation on man's part to conserve them both quantitatively and qualitatively.
- Doctrines of environment in Islamic perspective match the sustainability principles that call for environment conservation, rational consumption of resources, preserving resources as air and water, call for greenery and plantation, and keeping environment balance.

Traditional architecture, in the Arab world, responded to Islamic *sharia'h* and integrated with Islamic legislations, thus it has great potential of sustainability and utilising natural available resources. The traditional architecture response to sustainability and environmental issued can be illustrated as follows:

- Sustainability principles on which traditional architecture, especially houses, design are integrated on both urban planning and architectural design levels.
- Traditional architecture achieved environmental sustainability, on urban planning level, by modifying natural environment through compact urban planning, narrow streets treatment and orientation, shading passageways and attached buildings
- On architectural design level, traditional architecture achieved environmental sustainability, through utilizing natural indigenous materials, depending on passive cooling & heating strategies using renewable energy and natural ventilation.
- Courtyard house was the most appropriate design solution to provide privacy and comfortable internal environment.

Issues raised in this chapter indicated the importance of referring to sustainability principles in Islam philosophy; this will form a theoretical base in formulation of sustainability social assessment method that will be carried out in chapter five and discussing domestic buildings, in the UAE, in chapter six.

Part One

Theoretical Background

Chapter 3

Impact of Socio-economical Development on Architecture in the UAE

Main Headings

- 3.1. UAE: General View
- 3.2. Socio-cultural Changes on Modern Architecture in the UAE before Federation
- 3.3. Socio-economical Boom and Architecture in the UAE after Declaration of Federation

Chapter Three: Impact of Socio-economical Development on Architecture in the UAE

Introduction

Most of the urban settlements in the United Arab Emirates were situated along the coastline such as Dubai and Sharjah, on an island such as Abu Dhabi, or in the desert as Al Ain and Lewa oasis. Architecture of the region was a product of the natural environment and social values. After the discovery of oil in the sixties, economic prosperity allowed rapid changes in the social and cultural values of the society. The UAE, as many other Third World countries, was eager to follow the Western model of modernization and development. As a consequence, the urban environment was changed to meet the new ambitions. Modern buildings replaced traditional architecture and the simple lifestyle of the inhabitants was transformed to a modern one. Architectural boom was related to the introduction of new building materials to the area such as concrete, steel and glass, as well as electricity to power air-conditioning, completely revolutionizing the building process. As a result of new technology, architecture was suddenly freed from its old constraints, and there was a rush to produce buildings of a novel design and appearance.

This chapter looks into natural and cultural background of the UAE. It investigates architecture correspondence to the ambient environment following architecture development during the 20th century. It traces roots of modernization during the first half of the 20th century pursuing the architectural boom the country witnessed since declaration of federation in 1971. This chapter is part of the theoretical background that provides a holistic view about the environment where this research has been undertaken via tracing architectural development in response to economic and cultural changes.

3.1. UAE: General View

The United Arab Emirates was established in 1971 as a federation of seven emirates. Few nations on earth have experienced more far-reaching change over the past few decades than the United Arab Emirates. This federation of seven ancient Emirates - Abu Dhabi, Dubai, Sharjah, Ras al-Khaimah, Umm al Qaiwain, Ajman and Fujairah - is not only the world's fourth largest oil-producer, but also its richest state per head of population, and the new commercial hub of the Middle East (www.uae.gov.ae - Last accessed 21-03-2004)

3.1.1. UAE: Location and Geography

Formerly known as the Trucial States, seven emirates along the Arabian Gulf coast of the Arabian Peninsula together form the United Arab Emirates. It is bordered by Qatar on the northwest, Saudi Arabia on the west and south and Oman on the east and northeast - Figure-3.1.

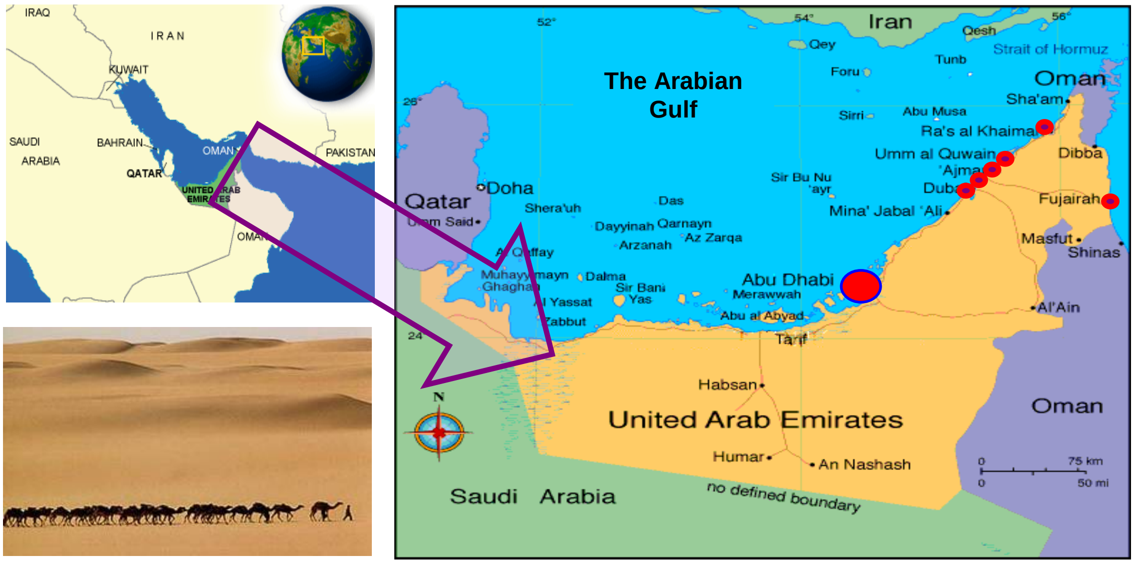


Figure 3.1 - UAE map: Location & Geography
(Source: the author based on www.travel-island.com , www.uaemaps.com)

The UAE stretches for more than 650 kilometres along the southern shore of the Gulf. Most of the coast consists of salt pans that extend far inland. The largest natural harbour is at Dubai, although other ports have been dredged at Abu Dhabi, Sharjah, and elsewhere. The smaller islands, as well as many coral reefs and shifting sandbars, are a menace to navigation. Strong tides and occasional winds further complicate ship movements near the shore.

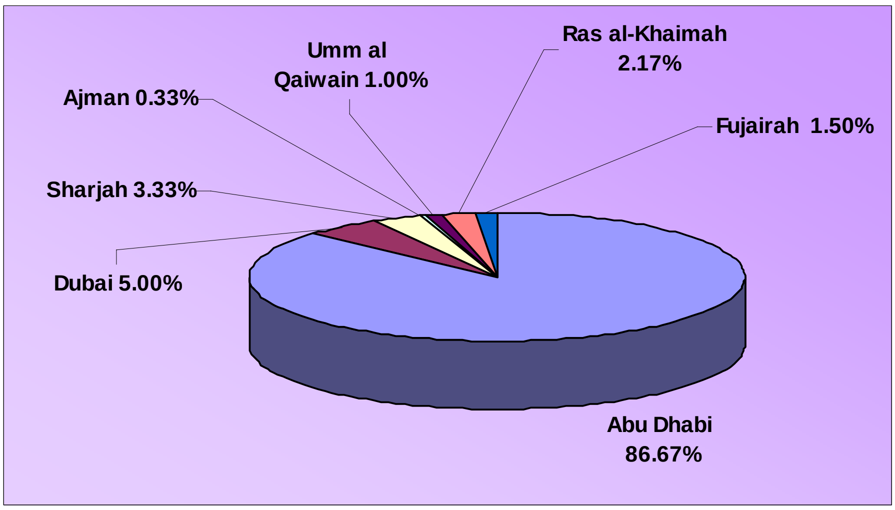


Chart 3.1 - Emirates Area Percentage in the UAE
(Source: the author based on UAE Yearbook, 2006)

The total area of the UAE is approximately 77,700 square kilometres. The largest emirate, Abu Dhabi, accounts for 87 percent of the UAE's total area (67,340 square kilometres). It stretches along the Arabian Gulf coast. The six other emirates are clustered on the Musandam Peninsula, which separates the Arab Gulf from the Gulf of Oman; they are Dubai, Sharjah, Ajman, Umm al-Qaywayn, and Ra's al-Khaymah on the Arabian Gulf side and Al-Fujairah on the Gulf of Oman side. The smallest emirate, Ajman, encompasses only 259 square kilometres- Chart 3.1.

Geographically the country is divided into four areas: the mountain zone in the East, gravel plains west of the mountains, the coastal strip where most of the towns are located and the great desert of the interior- Figure 3.2. The topography is mostly desert land and sand dunes covering more than 75% of the area which is the end of the Empty Quarter of the Saudi Desert. The Eastern coastal stretch is continuous from *Kalba* in the South to *Khorfakan* in the North. The Western coastal stretch starts as narrow as 1 km South of *Sham* and widens gradually towards the North with several islands and coral reefs in the Gulf (Mahgoub, 1997, P.5).

Figure 3.2 - UAE Geographical Diversity

(Source: UAE Yearbook, 2006; the author)

3.1.2. UAE: Climate

UAE lies between 22°50' and 26° north latitude and between 51° and 56°25' east longitude, which means that most of its land is located in a sub tropical area where Cancer latitude (23º 5") crosses over its southern third part. It is exposed to vertical sun during the summer time and most of the autumn and spring seasons.

Thus, the climate of the area could be classified as Hot Arid, except the coastal strip, with the lack of significant precipitation. Clear sky and the lack of vegetation enhance the heat effect not only during the day time but also well into the short evening hours especially during the summer season when day hours exceed 16 hours. Humidity is high because of evaporation from the nearly closed Arabian Gulf reaching 90% in some areas near the coast during the summer time making the temperature unbearable.

The hottest months are July and August, when average maximum temperatures reach above 48° C on the coastal plain. In *Al Hajar* and *Al Gharbi* Mountains, temperatures are considerably cooler, a result of increased altitude. Average minimum temperatures in January and February are between 10° C and 14° C – Chart 3.2. During the late summer months, a humid south-eastern wind known as the *Sharqi* (the eastern) makes the coastal region especially unpleasant. The average annual rainfall in the coastal area is fewer than 120 millimetres, but in some mountainous areas annual rainfall often reaches 350 millimetres. Rain in the coastal region falls in short, torrential bursts during the summer months, sometimes resulting in floods in ordinarily dry *wadi* (valley) beds. The region is prone to occasional, violent dust storms, which can severely reduce visibility.

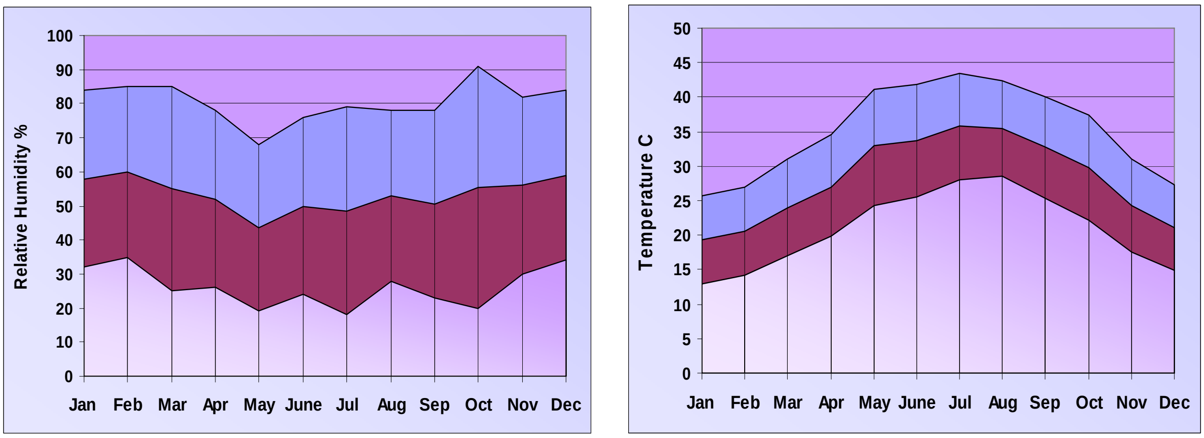


Chart 3.2 - UAE Monthly Temperature & Relative Humidity Average

(Source: the author based on UAE Annual Statistical Book, 2003)

3.1.3. UAE: Historical Overview

Despite its harsh climate, civilization has flourished in this region since the earliest times. There is archaeological evidence of fairly well-to-do communities who lived in the area as much as 5000 years ago (Heard-Bey, 2004). This area was converted to Islam in the 7th century. Early British expeditions to protect the India trade from raiders at Ras Al-Khaimah led to campaigns against that headquarters and other harbours along the coast in 1819. The next year, a general peace treaty was signed to which all the principal sheikhs of the coast adhered. In 1853, a treaty was signed with the United Kingdom, under which the sheikhs (the "Trucial Sheikhdoms or States") agreed to a "perpetual maritime truce." It was enforced by the United Kingdom, and disputes among sheikhs were referred to the British for settlement. Primarily in reaction to the ambitions of other European countries, the United Kingdom and the Trucial States established closer bonds in an 1892 treaty, similar to treaties entered into by the U.K. with other Gulf principalities (The Columbia Electronic Encyclopedia, 2006).

After World War II the British granted internal autonomy to the sheikhdoms. Discussion of federation began in 1968 when Britain announced its intended withdrawal from the Arabian Gulf region by 1971, to end the treaty relationships with the seven Trucial States. When the British-Trucial Sheikhdoms treaty expired on December 1, 1971, they became fully independent. On December 2, 1971, six of them entered into a union called the United Arab Emirates; the seventh emirate, Ras Al-Khaimah, joined the federation in early 1972 (www.uae.gov.ae – Last accessed 16-03-2004).

Over the period since its federation in 1971, the United Arab Emirates has witnessed dramatic changes as the revenues from its oil and gas production have been put to good use in the building of a modern infrastructure, while its population has grown rapidly (Al Abed & Hellyer, 2001, P.6).

3.1.4. Population and Society

The population of the United Arab Emirates is concentrated primarily in cities along both coasts, although the interior oasis settlement of *Al-Ain* has grown into a major population centre as well. Several Emirates have enclaves within other emirates. The harsh environment and marginal economic conditions kept the population of the region low and economically depressed until the exploitation of oil. According to estimates, between 1900 and 1960 there were 80,000 to 95,000 inhabitants in the emirates, mostly in small coastal settlements. Although the population of the emirates probably did not increase a great deal during this period, there were considerable shifts within the territories, caused by changes in economic and political conditions.

Abu Dhabi's onshore oil exports began in 1963, bringing wealth and a demand for foreign labour. The 1968 census, conducted under the British, was the first in the area; it enumerated 180,226 inhabitants. Ever greater demands for labor and expertise fueled a population boom throughout the 1970s and early 1980s. Although the population density was about twenty-five persons per square kilometer in 1991, the population was unevenly distributed among the seven emirates. The three most populous emirates, Abu Dhabi, Dubai, and Sharjah--together accounted for roughly 84% of the total population. The remaining 16% lived in Ras al Khaimah, Ajman, Al Fujairah, and Umm al Qaiwain.

The population of the UAE is overwhelmingly urban, with more than 90 % of the people living in cities. The largest city, Abu Dhabi, the federal capital, Dubai, the second largest city and the UAE's main port and commercial center, then Sharjah. Other northern emirates have many fewer inhabitants. Chart 3.3 shows population percentage in different emirates in the UAE.

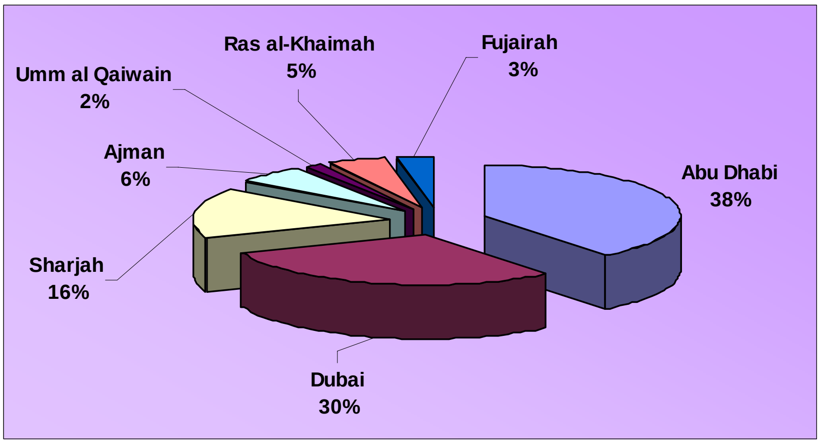


Chart 3.3 - Emirates Population Percentage in the UAE

(Source: the author based on UAE Yearbook, 2006)

The UAE had an officially estimated population of 1.9 million in mid-1991; ten years later the population of the UAE was estimated to be 2.94 million in 2001, with a growth rate of around 6.5% a year. This was to slow to 2.9% by the year 2005, when the population was estimated to be 3.48 million (The World Factbook, 2006). The latest census conducted in December 2005 and published in July 2006 showed that the total number of UAE's population has reached 4,104,695 with population growth rate 1.52% - Chart 3.4 (www.uaeinteract.com- Last accessed 18- 08-2006).

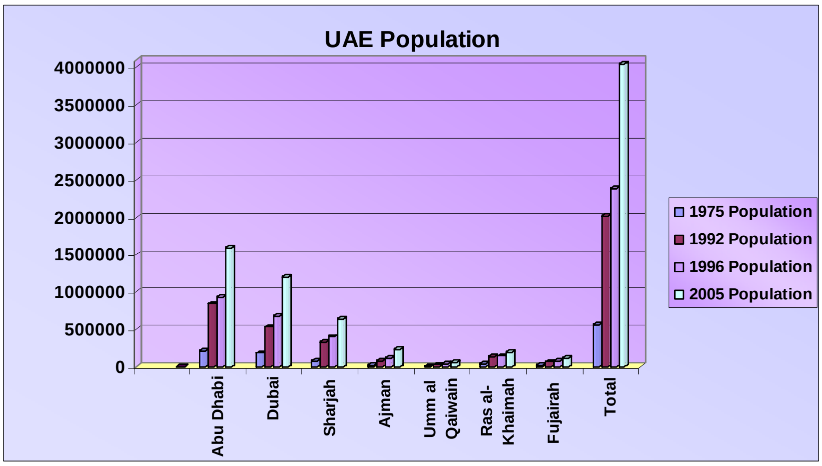


Chart 3.4 - UAE Population Development

(Source: the author based on UAE Yearbook, 2006)

Population demography in the UAE is unbalanced between nationals and expatriate residents; UAE citizens are less than one fifth of the total population. The number of foreign workers has increased dramatically since 1968, when they constituted 36% of the total population. By 1975 foreigners accounted for 70% of the population, increasing to 80% in 1980 and to 88% in 1985. Since 1985, the percentage of foreigners has levelled at 88%. The latest statistics show that UAE citizens account for a little over 19 % of the population, with the rest of the population coming from: other Arab and Iranian 23%, South Asian 50%, other expatriate (Western and East Asian) 8% - Chart 3.5 (NI World Guide 2005/2006- www.alertnet.org – Last accessed 21-8-2006).

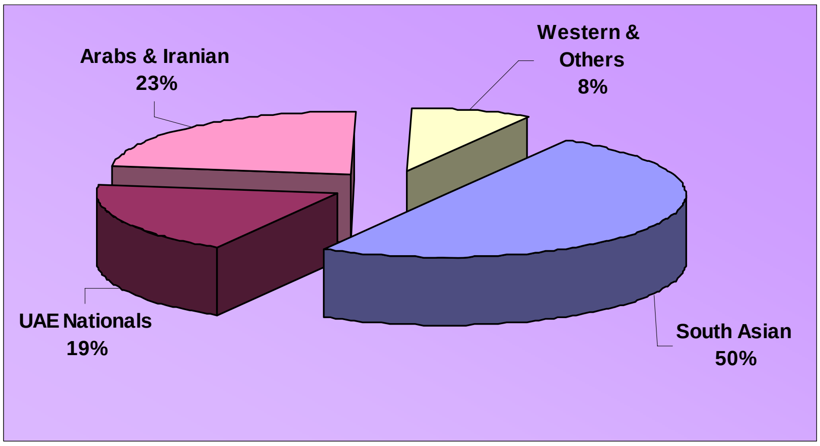


Chart 3.5 - Ethnic grouping percentage in the UAE society

(Source: the author based on NI World Guide 2005/2006)

3.1.5. Economy & Resources

Life on the Trucial Coast - as it was known until the 1970s - and in its hinterland, was one of considerable hardship. In the towns, fresh water was scarcely available and often had to be drawn by oxen from deep wells, or even brought in barrels from neighboring islands by dhow. Tribesmen would harvest the unreliable winter rains by stretching a sail with a hole in its center between two poles, and in the merciless heat of the Arabian summer would trap the cooling winds by the ingenious use of wind-towers made of sackcloth or cotton. On the sun-blasted terraces of *Al Hajar* Mountains, subsistence farmers eked out a bitter existence, and in the interior the hardy Bedouin scoured the dunes of the great Empty Quarter for pasture. In the hot months, members of these various groups would come together to work as divers in the pearl-yielding oyster beds which flourished in the warm, shallow waters of the Gulf. For almost three millennia the economy of this region was bound up with the pearling fleet, culminating in a boom that was only ended by the cultured pearl invention, in the 1920s (www.uae.gov.ae – Last accessed in 15- 03-2004).

The economic resources of the country were not enough for any one family to rely on only one way of making a living. In order to survive, people had to be versatile; people had to interchange roles within a group. In the Northern Emirates some tribal people moved to the coastal settlements of Sharjah, Dubai and Ajman, earning enough in a good year to maintain themselves and their families on the season's takings, and they depended entirely on this occupation – Figure 3.3.

Figure 3.3 – Samples of the old ways of living in the UAE
(Source: the author based on www.uaeone.com)

Between the decline of the pearling trade because the markets became swamped with Japanese cultured pearls at the very time of the world economic slump and the first export of oil, lay over 30 years of poverty aggravated by inflation of the price of imported food, world war rationing, locust plagues and dashed hopes of oil discoveries similar to those in neighbouring Qatar, Saudi Arabia or Kuwait.

After oil discovery and production commercially in the 1960s, The United Arab Emirates became important to world energy markets because it contains 98 billion barrels, or nearly 10%, of the world' s proven oil reserves. The UAE also holds the world's fifth-largest natural gas reserves and exports significant amounts of liquefied natural gas (CIA World Factbook 2003).

The UAE has an open economy with a high per capita income and a sizable annual trade surplus. The gross Domestic Product GDP per Capita was 59,844 in 2003. UAE is considered of rich oil and gas countries where their reserve of oil is about 97.8 billion barrels; 94% of this reserve is in Abu Dhabi, while UAE natural gas reserve is about 212.1 trillion cubic feet; 92% of it in Abu Dhabi. Its wealth is based on oil and gas output (about 33% of

GDP), and the fortunes of the economy fluctuate with the prices of those commodities (UAE Yearbook, 2006, P.344). The UAE citizens' annual income is considered one of the highest in the world; it reaches 61 thousand Dirham (about 17 thousand USD) (UAE Yearbook, 2006, P.224).

Since 1971, the UAE has undergone a profound transformation from an impoverished region of small desert principalities to a modern state with a high standard of living. At present levels of production, oil and gas reserves should last for more than 100 years. The government has increased spending on job creation and infrastructure expansion and is opening up its utilities to greater private sector involvement (www.worldfacts.us/United-Arab-Emirates - Last accessed 12-09-2005). Industries involving the area's oil and natural-gas deposits are still critical to the increasingly diversified economy, but international banking, financial services, regional corporate headquarters, real estate development projects and tourism are also important to support the country economy in the oil depletion expectations in the coming few decades (www.infoplease.com - Last accessed in 12-09-2005).

3.2. Socio-cultural Changes on Architecture in the UAE before Federation

Tracing the roots of modern architecture in the United Arab Emirates necessitates an overview on the nature of the society at that time. As separated sheikhdoms or states, each emirate experienced different levels of modernity depending on each emirate economy, location, local individuality, and ruler's policy and vision.

The early stage of modern architecture in the United Arab Emirates began in 1930 when the first airport was built in Sharjah; few new buildings were erected in 1940s. The modernization process accelerated in the 1950s and 1960s when expectations of oil production attracted the sight of western companies to the region as a future source of energy and its potentiality for un-preceded opportunities and investments. These expectations were enhanced with the emirates rulers' wide visions towards the future and their persistence to be in the same modern levels that the neighbouring counties began to experience at that time.

The declaration of the federation in 1971 was the turning point in the United Arab Emirates in all aspects; the country experienced drastic economical and social changes that were of great influence on the architectural boom the country witnessed and altered the realm of its people ever since.

3.2.1. Architecture in the United Arab Emirates 1900-1930: Continuity of Traditional Architecture

In spite of the ancient history of the United Arab Emirates region the urban settlements were small and fragmented depending basically on resource availability and location protection. Consequently most of the main cities, such as Dubai and Sharjah, were established on a land where both a creek and fresh water were accessible. Sometimes the location was a real island as that of Abu Dhabi where it can be reached only through the shallow waters when the tide is low (Ouf, 2000, P.21).

Before the discovery of oil, the inhabitants of the UAE lived a simple and traditional life. The economy was simple and the inhabitants depended on date crops and sheep herding as the main sources of income. Traditional architecture found in the region reflected their social and cultural values. It responded to the harsh natural environment with innovative solutions suitable for the mostly hot-arid weather conditions.

Most of the cities in the United Arab Emirates dated from the 18th and 19th century. Abu Dhabi was erected in 1761 by Sheikh *Dhiab Bin Essa Al-Nihayan* as a capital to the Emirate. Dubai was thoroughly described for the first time by the British *Lieutenant Cogan* in 1822 with 1200 inhabitants, yet Dubai as an independent emirate appeared in 1833 when the Maktoom family, originally from Abu Dhabi, ruled the city (Guy, 1990, P.359). Sharjah dated to the 17th century but it was developed when the Qawasim ruled it since the early 18th century (Ouf, 2000, P.22). These cities developed gradually into a busy commercial centre where people of differing cultures and traditions from far and wide settled and inter-mixed, eventually leading to the unique community which is seen today. Due to the simple life the inhabitants of the United Arab Emirates were living and shortage of resources and the motivation to change, architecture in the first four decades of the 20th century remained traditional. Even the few countable new buildings erected in Sharjah and Dubai were public and had no direct influence on the way people built, the building materials they used or the construction techniques they followed.

Until the1940s, when oil-exploration started in the United Arab Emirates, there was no electricity, any plumbing or telephone system, not a single public hospital or modern school, no bridges, no deep-water harbour, no metalloid roads (www.uae.gov.ae – Last accessed 12-09-2006). Urban fabric of cities in the United Arab Emirates remained organic. Even in the 1950s when few main roads were opened, the over all urban fabric of the city, especially the residential, reserved its traditional characteristics.

The traditional architecture found in the region reflected its people social and cultural values. It responded to the harsh natural environment with innovative solutions suitable for the hot climate conditions. Being a multi-cultural society, traditional architecture in the United Arab Emirates was a result of the cultural mixture of different nationalities of people who lived there- Figure 3.4. In general it is influenced by Islamic architecture which developed in the area (Bukhash, 2000, P.19).

Figure 3.4 –Sharjah city in 1930s: traditional urban fabric and low-rise buildings
(Source: Juma Al-Majid Centre for Culture & Heritage, 2005)

Most buildings in the United Arab Emirates, until the 1940s, were to be categorized under five types: defensive, religious, residential, markets and public buildings. Most of the buildings in the United Arab Emirates dated from the 18th and 19th century, because most of the urban settlements referred to that era. Even buildings that were erected in the early decades of the 20th century as forts, houses, or schools were built in the traditional way.

3.2.1.1. Defensive Buildings

Defensive buildings as castles, forts and watchtowers were fundamental features of the cities in the United Arab Emirates. In the 18th and 19th centuries cities were small and fragmented so they had to be secured and protected against enemies and dangers; they were built of coral stone as a strong and durable material and readily available locally. The fort was the main element of the city while people's houses were built nearby. In most cities of the United Arab Emirates the ruler's residence and court was integrated within the fort, which was a symbol of the emirate status and might (Ouf, 2000, P.24). Forts were also places of shelter for the people whenever they were attacked as the Fort Palace (Qasr Al-Husin) that was built in 1793 by Sheikh Shakhbout Bin Dhiab Al-Nihayan of Abu Dhabi (Maitra,. & Al-Hajji, 2001, P.15) – Figure 3. 5.

Figure 3.5 –Fort Palace in Abu Dhabi: the most important feature of the city

(Source: Maitra & Al-Hajji, 2001)

Each city had its own forts; most of them were built in 18th and 19th centuries, few were built during late 19th century and early decades of the 20th century- Figure 3.6. In Sharjah emirate, Sheikh Saed Bin Hamad Al-Qasimi built Al-Gail fort in Kalba city in 1903. Al-Jahili fort was built in 1898 by Sheikh Zayed Bin Khalifa 1st, Eastern Fort in 1910 by Sheikh Sultan Bin Zayed, and Qasr Al-Husin in Abu Dhabi was expanded in 1936-1939. Al-Muaejaie fort was built in 1946 and Al-Muabaá fort in 1948 by Sheikh Zayed Bin Sultan in Al-Ain city (Rashid, 2004, PP. 83, 84, 86).

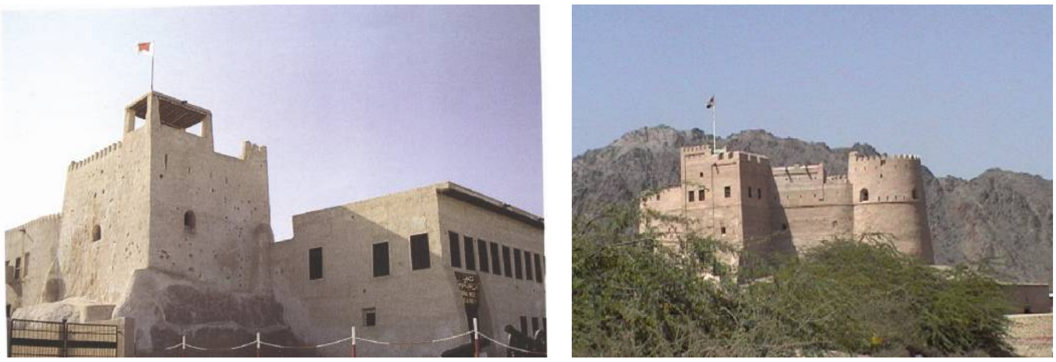


Figure 3.6 - Castles were defensive buildings and the ruler residence

(Source: the author, 2004)

3.2.1.2. Religious Buildings

Religious buildings, especially mosques, were one of the most important features in each city, Mosques were built in both residential and commercial districts to enable people to do their prayers five times a day, besides the grand mosque (Al-Masjid Al-Jamie) for Friday prayer and discussion of society affairs. In residential areas small mosques were constructed from coral stones and gypsum and were simple with no sophisticated ornaments and decorations that characterized most of the mosques in the Islamic World. Unlike residential buildings, mosques had openings to the outside for natural lighting and ventilation.

3.2.1.3. Residential Buildings

Residential buildings formed most of the city urban fabric. In urban coastal cities, there were two types: The palm tree frond houses "*Arish* or *Parasti*" for the low-income people and the large courtyard houses made from coral stone and gypsum for the rich people. In the nineteenth century, most of the houses were of one storey only. In the beginning of the twentieth century when coastal cities, especially Dubai, opened its doors for international traders, many merchants settled in the city and started building two storey houses. Wind-towers and toilets were introduced into the houses in the 1920's (Bukhash, 2000, P.20).

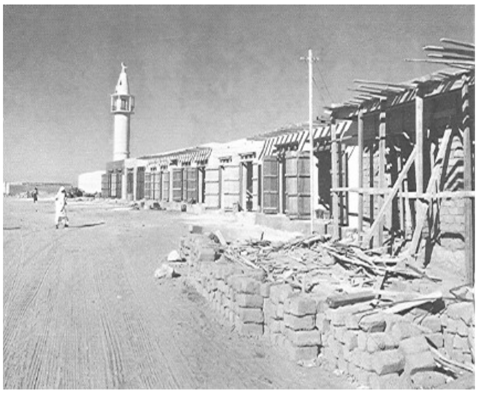
Houses were inward looking corresponding to environmental conditions and social values. All the private spaces opened to an internal open courtyard to provide privacy and modify internal environment for the inhabitants. External elevations were massive and almost solid especially in the ground floor level. Small opening appeared in the first floor in repetitive sequence; the vertical elements were the barjeels (wind catchers) providing internal spaces in the house with natural ventilation. The houses were arranged close to each other with in an organic pattern creating narrow shaded alleys (Sikkas) – Figure 3.7. This planning strategy provided climatic protection where different pressure zones were created between shaded and sunny spaces causing natural air movement necessary for the hot humid climate of the coastal cities. Buildings houses in the traditional way continued during the first half of the 20th century until modern building materials such as concrete began to be used in domestic buildings gradually in the 1950s.

Figure 3.7- Accommodation to environment in traditional architecture in the UAE: solid walls, small openings, light finishing, courtyard, & barjeels

(Source: the author, 2005)

3.2.1.4. Markets (Souqs)

Markets (Souqs) were the economical vein of the city in the United Arab Emirates especially coastal cities where the "Souq" was linear along the coast or the creek. The souq consisted of several shops arranged linearly in a respective sequence connected with residential districts with certain routes perpendicular to the main souq stream – Figure 3.8 (Dubai Municipality, 2004, P.46). Some of the old souqs are still vital playing an important role in the city economical life, especially in Dubai and Sharjah.



Al-Ain Market

Dubai Market

Figure 3.8 – The old market (Souq)

(Source: Juma Al Majid Centre for Culture & Heritage, 2005)

Public Buildings as schools, *Majlis*, rest houses (Khans), and administrative buildings such as customs were sacred because of the simple life inhabitants used to live before oil discovery in the country; they were located according to each building function and requirements. Most of these buildings were built in the 19th and early 20th century- Figure 3.9. Even public buildings erected in the first three decades of the 20th century were built traditionally.

Al- Ahmadiya School

Majlis Umm Al Sheef

Figure 3.9 – Traditional Public Buildings in Dubai

(Source: Dubai municipality, 2005)

Al-Ahmadiya school is an example of public buildings. It was the first formal school in Dubai established in 1912 by a well-known merchant called *“Ahmad Bin Dalmook”* and named after him; it is considered one of the oldest *Nizamiyyah* Schools in the United Arab Emirates. When the school was built, it was one storey high, rectangular in plan, about 25 x 27 meters, with a courtyard in the centre, and about 10 small classrooms for teaching- Figure 2.9. (Bukhash, 2000, P.119).

3.2.2. Architecture in the United Arab Emirates 1930-1950: Early Modern Buildings

The economical and social circumstances, in the United Arab Emirates, were difficult in the 1930s and 1940s because of cultured pearls introduction by Japan and the start of World War II. These unstable conditions and oil discovery in other Gulf countries as Bahrain, Saudi Arabia, Qatar and Kuwait led to emigration of about 18000 male of the Emirates residents to these countries looking for living resources for their families and more job opportunities (Anderson, 1995, P.66). The population therefore markedly decreased from 38000 in 1940 to 20000 in 1953 (Bukhash, 2000, P.165). Harsh conditions at that time led to slow steps towards modernity in architecture in the country and cities remained traditional in urban planning and architectural features – Figure 3.10.

Dubai

Abu Dhabi

Figure 3.10-Traditional urban fabric in the UAE citiesin the late 1940s

(Source: Juma Al Majid Canter for Culture & Heritage, 2005)

Early seeds of modernizing architecture in the United Arab Emirates started in the1930s. British presence in the coast emirates was of great effect on importing modern architecture values to the region. This era witnessed the emergence of un-preceded buildings. Yet the effect of these buildings was limited on the built environment in the region. Building in the traditional ways sustained. This may be referred to the absence of an effective political frame to demonstrate the change into the society norms and traditions (Al-Mansoori & Al-Naim, 200, P.85).

The first modern building in the United Arab Emirates was Sharjah airport. It was built in 1930 when the air navigation began in Sharjah Emirate, which gave birth to new developments to the area. - Figure 3.11; it was used as a rest point for passengers between London, India, and Australia, and then as a fortified hotel during the World War II. Even though being small in size at that time, the first Sharjah airport provided all the facilities of a typical airport, which included facilities for fuel, maintenance, ground services, passenger services (transit/short term). The British aircraft, model HP42, was said to be the first aircraft to land in Sharjah airport in 1932 (www.sdci.gov.ae – Last accessed 11-08-2006).

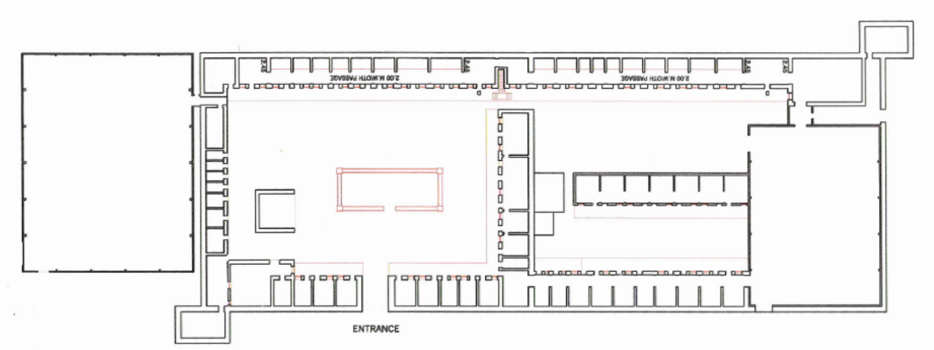


Figure 3.11-Sharjah Airport (1930): the first modern building in the UAE

(Source: Sharjah Heritage Directory, 2006)

The airport was designed by British engineers, yet built by locals using indigenous building materials (Zahlan, 1978). Being built for its benefits, the British government financed that building. The construction process was the ruler of Sharjah responsibility; he was to provide labor, transportation, and stones that were brought from Abu Mousa Island, while British government provided the building with doors, windows, steel angles, and corrugated iron (Anderson, 1995, P.67). This was upon the agreement set between the British government representative and the ruler of Sharjah. The airport building was restored and became a museum called “Station (Al-Mahattah) Museum” in 2000 – Figure 3.12.

Figure 3.12 -Sharjah airport in 1960s and after restoration in 1990s

(Source: www.uaezayed.com; the author, 2006)

The airport and fort was an example of the colonial architecture that tried to combine between modern and Indigenous building material, traditional construction techniques and design concept. In spite of using imported materials as iron beams for roofing and large sheets of glass in the control tower; the building had the region architecture features: internal courtyard, solid elevations with small openings, and arched corridors – Figure 3.13.

Figure 3.13-Sharjah Airport: combination between modern materials and ambient environment

(Source: the author, 2006)

During the 1930s another public building was built and it was a fine example of early 20th century architecture; Al Wakeel House (house of Agent). It was the first office building in Dubai dedicated exclusively to administration. It was built in 1934 by Sheikh Rashid at the edge of the Creek near the abra landing- Figure 3.14. This early office building reflects the primitive facilities that Dubai's bureaucracy had to contend with (www.dubaitourism.co.ae – Last accessed 11-10-2006).

Figure 3.14 -Al-Wakeel House: the first office building in Dubai (before and after restoration)

(Source: Dubai Municipality, 2007)

The phase between 1930 and 1950 was not a turning point in modern architecture in the United Arab Emirates; at least not as a direct motivator. Yet the new modern buildings that were built throughout this era such as Dubai Clinic (1939) and Imperial Bank in Dubai (1946) introduced the people of United Arab Emirates to different types of buildings and construction techniques they didn't know before. Definitely, these few buildings can be considered the early beginnings of the drastic changes and the grand development the region witnessed in the subsequent decades.

3.2.3. Architecture in the United Arab Emirates 1950 -1960: Crucial steps for Modernization

When new wealth arrived in the mid-twentieth century, it introduced new building materials to the area, such as concrete, steel and glass, as well as electricity to power air-conditioning, completely revolutionizing the building process. The 1960s saw the beginning of the modern movement in the development of cities throughout the Emirates (Zandy, 1993, P.30).

This decade witnessed erection of new buildings; mostly public utilizing modern materials, for example, as the British Agency (now Embassy) in Abu Dhabi in 1957 (Kay, 1989, P.17). However the traditional ways of building stayed on in domestic building but in a limited scale as Majlis Al Ghuraifa that was built in 1955 as a summer retreat for Sheikh Rashid bin Saeed Al Maktoum (www.sheikhmohammed.co.ae – Last accessed 11-10-2006).

As modern building materials were frequently used in the 1950s as concrete and steel, construction methods and building techniques had to cope with the new materials. Cement was first imported to Dubai in 1955 and the first concrete block house was built in 1956 (Heard-Bey, 1982, P.261). Cement was much cheaper than gypsum, which was traditionally used for building construction, so within few years the traditional building methods with coral stone and gypsum vanished and replaced with ready-made cement block construction. This was the beginning of a new era where traditional ways and forms of architecture were abandoned and new modern styles adopted (Karim, 1999).

The declaration of "Coast Emirates Council" in 1952 was of great effect on modern architecture evolution in the United Arab Emirates. The council began to finance projects that served the society as schools and hospitals (Heard- Bey, 1982, P. 259). During that era other types of buildings were erected responding to modern development in the country as hotels, modern schools, hospitals and markets. The accelerating economical development in Dubai translated into architectural growth in the city since 1950s; Airlines hotel was built in Bur Dubai in 1958, large shops were constructed made of two adjacent spaces with one wind-tower at the top to reduce the heat of the summer (Karim, 1999) and the city witnessed the first modern street in late 1950s.

Sheikh Rashid bin Saeed Al-Maktoum, who is considered to be the founder of modern Dubai, signed a contract with an Austrian company to dredge the creek in order to facilitate the entry of large ships to unload their goods In 1958 (Bukhash, 2000, P.162). In the same year twenty years after the short-lived attempt, a new municipal Council was set up in Dubai, and the nucleus of a municipal demonstration was organized (Heard-Bey, 1982, P.259). This led to the erection of the first modern Dubai municipal building in Deira. Maktoum Hospital was the first modern hospital to be built in Dubai in 1951 for the benefit of the population of all the country (Heard –Bey, 1982, P.266). In this building new materials and techniques: skeleton structure was used; steel columns and cement blocks – Figure 3.15. In 1958 the British consultant John Harris was appointed to design the extension of Maktoum Hospital using concrete for skeleton structure (Cantacuzino & Browne, 1977). To add the effect of regionalism to the building, Harris used wooden partitions for entrance shading and concrete pointed arced-beams for elevations treatment. This approach was just a facial mask and did not encompass deep cultural dimensions and conceptual profundity that the traditional architecture encloses (Al-Mansoori & Al-Naim, 2005, P.88).

Al Maktoum Hospital in Dubai
(Source: Dyck, 2004)

Dubai Municipality building in Diera
(Source: Shuckla, 2006)

Figure 3.15–Modern buildings in Dubai in 1950s

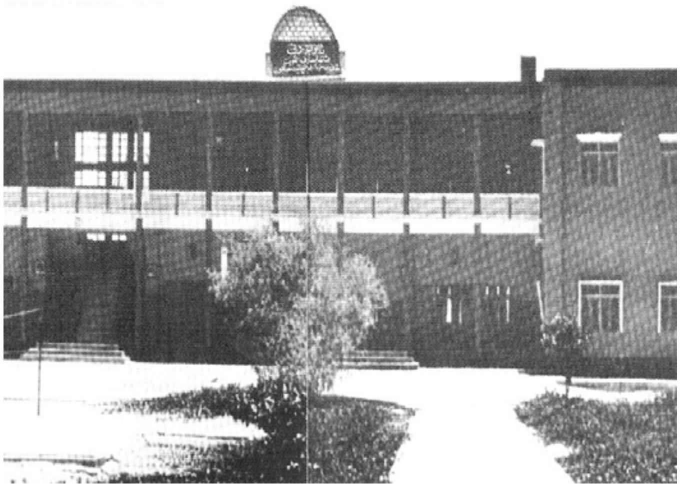
School Buildings in 1950s

Building modern schools was a remarkable step towards modernity in the United Arab Emirates. Until the 1950s, education in the Emirates was based on rudimentary schooling provided by Qur'anic teaching at *madrassahs* attached to community mosques (Shukla, 1999, P.11). During the early 1950's the UAE witnessed important development in formal education, together with teaching by religious men, known as "*Al-Muttawa*". Arabic teachers from Kuwait, Qatar and Egypt played an important role at this early stage. The delay in the development of formal education in the United Arab Emirates is attributed to several factors such as the political and economic situation in the region during that period which also hindered development in other fields (www.dubaitourism.co.ae – Last accessed 22-09-2006).

Formal education depends on formal teaching methods, the teacher, the student and the curriculum, which was controlled by an academic authority evolved in stages throughout the United Arab Emirates. This started in the Emirate of Sharjah in 1953 when Al-Qasimiya School was established, where teaching took place with the assistance of a teaching delegation from the state of Kuwait, who supervised the curriculum, provided books and teachers. The school provided structured education for some 450 boys between the ages of six and seventeen that year (Heard- Bey, 1982, P.261). Al-Qasimiya School catered for many of the residents of Sharjah. The arrival of academic and cultural delegations from Qatar and Egypt in 1954 led to the opening of a school for girls, where the same curriculum was followed.

The success of the new schools encouraged other emirates, acknowledging the importance of education, to build their own schools. During this era Kuwait built 28 schools in the emirates, including facilities in Ajman and Umm al Qaiwain. Kuwait also funded teacher trainees from the emirates to go abroad for training. The British government also built schools in Abu Dhabi, Dubai, and Khur Fakkan and established an agricultural school in Ras al Khaimah in 1955 and a trade school in Sharjah in 1958 and another trade school in Dubai (Heard- Bey, 1982). The first boys' school opened in Al-Ain city in 1958 then the school for girls in 1967- Figure 3.16 (Dyck, 2004, P.82).

The first boys' school in Al Ain in 1958
(Source: Zayed: Journey in Photos, 2001)



The first boys' High school in Bur Dubai in 1959
(Source: Dubai Municipality, 2007)

Figure 3.16 –School Buildings in the UAE

Even traditional schools as Al-Ahmadiah in Dubai introduced a new curriculum in 1956, with subjects such as English, Sociology and Science. The increasing number of students led to overcrowding and as a result, another house was rented and annexed to the school. In 1963 this building was closed and the school was moved to a new location to accommodate more students (www.dubaitourism.co.ae – Last accessed 12-09-2006).

School buildings were simple, one or two stories, yet these buildings had a role in modernization of the built environment in the country because they formed the seed for what was called "Systematic or Mass production building" that became the basic motivator to the accelerating modern architectural development in the United Arab Emirates (Al-Mansoori & Al-Naim, 2005, P.88).

3.2.4. Architecture in the United Arab Emirates 1960-1971: Turning points towards Modernity

The 1960s was a conclusive decade for evolution of the built environment in the United Arab Emirates. This era was filled with revolutionary ideas in different aspects in the Arab World. This was augmented with discovery and economical production of oil in the United Arab Emirates. The image of modernity began crystallizing in the emirates rulers' vision and serious efforts were made to build a unified strong entity for the emirates.

This decade, as Professor Friedrich Ragette declares, witnessed the most extensive and dramatic blending of modern and traditional in the Arab world that has taken place in several of the small states of the Gulf region as Dubai and Abu Dhabi; these cities have undergone dynamic, almost boom-town expansions during the 1960s (Ragette, 1972, P.7).

Kuwait established its first representative office in the Trucial Emirates in 1963. It started to build many projects such as mosques, schools, and health buildings. Establishment of "The Development Office of the Trucial states Council" with its headquarters in Dubai in 1965 boosted the building growth and development process in the country, especially that the council was provided with a number of agricultural, medical and technical experts (Heard-Bey, 1982, P.262).

Definitely, 1966 was a decisive year in development process for the country when sheikh Zayed Bin Sultan Al-Nihayan became the ruler of Abu Dhabi. He led the emirate and the city, which will be the capital of United Arab Emirates after federation, towards new aspects of economical prosperity and social development that were of great effect on evolution of the built environment and architectural scene in the country.

3.2.4.1. Multi story Buildings in 1960s

Throughout the 1960s, multi story buildings began to emerge in Dubai, Sharjah, and Abu Dhabi. In 1962, two buildings could be recognized at Abu Dhabi chorniche; the Shore hotel built by the Lebanese company (KAT), and two-story Abu Dhabi municipality building characterised with straight lines and front balconies. Abu Dhabi Petroleum Company (ADCO) headquarters was built in 1963; this building was the first in Abu Dhabi to utilize concrete skeleton structure and concrete finishes for elevations; this building responded to local environment and climate in its elevation treatments (Al-Mansoori & Al-Naim, 2005, P.91).

Figure 3.17 – Multi-storey buildings forming the area skyline in Dubai in mid 1960s
(Source: Shuckla, 2006)

Dubai creek, being the city business center, witnessed the emergence of many multi- story buildings forming the modern skyline of the creek and the city ever since – Figure 3.17. To get along with modern lifestyle and growing visitors to the city new cinema and hotels were built in Dubai, for example, as Ambassador Hotel in Bur Dubai and Carlton hotel in Deira in 1968 (Dubai, P.28).

One of the distinguished buildings in this era was the First National City Bank in Dubai. Tony Irving and Gordon Jones were commissioned by First National City Bank of New York in 1964 to design a building for the picturesque waterfront of old Dubai, "The Creek." The bank, completed in 1967, reflects the vertical columns, divided bays and strong entablatures of the traditional wind towers of Dubai that still rise above many of the old houses around the site. The building is of concrete (some pre-cast), with exposed surfaces left un-plastered. Patterned screens on all elevations provide sun shading, as well as acting as security barriers – Figure 3.18. The angled arms at the top hold gold-anodized aluminium cylinders, which contain floodlights for security and decorative lighting. Because ground water was found very near the surface, the building is raised on a platform to strengthen the foundations. The platform also provides space for planting. The interior of the bank is finished in bright colours and the public lobby features a mural formed from perforated, decorative white cement panels similar to those used as ventilation openings in traditional Dubai houses (Ragette, 1972, P.12).

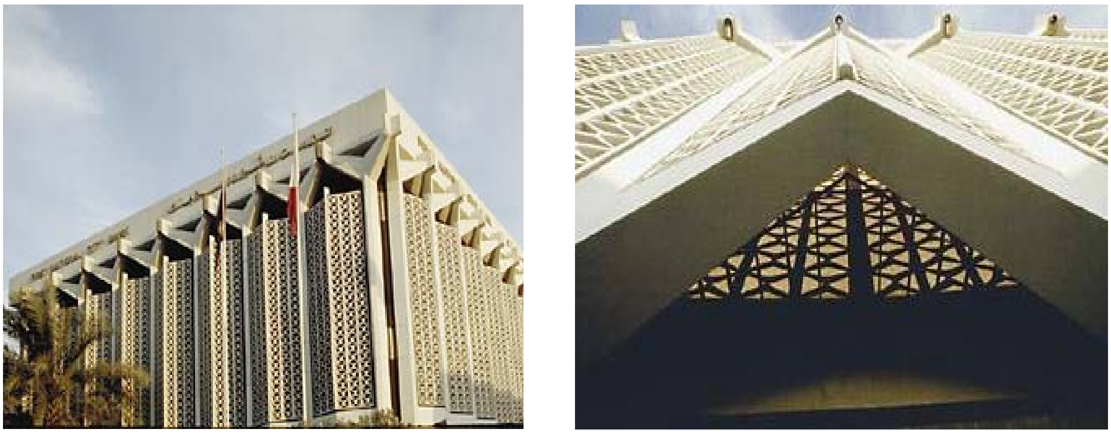


Figure 3.18 -The First City Bank of New York with its white screens on Dubai creek

(Source: Ragette, 1972)

3.2.4.2. Public Services and Municipalities

The 1960s witnessed the improvement of public services when municipalities began to be established or reorganized in all the emirates. Though Sharjah municipality was established in 1948 as the first in the Gulf region, it was reorganized in 1971 (Anderson, 1995, P.74). In Dubai an authority was established in 1954 to manage municipal works; yet in 1961 Dubai municipality and the first municipal council for the city was formed to set up regulations for services and construction in Dubai emirate. The municipality started to offer municipal services and building public projects such as: the new vegetable & fish market, public WCs, water tanks, phone services, public swimming pools, children playgrounds, modern markets even low-income housing project was erected in 1963 (Dubai, P.24).

In 1961 the Dubai Electricity Company was established thus providing houses and shops with electricity which enabled the wind-towers to be replaced with fans and later air-conditioning (Bukhash, 2000, P.162). In the meantime municipalities were established in other emirates and cities; Ras al-Khaimah municipality was established in 1959, Al-Ain municipality in 1967, Ajman municipality in 1968, Um al-Qaiwain municipality in 1968, and Al--Fujairah municipality in 1969 (www.uaezayed.com – Last accessed 11-09-2006). These municipalities offered and organized public services as: buildings licences, health issues, markets, cleaning and urban and architectural regulations.

3.2.4.3. Transportation Projects and Airports

Constructing modern streets and transportation projects began in the 1960s. In Dubai asphalt roads started to be laid to ease transportation between various sectors of Dubai city; laying roads in the historical settlements led to demolishing of many houses. The first bridge to connect the two sides of the creek was built to save cars from travelling between Bur Dubai and Diera via the detour around the head of the creek. After one year of construction, the bridge was opened to traffic in May 1963, rising twenty-five feet above mean tide level, thus allowing vessels to pass beneath to the still undeveloped banks of the inner creek. Building boom in both the public and the private sector accelerated; the expansion of the RAF base (Sharjah Airport) in 1967 contributed to the quickening pace of economic growth. Therefore Sheikh Rashid Bin Saeed of Dubai decided to have the design of the extension to the harbour altered to include fifteen berths; constructing Rashid Port project that has started in the late 1960s was officially opened in October 1972 (Heard-Bey, 1982, P.260).

The growing relations with other countries in the 1960s and expectations of a flourishing economy required constructing modern airports in the country. The first modern airport in Dubai was built in the early 1960s (1959-1961) to attract world airlines to Dubai as a landing spot between Europe and south-east Asia where viscounts of Kuwait Airways started a route three times a week (www.dubaiairport.com – Last accessed 11-10-2006). Dubai airport was a simple building about four kilometres from the city provided with required equipments. It contained passengers' hall and civil defence station for emergency. The runway was about 6 thousand foot long adequate for Dakota and Heronze planes (Dubai, P.58) – Figure 3.19.

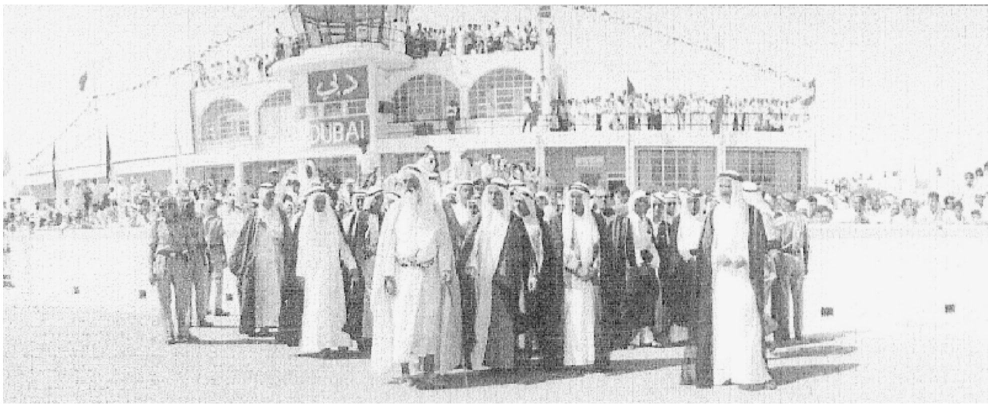


Figure 3.19- Dubai airport in the 1960s

(Source: Past Echo: Dubai in Half Century, 2000)

The airport was expanded in 1963; then in 1968, Page & Roughton were commissioned to design a new airport in Dubai (Dubai, P.58). The architects were asked to design a terminal aimed less at serving projected air-transport needs than at persuading international airlines to use the field as a major transit traffic centre. The result, in any case, was a structure that provided ahead-of-its-time passenger facilities for jumbo jets, including restaurants and kitchens to serve 400, a tax free-zone shopping area, and even sleeping accommodation for stranded travellers. Plans also called for more than ample ground service and fuelling facilities for the aircraft themselves (www.dubaiarport.com – Last accessed in 11-10-2006).

Figure 3.20- New Dubai airport opened in the 1971

(Source: Ragette, 1972)

To achieve an arabesque quality, the architects created a visually open and vaulted structure rather than relying on purely decorative motifs. The roof is composed of 56 lightweight, insulated "umbrella" units made of glass-reinforced plastic framed by steel, and supported on reinforced concrete columns. The umbrella units are similar to those of the Dhahran Air Terminal, completed just ten years earlier – Figure 3.20. The dome over the VIP lounge is also of reinforced plastic. A 36m concrete control tower compliments the curve of the vaulting and also punctuates the long horizontal line of the roof. Automobile traffic approaches the second level of the three-level terminal on an elevated roadway and passengers reach the aircraft by means of spiral ramps at the end of three shaded fingers (Ragette, 1972, P.13). The building was completed early in 1971 and opened in May 1971.

Figure 3.21- The new international Airport in Abu Dhabi

(Source: Ragette, 1972)

A new international Airport in Abu Dhabi was planned to be built in 1960s by the consultants and architects, Canadian Consulting Company. The angular treatment of arches and protruding pointed vaults in reinforced concrete lends an exotic, yet starkly modern appearance to Abu Dhabi's air terminal building – Figure 3.21. The contractors, Skanska-Kettaneh, completed the project in April 1971 (Ragette, 1972, P.8).

3.2.4.4. City Urban Planning in the United Arab Emirates

Moving towards modern development, the United Arab Emirates was keen to follow the Western model of modernization and development. As a consequence, the urban environment was changed to meet the new ambitions. Modern planning schemes began to emerge, major grid-iron streets were erected, multi-story western style buildings replaced traditional architecture and the simple lifestyle of the inhabitants was transformed to a modern one.

Abu Dhabi

The first modern urban planning for Abu Dhabi city began in the 1960s with the growing expectations of coming oil income. In 1961, the British consultant John Harris was appointed to put an urban plan for Abu Dhabi. The proposal was to keep the traditional urban fabric and demolish few buildings to open a new road. The Administrative city centre was to be put in the un-built district in integration with the old castle Palace. This proposal was not conducted

In 1962 the British consultant Sir William Halcrow & partners and the consultant Scott & Wilson, Kirpatrick & Partners presented a development plan for Abu Dhabi city to the ruler at that time Sheikh Shakhbout Bin Sultan. The proposal aimed to build a modern city for 100000 inhabitants supplied with high living standards yet conserving social traditions and customs. Making the Fort Palace as the city focal point, this plan suggested conserving the Fort Palace and few nearby valuable buildings and demolishing all the building between the Castle Palace and the sea to build the administrative centre coherently with the castle and the big mosque. The buildings were two to three stories to keep the scale of the Fort Palace as the administrative centre focal point (Al-Mansoori & Al-Naim, 2005, PP.89-90).

The concept of neighborhood in the modern Western sense was implemented for the first time. The neighborhood was designed for 7000 inhabitants provided with the public services and facilities as: mosques, clinics, shops, police stations, and library and assembly hall. The new concept of neighborhood was an opposing scheme to the traditional organic one; it neglected the ambient environment, the place uniqueness, and society needs, traditions, values and way of living. This proposal was not carried out, yet the consultant Arbecon was appointed to modify it according to the new growth during the sixties when oil began to be excavated commercially providing Abu Dhabi with financial resources supporting the development process in the emirate.

Dubai

Before the 20th century Dubai was a small Emirate where the ruler *"Sheikh"* of the tribe owned all lands, and he granted it to his followers and citizens without ownership. At the beginning of the twentieth century when merchants from neighbouring countries settled in Dubai, they started buying lands from the citizens after the ruler's permission (Bukhash, 2000, P.36).

In 1959 Sheikh Rashid bin Saeed Al-Maktoum, who ruled Dubai from 1958 to 1990, assigned a British planning consultant for the first city plan. This city plan replaced the traditional fabric of the city with its narrow alleys and courtyard houses with a modern European plan. The need to wider roads and planning further development of the city led to the engagement of the British firm of architects and urban planners, John Harris, to draw up a town plan for Dubai. Shortly afterwards, a survey was started to search for a better supply of water and an organizing plan for the city was carried out; accordingly the Lands Department was set up in 1959 and ownership of lands had to be registered (Heard-Bey, 1982, P.262).

Sharjah

Sharjah was the pioneer amongst the emirates in moving towards modernity. Yet urban and architectural development was slow in Sharjah in the first four decades of the 20th century; it remained within a narrow less than a kilometre strip on the southern shore of the Arabian Gulf. Many of its inhabitants left the city seeking for better work opportunities in Dubai and Abu Dhabi that were developing consistently at that time (Anderson, 1995, P.91). Till 1960, Sharjah was a small city with few military and government buildings. In 1965 Sheikh Khalid and his brother Sultan Bin Mohammed Al-Qassimi (the present ruler) encouraged Sharjah residents who were working in other Gulf countries at that time to come back to contribute in modernizing Sharjah city. To enhance its city economy, the city creek had to be dredged and a new port was to be built. In 1965, the work began in the new port; it finished in 1969 becoming a major step towards drastic changes to Sharjah economy and importance.

British consultant Halcrow presented a proposal for planning Sharjah marina in the mid 1950s. The first urban planning report was set in 1963; the city was to be planned for 20000-30000 inhabitants to be extended to 60000 in the future. According to this report the city was to contain seven elements: city centre, the marine, aviation centre, industrial zone, residential districts, hospitals, and broadcasting station; these elements to be connected by a net of grid iron system roads (Al-Mansoori & Al-Naim, 2005, P.93).

To cope with new circumstances, Halcrow developed the proposal in 1969. The city was to be divided into eight zones according to land use, separating the industrial zones from the residential districts (Anderson, 1995, P.91). According to this proposal the traditional urban fabric was to be demolished and substituted with modern grid iron roads and the organic residential fabric will be replaced with geometric detached plots. Such modern urban plans led to distort the traditional urban fabric erecting modern western style buildings, accordingly many wonderful examples of the traditional buildings disappeared as well as some of the early modern buildings as the British residency in Sharjah that was demolished to build a big modern shopping centre (The Central Souq). This building was a good model for the colonial architecture that tried to modify with the ambient environment with its big courtyard, pointed arches and Gulf oriented balconies (Anderson, 1995, P.218). The building used as a hotel called (Service Hotel) in late 1960s then as Sharjah Police headquarter before its demolition regardless its architectural, cultural and historical values – Figure 3. 22.

Figure 3.22- The British Residency in Sharjah one of the early modern buildings in the UAE

(Source: Jumah Al-Majid Centre for Culture & Heritage, 2005)

New roads were essential for city development and the entire coming city planning schemes were mostly for cars where iron grid roads were the main feature of all major cities in the United Arab Emirates. Al-Arouba Street was the first to be opened in Sharjah in 1965 on King Faisal Bin Abdel Aziz of Saudi Arabia expense. Although the street was sandy in the beginning, it became the city's milestone for development where many commercial buildings and office were built on its two sides (Anderson, 1995, P.75).

These buildings were multi-storey using modern materials as concrete and steel; they replaced the old traditional buildings of the city centre. The street also supported Sharjah prosperity being the main route that connects Dubai with northern emirates: Ras Al-Khaimah, Ajman and Um al-Qaiwan through Sharjah. Opening new roads, as al-Wehda Street, was of great effect on the city architectural and urban development – Figure 3.23.

Figure 3.23 – Al-Wehda Street in Sharjah in early 1970s: Multi-story buildings creating the city skyline

(Source: Shuckla, 2006)

3.2.4.5. Modernity in Other Emirates

The development of modern architecture in the United Arab Emirates has followed a number of paths, depending on the individual emirate. This is not only as a result of the differing rates of development between them, but also their particular characters and history (www.uaeone.com). Steps towards modernity went on in all the emirates in the sixties of the 20th century but in different levels.

Al-Ain city

Al-Ain is an oasis within the Abu Dhabi emirate that moved slowly towards modernity during the 1960s. Until that time, people remained building in the same traditional way – Figure 3.24. The city flourished as a modern city after declaration of federation in 1971. The Oasis (Al-Waha) hospital was the first modern building in the city built with mud and palm in 1960 by getting use of available ambient resources and indigenous materials. The hospital has developed and expanded to meet the growing needs of its community; the original palm branch was destroyed by fire in October of 1963. Later in 1964 the hospital and medical staff housing was built with cement brick (Dyck, 2004, P.41).

Leon Blosser, who came to Al-Ain city with his family in January 1964, started his first assignment by building the hospital rooms with cement blocks. He began to design and produce the concrete blocks by himself. Leon made his own cement block machine using an old truck chassis and standing it on end. The cement was to be brought from Dubai while gravel from the wadi (valley) and sand from the desert.

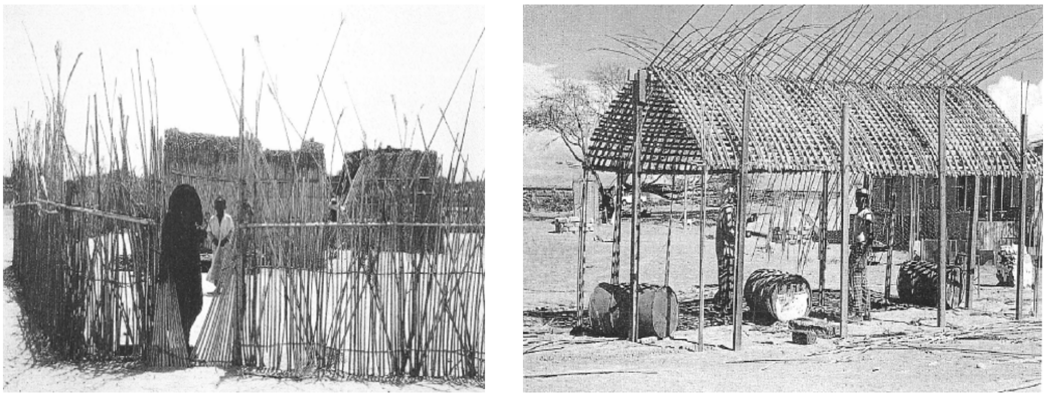


Figure 3.24-The Arish houses built of palm trunks and fronds in Al-Ain city in 1960s

(Source: Dyck, 2004)

Besides buildings materials, modern features were used in the hospital and staff housing; straight lines for openings, white paint, and the desert cooler as a new method for air conditioning. Desert coolers were used in the hospital in 1965-1966 being the first building in Al-Ain to have any central cooling- Figure 3.25. Main electricity became available in al-Ain gradually; at the beginning the electricity power served in the downtown and palaces in 1968-1969 reaching the outlying areas in 1971-1972 (Dyck, 2004, P.58).

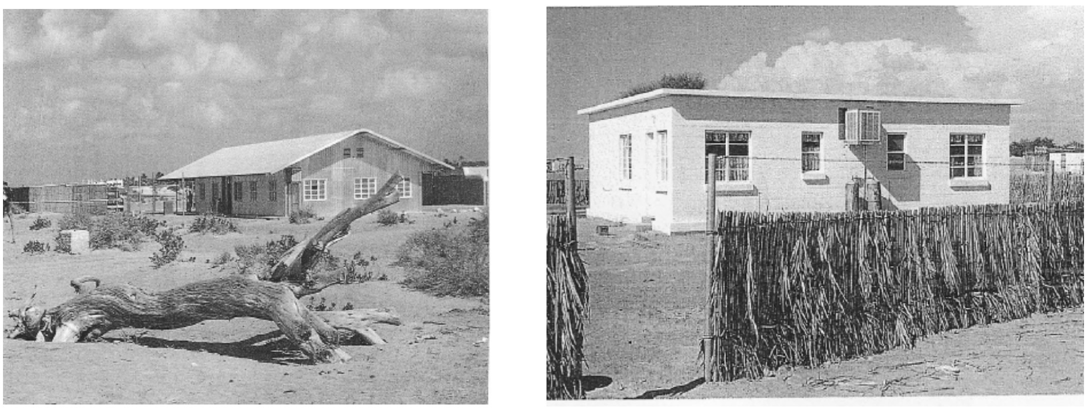


Figure 3.25- Oasis Hospital and staff housing in Al-Ain where the desert coolers are used

(Source: Dyck, 2004)

Al-Fujairah

The first government housing project in the United Arab Emirates was built in Al-Fujairah. The emirate ruler at that time Sheikh Mohammed Al-Sharqi thougt that building houses for the people instead of electricity station was more useful. By the year 1968, 42 houses were built. The houses were designed by British and Indian architects from "The Development Office of the Trucial states Council". Each house consisted of two bedrooms, living room, kitchen, and bathroom. Building structure was of reinforced concrete, walls of 20cm - concrete brick finished with cement plaster from both sides. All modern building materials, at that time, were imported from Japan and labour from India (Al-Mansouri, 1997, P.125).

Ras Al-Khaimah

Early steps for modern architecture in Ras Al-Khaimah began in early 1960s. Ras Al-Khaimah hospital as the first modern building in the emirate was built in 1963. By mid 1960s the Ruler court building, ruler residence, and ruler deputy residence were built. To respond to the ambient environment, the designer utilized the inner courtyard as the main design feature, yet building materials and elevation treatments were modern. The common feature of modern building in Ras Al-Khaimah during 1960s was the combination between local building materials and modern construction systems; stones were brought from nearby mountains while concrete was used for the skeleton structure in columns and beams. Most of these buildings were public: Electricity & Water building, the industrial school, the British Bank and few multi-story buildings that began to formulate the city skyline (Al-Mansoori & Al-Naim, 2005, P.95). Ras Al-Khaimah, with its natural resources of stones and sands available in the nearby mountains and plains made the city, as recommended by the consultant Halcrow in his study for the new city of Ras Al-Khaimah, the leading centre for cement, stone and ceramics in the country. Consequently the first cement factory in the United Arab Emirates was erected in Ras Al-Khaimah in the 1970s (www.alshargalawsat.com – Last accessed 20-9-2006).

3.3. Socio-economical Boom and Architecture in the UAE after Declaration of Federation 1971

Architecture in the UAE was influenced by rapid and drastic economic, social & cultural changes that took place in the Gulf region during the second half of the 20th century and the declaration of federation in 1971. New planning systems began to be applied to the traditional cities of Abu Dhabi, Dubai & Sharjah where new major streets were erected and new modern planning schemes emerged replacing organic traditional compact urban fabric.

The economic wealth associated with the discovery of oil in the sixties and the economic boom during the seventies encouraged the use of modern construction systems and materials. The introduction of new architectural styles in the region was made by foreign as well as local architects. Air-conditioning units became available in all buildings replacing the traditional wind catchers. Concrete, steel, glass, and other modern building materials were introduced by the construction industry. Shiny glass skyscrapers, reflecting the burning sun, have changed forever the urban landscape of the city in the UAE.

3.3.1. Architecture in the United Arab Emirates 1971-1990: Architectural Boom

After the economic boom and social prosperity enjoyed by the country since 1971, there was an urgent need to build new buildings to meet the new demands of the people. Planning departments were established to work on planning cities and villages. Municipalities and Departments of public works were focusing on building public buildings and housing developments. Dependency on cars and other means of transportation caused the cities to expand rapidly. This uncontrolled expansion transformed major cities into metropolitan areas and changed the traditional life style into a modern one – Figure 3.26. The government constructed several public housing projects in different parts of the country. Houses were built and handed to citizens after completion of construction. The design of these houses was not suitable for the cultural values and needs of the inhabitants, especially Bedouins who were forced to settle in these projects. The owners had to make informal additions and changes to the houses to satisfy their needs (Mahgoub, 1997, P.9).

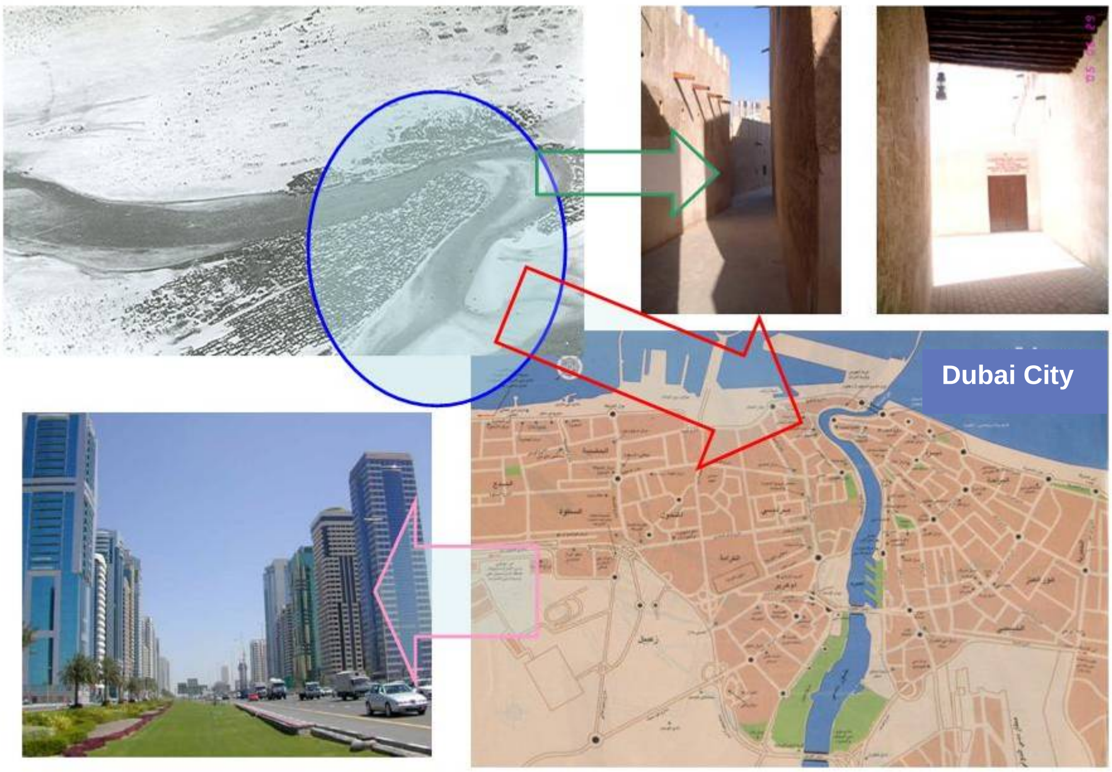


Figure 3.26– Traditional urban fabric transformed to modern grid iron in the UAE
(Source: the author)

Oil resources have enabled massive modernization. Towns have been transformed from mud-walled communities into commercial capitals integrated in the global economy. Urbanization has been characterized by unparalleled growth. UAE cities have been heavily influenced by the global city type. Some UAE cities as Dubai and Abu Dhabi are of the most modern cities in the world. Dominant urban features include skyscrapers in the commercial city centres, multi-storey residential buildings, large shopping malls, wide boulevards, an extensive network of highways, and sprawling new suburbs (United Arab Emirates www.everyculture.com/To-Z/United-Arab-Emirate - Last accessed 24-08-2005)

The seventies of the 20th century witnessed the introduction of the modern buildings materials and techniques in the UAE. There was a building boom in the emirates that very few countries have ever experienced. Buildings sprouted out of the ground overnight and although the highest technology was used, the speed in construction led inevitably to carelessness and mistakes (Zandy, 1991, P.29).

During the 1970s, many infrastructure projects including roads, drainage, housing and commercial buildings, were started. The 1980s witnessed more infrastructure projects and modern buildings with some relation to local culture. Some of local architects graduated and tried to design buildings with reference to traditional architecture. Dubai municipality had shade and water pools introduced into its buildings while Al Wasl hospital used traditional arches (Karim, 1999). Life style has changed; dependency on technology and modern appliances made people look for comfortable life and new social values replacing the traditional ones as substitution for the old weary days.

3.3.1.1. The Western Trend: High Technology and Modern Materials

The Seventies and Eighties witnessed the use of imported architectural styles, construction systems and building materials. The character of architecture and visual structure of cities in the UAE formulated during 1970s and 1980s when a number of consolatory architects were summoned to important public buildings. Architects from other Arab countries were invited to design buildings. Arab architects took the first moderation steps as: Midhat Al Madholoum (The Employee Residence). Sae'd Kareem (the Airport Building & Manhal Palace), Ali- Naief Masood (Senior Official Villas), Abdulrahman Makhlouf (Central Market in Abu Dhabi), Husham al-Hasani (the Grand Mosque) (Al Mansouri & Al Naeim, 2004, P.17), and Mohammed Makkiya (Dubai Hilton Hotel in 1973, the Diwan Al Amiri in 1984, and the Dubai retail market in 1983), Jafar Tukan (the Ministry of Finance Building in Abu Dhabi in 1979), Rifat Chadirji (the National Bank of Abu Dhabi in 1970) and Maath al Alousi who planned the Diera creek recreational facilities in Dubai in 1978 (Kultermann, 1999, P.191).

These architects applied their education, knowledge and training in other parts of the world on the design of these buildings. Following that period, architects from western countries played a larger role in design and construction of new buildings. The use of reinforced concrete, new building materials, and construction technology dominated the practice of architecture during 1970s and 1980s. High technology and mechanical services led to total neglect to environment and wide glass openings-Figure 3.27.Artificial air-conditioning replaced small windows and natural ventilation through wind towers. Availability of oil resources at that time encouraged these types of buildings that consumed a lot of energy.

Figure 3.27–The architecture of glass and high technology: total neglect to environment
(Source: the author, 2006)

In some ways, the reduction in oil revenue had a settling effect on the style and state of architecture. Builders chose architects and styles without knowing that what they created would now take its place in time. Driving down on of the modern streets of Dubai, Abu Dhabi and Sharjah, you could be anywhere in downtown Manhattan, Boston or Singapore. There is modern use of glass and concrete which are impressive, but showing little link with tradition (Zandy, 1993, P.31). Big Cities in the UAE became metropolitan ones and could lose relations to its roots and local identity.

3.3.1.2. Interpretational Trend: Inspiration from Traditional Motives

In an attempt to implement regionalism to contemporary architecture in the UAE, environmental features have been used in many projects. Wind tower (*Barjeel*) was the most preferable traditional motif used in modern buildings during that era. The necessity of natural air cooling and cross-ventilation is paramount, and several architects have successfully adapted the old type of wind tower as a model for their buildings.

The most well-known building utilizing wind tower is the Islamic market (Souq) in Sharjah (1977), designed by the English architect Michael Lyell, where he combined the barrel-vaulted roof taken from the linear tradition market with series of wind towers to guarantee adequate air circulation and natural ventilation-Figure 3.28. Other examples are the Al-Ittihad School in Dubai by John R. Harris (1976-1977). The design conceived like a village cluster to break down the scale and provide a variety of sheltered spaces. The four school types (infants, junior, middle, and senior school) are arranged in spiral form around a central administration block, a concept which is repeated at the level of each school and the units which make up each school. The roof shape constructed of plywood covered with synthetic rubber sheet was especially developed to emphasise the concept of clusters. The prototype kindergarten designed by the Arabic architect Jafar Tukan in 1977 based on clustered square–shaped individual units embracing activities areas. The building utilized the wind tower to provide natural ventilation for class rooms and courtyards (Cantacuzino & Browne, 1977, P. 393).

Figure 3.28 –The Islamic Souq in Sharjah: utilizing wind tower and vaults in modern buildings
(Source: the author, 2006)

Inward plan and courtyard design was interpreted in many buildings with innovative visions. Dubai municipal building by the Civic Design Studio and chief designer Kazuyuki Matsushita (1974-1980) based on the large open courtyard, interpreted as an oasis, which connects the round council chamber, the city hall, and the executive office section- Figure 3.29. The main concept as described by the designer (Matsushita, 1980, P.13):

> "After studying and analyzing the project, we decided to propose as a basic concept the idea of new citizens' plaza, which is the best way to produce a symbol of Dubai's increasing prosperity. We therefore wanted to create on the site, not just a municipal building, but also a green plaza (*Mydan)* refreshed by the sparkling, beautiful river that flows by it".

Figure 3.29- Dubai Municipal Building

(Source: the author, 2006)

The most important and significant link between traditional and contemporary architecture is manifested in the unity of building and city fabric. In combining various urban functions the residential and commercial centre in Abu Dhabi by the Czech group SIAL (1982) follows the old regional patterns, as do the university town of Al-Ain by Japanese architect Kisho Kurokawa (1988) who integrated new demands with elements from the regional traditional architecture establishing a new level of architectural identity (Kultermann, 1999, P.191).

3.3.1.3. Random Architecture

There are several attempts to use elements from traditional architecture in the design of modern buildings in the UAE. This approach influences the design of openings and facade more than the interior design of buildings. Borrowed mixture of styles was used; Modern, Indian, Islamic, Arabian, and other styles are used according to the desires and preferences of owners and clients (Mahgoub, 1997). Many villas and commercials building borrowed traditional features as wind tower as symbols to reflect identity without investigating the intellectual content. The analogy of wind towers were some times lifted to the roof or built directly on the ground, some were without any function or they were used as staircase or service cores – Figure 3.30.

Figure 3.30–Traditional symbols a disguised method to reflect identity in modern buildings

(Source: the author, 2006)

3.3.2. Architecture in the United Arab Emirates 1990-2000: Searching for Identity

After the first spate of modern buildings had completely altered the urban landscape of the UAE in the 1970's, a renewed longing for something more traditional was felt. The Government became increasingly aware that the potential loss of the country's heritage should be checked. Renovation projects were started on major old buildings still sufficiently intact to be restored, and architects began to incorporate at least some traditional elements in their new creations (www.uaeone.com – Last accessed 14-07-2005). Predicatively, traditional architecture offers the greatest potential for the development of a viable contemporary regionalism of consistent high quality, capable of providing for many building types, both old and new. The potential diverse from the sheer richness of the heritage diversified over centuries of continues development (Abel, 2000. P. 171).

Figure 3.31 – High-rise buildings in the UAE: modern building materials and Hi-tech
(Source: the author, 2005, 2006)

The late nineties and the emergence of the new millennium witnessed qualitative changes along with the trends of globalization, yet more tending to reveal the region identity. Some projects became an identity to the UAE that witnessed innovative audacious projects such as Burj Al-Arab (Arab Tower), twin towers, Al-Nakheel project (Dubai) and Baynoona tower (Abu Dhabi). Regardless our agreement or disagreement, these projects became landmarks for the location where they were built - Figure 3.31. There is some of the best regional architecture built in the UAE, designed by western and Arab architects trying to create an alternative to the prevailing international models (Kultermann, 1999, P.173).

Searching for identity in contemporary architecture in the UAE, especially in the last fifteen years, materialized in two directions; revival of traditional architecture features as interpretation for contemporary architecture and revitalization the cultural heritage by conservation of traditional architecture as a growing public interest in the quality of the built environment through aspiring to the renaissance of local identity (Al-Zubaidi, 2004 Dec., P.80).

3.3.2.1. Revitalization of Traditional Architecture: Conservation of the Heritage

Although some early urban planning proposals in the UAE asserted the conservation of the traditional urban fabric of the city for the good of its people, few policies were suggested. unfortunately the idea of demolishing the traditional fabric partially or completely was the preferred scheme and building according to Western values irrelevant to society traditions and life style was the dominant method (Anderson, 1995, P.122).

During architectural boom in the UAE, especially in the 1970s and 1980s, many traditional buildings and heritage symbols were demolished for they were symbols of retardation and poverty. Several remarkable merchants houses in Bastakia area (Dubai) were demolished to build the ruler court, so was the British agent’s residence at Mujarra district (Sharjah) that was replaced with the Central market (Souq) (Anderson, 1995, P. 218). Many buildings within the traditional urban fabric were demolished to erect new modern streets without any consideration to these buildings’ architectural, historical or cultural values. This was a symbol for cutting any roots related to the past.

In the late 1980s and early 1990s, a growing public interest emerged in traditional architecture and the quality of the built environment as a whole. It was not only nostalgia to the past but also a concern for the future. Many critics are concerned of the cultural continuity and the loss of cultural identity (Mahgoub, 1997, P.13).

The traditional core in the UAE is getting more attention in the last 10-15 years, where some buildings and traditional fabric, or what was left of them, have been restored as the Bastakia and Shandagha districts in Dubai, and Shawaihen and Muraijah districts in Sharjah, besides some historic houses and forts in other Emirates. It was an attempt to conserve the identity of these traditional cores; the policy was to revitalize these sectors reacting with the busy life of the city. The restored buildings were used as museums, restaurants and shops; some of these buildings became part of the cultural life of the city especially in Sharjah Figure 3.32.

[

Figure 3.32 -Restored traditional buildings in Sharjah
(Source: the author, 2005)

Revitalization of architectural heritage and conservation cultural values in an environmentally sensitive manner requires detailed planning; knowledge of materials and their interactions; knowledge of construction, craft techniques, skilled technicians, and available resources. It is not just nostalgia that draws people to traditional architecture. Much of what is valued in this architecture is its sustainability and response to the climate, natural setting, and locally available building materials.

3.3.2.2. The Neo-Traditional Trend: Interpretation of Traditional Architecture

A new trend emerged in the 1990s; its goal was to revitalize the architectural heritage of the past and use its features to stress identity and architectural style of the area. Many of the buildings which were built during the seventies were replaced by new buildings using architectural features assumed to be more related to the region (Mahgoub, 1997, P.9). Some of these attempts were successful while others were overdone

The decade of the 1990s is considered the maturing stage of architecture in the UAE, where most of the main buildings are designed with some respect to the traditional culture and heritage. More than 40 buildings have been restored in the past eight years and used as museums, restaurants and shops (Karim, 1999). .

Nevertheless, traditional architecture features offer dramatic metaphors for regional forms of shelter, as well as rational responses to the harsh climate giving modernism a subtle but telling shove in direction of regionalism (Abel, 2000, P.174)- Figure 3.33.

Sharjah Theatre

Sharjah Art Museum

Figure 3.33- Modern buildings utilizing traditional features
(Source; the author, 2006)

These building complexes demonstrate a close interconnectedness between the character of the traditional environment and the contemporary architecture. Tent architecture is one of the oldest and more appropriate architectural systems in the region. The old traditional function of the tent was given exciting contemporary forms. The National Museum in Al-Ain by Kisho Kurokawa (1996-1997) uses the idea of the tent by incorporating an elaborate structure partly covered by a large tent roof. Several malls and shopping centres construe the tent as a symbolic interrelating form to the desert environment such as golf club and camel racetrack in Dubai and Sahara Mall in Sharjah (2001) –Figure 3.34.

Figure 3.34 - Tent as an identity feature in modern architecture in the UAE: Sahara Mall in Sharjah
(Source: the author, 2006)

The Headquarters for the Marine Operating Company (1996) in Abu Dhabi by Jung/ Brannen with Nader Ardalan and Mandala international is an attempt to integrate cultural traditions into a contemporary office complex by adding covered interior spaces and interior gardens. The design concept has artistically and authoritatively reinterpreted the traditions of this ancient land, drawing on its inexhaustible fountainheads of archetypal imagery metaphors and symbols to preserve a cumulative memory for the future (Ardalan, 1993, P.37). Nader Ardalan wrote about the revelation of the internal garden (Kultermann, 1999, P.199):

> "*The enclosed Paradise Garden theme pervades and inspires the most poignant metaphors in Islamic cultures towards man's harmonious relationship with nature*".

Many malls and office buildings invested the concept of internal courtyard covered with light structure creating a magnificent relation with environment as Sahara Mall in Sharjah, Emirates mall and Wafi centre in Dubai, and Marina Mall in Al Ain – Figure 3.35.

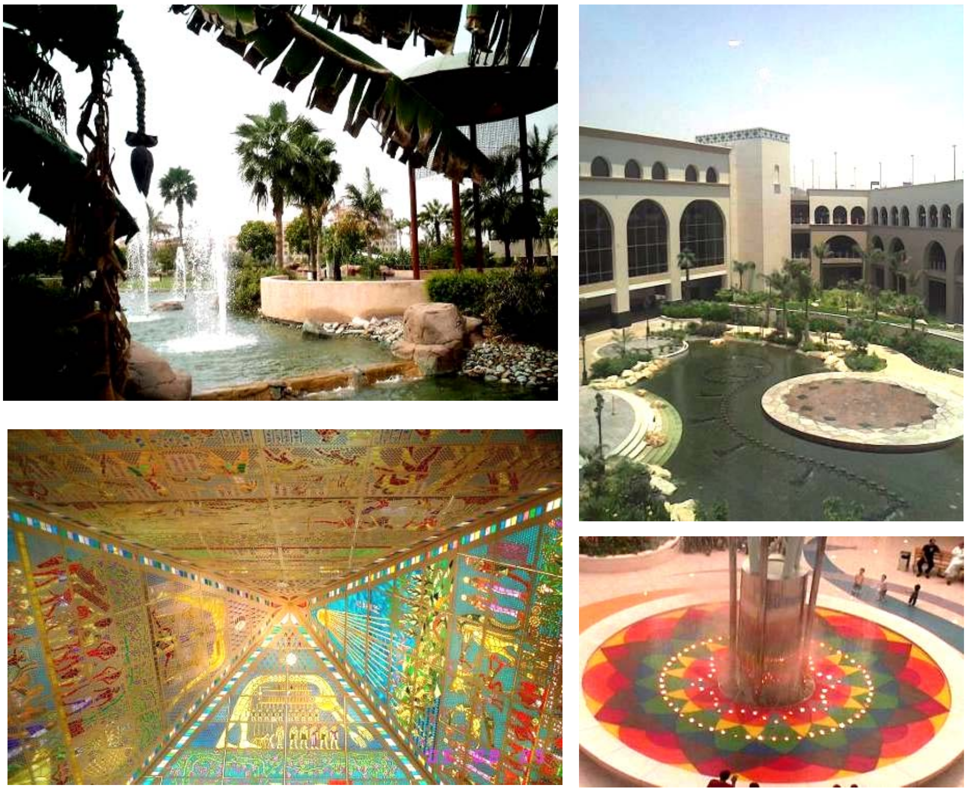


Figure 3.35- Courtyard and inward design concept in modern architecture in the UAE
(Source: the author)

3.3.3. Architecture in the UAE in the 3rd Millennium: Environmental Issues & Sustainable Development

The impact of modern architecture and the international style in major cities in UAE may be coupled with the extensive cultivation projects implemented in what originally was barren arid landscape bordering in the expanse of the desert sands. The quality of change has therefore been ecological in terms of the effects seen in the built and natural environment (Damluji, 2006, P. 2). The architectural boom the country witnessed in the last three decades of the 20th century transformed the cities skyline. Unfortunately this massive expansion exhausted a lot of the country's natural resources especially energy (oil and gas). Most of the energy resources in the UAE are indeed depending on fossil fuels – Figure 3.36.

Figure 3.36- High-rise buildings: main energy consumers in the UAE
(Source: the author, 2006)

UAE has one of the largest ecological footprints per capita in the world; it reached 15.9 hectare/ person exceeding the world average 3.1 hectare/ person (WWF Living Planet Report, 2006). and the developed countries as New Zealand (9.8), USA (8.4), and Canada (7) (Elizabeth & Adams, 2005). Moreover the expectations of oil depletions within two decades in some emirates as Dubai and Sharjah and the global tendency towards sustainability and concerns of environment conservation, forced UAE to rethink of development strategies and building policies.

The construction industry, especially in Dubai, is booming based on huge tourism, retail and housing and office developments. Dramatic projects, such as the offshore Palm islands (three man-made islands, one the size of Manhattan), Dubai Tower (Burj Dubai) the world tallest tower to be finished in 2008 and Dubai land (a vast theme park), indicate new strategies towards sustaining economical resources – Figure 3.37. An initial estimate of the total value of construction projects (excludes oil and gas construction projects) underway and planned in the UAE is 176 billions US$ over the next five years (Osmond and Dijksterhuis, 2006, P.5). These projects consume enormous building materials and energy during construction process then operation and maintenance during building lifecycle. Moreover such projects raise many concerns about the environmental and social consequences and how they may affect the society demography and population in the UAE. Yet many think that such policies are essential for sustaining economical resources. Other emirates are following Dubai's steps in one way or another. Evaluating these projects and policies from a sustainable viewpoint is beyond the limits of this research.

Figure 3.37- Dubai Tower within the developed Dubai city: future trends in the UAE
(Source: UAE Yearbook, 2006)

3.3.3.1. Futuristic Trend: Environmental Sustainable Architecture

In a recent Youth Exchange survey conducted by the UNEP Region of West Asia showed that youth in the UAE were most concerned with the future of their environment. This was above all other concerns, including war, terrorism and crime (Naarden, 2006, P.35). Issues of environment and sustainability became one of UAE major interests mostly towards greening the desert and conservation of wild and marine life (www.worldfacts.us/United-Arab-Emirates. – Last accessed 12- 09-2005)

In March 1999, a new law was passed aimed at reducing air pollution. Developed in consultation with the different municipalities the new regulations limit excessive use of harmful gases. New regulations were also under discussion for controlling the use of leaded fuel which produces harmful emissions. The UAE enforces strict laws governing the use of chemical insecticides in agriculture to protect public health and reduce negative impacts on the environment. In line with international concerns about global warming and destruction of the ozone layer the UAE took positive steps to ban the importation of ozone depleting chemicals. At the present time any company wishing to import ozone-unfriendly material must obtain prior permission from the FEA. By the year 2005 it will be illegal to deal in any ozone depleting substances. Although the UAE's consumption of ozone-unfriendly substances does not exceed the rate prescribed in the Montreal Protocol the Government is also concerned about controlling the re-export of harmful substances.

Concerns about environment and sustainability necessitated legislations that implant these issues through building and construction process. Dubai municipality has issued an administrative decree in 2001 in the context of the application of thermal insulation system for buildings in the emirate of Dubai. The main goal of this procedure is to reduce electricity cost up to 40% and saving the country's energy resources (www.dm.gov.ae – Last accessed 24-03- 2004). Other municipalities followed that step. Building materials with sustainable qualities: thermal insulated, recyclable, low pollution are available in the market, yet they do not form only few percentage of the massive materials consumed in the building boom the country witnessed in the last few years.

The concept of designing buildings in a sustainable and environmentally responsible manner is gaining momentum in the UAE. In May 2005 the 1st international Conference on "Green Buildings: The Future in the UAE" was held in Dubai supported by international organizations, councils and professional societies such as the Word Green Building Council(World GBC), Green Building Council of Australia, India Green Building Council, World Renewable Energy Network (WREN) and ASHRAE.

Later in June 2nd 2006 the Emirates Green Building Council was launched in the UAE; it is a testament to the growing interest in the global concern. The Emirates GBC, as the council states, has the goal of advancing Green Building principles for protecting the environment and ensuring sustainability in the United Arab Emirates. Its vision is primarily centred on achieving the highest level of Sustainable Built-environment in the United Arab Emirates through the promotion of high-performance Green Buildings and environmentally friendly technologies (www.worldgbc.org – Last accessed12-11-2006).

The government and non-government organizations are taking practical procedures towards sustainability. The Government of Dubai recently announced its adoption of a "Sustainable Development Policy", a unique new initiative that applies world-class social and environmental standards to the organization's activities. A new Renewable Energy Division will be responsible for 'green' buildings, energy and water conservation and management, value-added real estate and 'green' power generation, and intends to set an example for other Dubai-based organizations in developing sustainable development practices (www.middleeastelectricity.com – Last accessed 12-11-2006).

This sustainable trend has materialised in some buildings in the UAE. Three buildings are in the process of getting LEED certification, while the USGBC has declared Dubai Cooling Chiller Plant (DCCP ONE) at Wafi City a LEED Silver Building with the potential of achieving a Gold rating (Design of the Time, 2006, P.38). Wafi City, a residential and commercial development in Dubai which includes the mall, residence, as well as the Pyramids recreation area, is building a luxury hotel as part of its expansion scheme. District Cooling Chiller Plant – DCCP ONE, which is the first phase of 20,000-ton central chilled water plant serving the whole Wafi City – Figure 3.38. This plant will provide indoor comfort systems and comprehensive facility solutions, with considerable savings in operational cost and power consumption (www.trane.com – Last accessed in 11-11-2006).

Figure 3.38- Sustainable buildings in the UAE: Wafi city Cooling Chiller Plant
(Source: www.ameinfo.com ; www.pbase.co)

The US embassy in Abu Dhabi and the Pacific Controls headquarters in Jebel Ali were considered sustainable buildings and they are aspiring to achieve the Platinum rating for the Green LEED Certification – Figure 3.39. The environment-friendly design of Pacific Controls' Green Building will emphasize on the key features of sustainable site development, water and energy efficiency, recycled or recyclable materials selection and indoor air quality. While the key tangible benefits of this green building project is expected to benefit in terms of providing 35% savings in energy as compared to normal buildings, and about 40% savings in water consumption; the intangible benefits will be in terms of providing better indoor air quality, health and productivity. Some of the key features to be addressed in Pacific Controls' Green Building are soil erosion measures, water efficient equipment, solar-thermal air conditioning for fresh air requirements, high-efficiency chillers, solar photovoltaic for building lighting, state of the art building management system, use of materials with high recycled content, variable speed drives for centrifugal fans and pumps, CO2 monitoring for indoor air quality, low volatile organic compounds (VOCs) in carpets, adhesives, sealants and paints and use of eco-friendly house-keeping chemicals (www.ameinfo.com – Last accessed in 11-11-2006).

Other buildings that have incorporated a more sustainable and environmentally friendly approach include the Hyatt Regency, Dubai, Al Maha Resort, Noor Al Maarif School, 21st Century Tower and the Mankhool Twin towers (www.eeuae.com – Last accessed 12-11-2006).

USA Embassy in Abu Dhabi
(Source: www.dexigner.com)

Pacific Controls headquarters
(Source: www.ameinfo.com)

Figure 3.39-Examples for sustainable buildings in the UAE

Within the high-rise buildings in Dubai Marina, a few buildings are designed as sustainable. One of them is a 27-story residential building designed by Atkins. The designer's strategy for the passive shading and ventilation of the building allows the optimization of an environmentally conscious design solution without any additional coats. The active design solution, employing solar PV technology utilises systems to their optimum to reduce energy consumption as well as operational and maintenance costs. Consideration has been given to the climatic condition of the region, the orientation of the building on the site, as well as the context (macro-to micro climatic assessment. Low e-coating clear glass, balconies, and sun screen walls were utilised to provide shading and natural ventilation to the internal spaces. The climatic solutions varied according to the facade orientation and treatment (Design of the Time, 2006, PP.38-39).

The 21st century is a challenge for UAE architects, as Luiza Karim indicates:" *architects have to coincide between new materials and designs on the one hand and reference to culture, climate and environment on the other hand*" (Karim, 1999). Architecture in the UAE in the 3rd millennium tends towards sustainability in different dimensions: environmental, social, or economical – Figure 3.40.

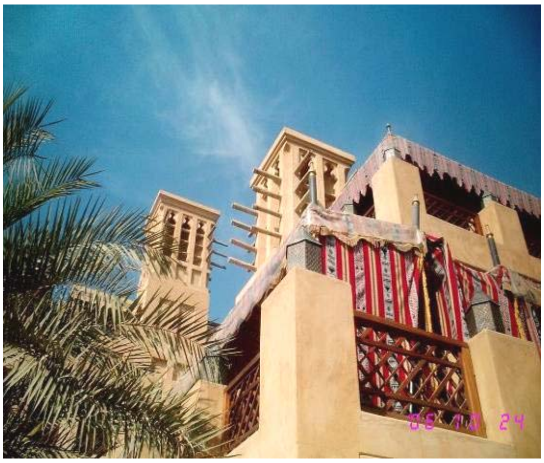


Figure 3.40- Inspiration from traditional architecture: Jumairah City in Dubai

(Source: the author, 2006)

The need for more sustainable buildings in the UAE, which is currently going through a construction boom, is mostly needed. This phenomenon, in addition to an increase in the population, is also closely connected to the rapid increase in energy consumption, especially for lighting and cooling, which is a priority due to severe climatic conditions in the region. The new wave of architectural boom the UAE witness needs to be evaluated and redirected thoroughly towards sustainability and environment conservation.

Conclusions

Accounting for the modern architecture in the United Arab Emirates, due to the development process of a small country with limited resources that became a modern one within a few decades, indeed, one of the most developed countries in the Arab world and the region.

Early steps towards modernity in the UAE Emirates in 1930s and 1940s were deliberate and the few modern buildings erected at that time were public serving British interests in the region. When the UAE began to get use of the profits of oil exportations, in the 1950s and 1960s, economic prosperity paved the way for rapid changes in all aspects of society's life. Modern architecture before federation in the country was characterized mainly by:

- Using new buildings materials as concrete, steel and glass.
- Modern construction systems as skeleton structure.
- Un-preceded types of buildings in the country.
- Design began to change from introvert to extrovert where big openings and windows appeared in the external elevations utilizing modern materials and features.
- Multi story buildings that began to appear as 2-3 stories in 1930s and 1940s became high-rise in subsequent decades.

After the declaration of federation in 1971, the architectural boom in the UAE during 1970s and 1980s tired to achieve the image of modernity in contemporary architecture in the country. Architecture during that era was characterized with:

- Using modern building materials steel and concrete and covered with glass panels.
- Utilizing up-to-date high technology in construction and services.
- Neglect to environment depending on artificial air-conditioning and lighting.
- Buildings were not appropriate to the region climatically and environmentally consuming a lot of energy.

During the 1990s and the new millennium qualitative changes were witnessed in the UAE along with the trends of globalization. This was characterized by:

- Tendency to reveal the local identity.
- Revival of traditional architecture features as interpretation for contemporary architecture.
- Revitalization the cultural heritage by conservation of traditional architecture.
- Approach towards sustainability and environmental issues.
- The government and non-government organizations are taking practical procedures towards sustainability.

Issues investigated in this chapter are a completion of what has been discussed in the previous two chapters that aimed to build the theoretical background of this research. Tracing architectural development in the UAE during the 20th century via investigating social and economical transformation, give an overall view to the context of this research and the region where case study will be chosen.

At this point, the theoretical background has been set. In the second part of this research, sustainability assessment methods will be investigated in order to develop SEAM and SSAM appropriate to assess the chosen case studies that will be discussed in the third part of this research.

Part Two

Formulation of Sustainability Assessment Method

Chapter 4

Formulation of Sustainability Environmental Assessment Method

Main Headings

Chapter Four: Formulation of Sustainability Environmental Assessment Method (SEAM)

Introduction

Building environmental assessment methods have emerged as relevant means of evaluating the performance of buildings across a broad range of environmental considerations (Cole, 2000, P.949). One of this research hypothesis is that it is possible to develop a sustainable assessment method to examine the sustainability potential in traditional & contemporary architecture especially housing, this chapter aims to develop sustainability assessment method adequate to the Arab World conditions.

This chapter investigates the sustainability environmental assessment methods through examining existing environmental assessment methods and analysing the main indicators of these methods to create a basis for formulation sustainability environmental assessment method (SEAM). The proposed SEAM will be used to assess sustainability potential in certain chosen case studies.

Analysing, developing, and identifying sustainability environmental assessment method adequate to the Arab World is one part the original contribution of this research. The other and most important part is testing SEAM concerning two chosen traditional and contemporary houses in the UAE, which is the empirical study of this research. Moreover, analysing environmental sustainability dimensions in domestic buildings (traditional and modern houses) in the UAE, in chapter six, is going to be according to the proposed SEAM criteria.

4.1. A Framework for Understanding the Concept of Sustainability

Through the literature review on sustainability and illustration in chapter one, many issues were discussed, definitions, goals, principles, and dimensions of sustainability. One of the significant conclusions of that discussion is that sustainability cannot be viewed as fragments. It is a holistic approach for dealing with ambient environment and available resources (human and natural).

In defining sustainability, it is of substantial importance to envisage its broad aspect that composes versatility of the components to be taken in consideration. In this respect, Naim Afgan and Maria Carvalho (2001, P.29), emphasize the wholeness of sustainability that has to include definitions of those components which are linked to specific parameters to be taken into a consideration of the assessment of sustainability of specific situation in global regional and local environments.

Among several definitions phrased to clarify the concept of sustainability that can be taken as a base for setting a framework to assess sustainability in architecture, is: "Sustainability is a broader term and encompasses economic, social and environmental concerns of development". Sustainability is considered to be a holistic approach for development: "Sustainable development is an approach that aims to balance the social, economic and environmental impacts of all our actions, now and in the future. Sustainability is achieving the above." (www.arch.hku.hk/research/BEER/sustain.htm).

In the previous definitions, we underline three key issues of sustainability: environment, society, and economy. These issues or dimensions are needed to outline the framework of assessing sustainability in architecture. Each of these dimensions has been discussed in chapter one and it is essential to emphasize its role in investigating sustainability potential in architecture.

At this point, a framework is needed to be set for assessing sustainability potentiality in buildings; in this research, it is the traditional and contemporary houses. The criteria for the sustainability assessment methods have to reflect the following aspects: environmental aspects, social aspects, and economical aspects.

4.1.1. The Need for Sustainability Assessment Method

Sustainability is a characteristic of dynamic systems that maintain themselves over time; it is not a fixed endpoint that can be defined. Environmental sustainability refers to the long-term maintenance of valued environmental resources in an evolving human context. The best way to define and measure sustainability is contested (Environmental Sustainability Index, 2005, P.11). While absolute measures of sustainability remain elusive, many aspects of environmental sustainability can be measured at least in relative terms (Esty, Levy, Srebotnjak, & de Sherbinin, 2005, P.1).

Through the previous discussion, a basis was constructed for developing Sustainability Assessment Method (SAM) to examine sustainability potentiality in traditional and contemporary architecture. The main goal of developing the assessment method is to create a framework for the comparative analysis that is going to be held to assess sustainability potentiality in traditional and contemporary architecture. However, before developing the SAM, it is essential to know what the SAM is and why it is needed. For achieving that goal, it is significant to define the importance of assessing buildings in different design stages and after occupation within the building life cycle.

Even though environmental assessment methods are not originally intended to serve as design guidelines it seems that they, in the absence of better alternatives, are increasingly being used as such (Crawley & Aho, 1999, P.303).

During the 1990s, the concepts of sustainable design and high performance buildings, as well as the increasing adoption of these concepts in the marketplace, have been furthered by the development of assessment tools (Todd; Crawley; Geissler; & Lindsey, 2001, P.325).

Assessment is considered a kind of evaluation. Robert Gutman and Barbra Westergaard (Gutman and Westergaard, 1974, P.322) define evaluation as, "*the comparison of an object to some standard of excellence*". In architecture, Lang, Burnette, Moleski, and Vashon (Lang, Burnette, Moleski, and Vashon, 1974, P.228) indicate that the term evaluation is used for the process of testing design criteria and the design solution for its acceptability. In this case, the building or the design solution represents the object, while the design criteria are the standard of excellence. Design criteria are derived from the factors of excellence from the evaluator's point of view (Mohammed, 2002, P. 137).

For sustainability, there are several methods for evaluation. Choosing the right method depends on the purpose of doing that evaluation, type of building or project, stage of design: pre building phase (elementary or final design stage), building phase (construction and post occupancy and operation stage), and post-building phase (demolition and discard).

According to this, it is concluded that assessing has an essential role in evaluating buildings performance and helps to develop the ongoing mechanism to review the quality of the assessments being made. Assessing is intended to provide information to improve the quality of decision-making. The importance of evaluation is to provide a feedback for future decisions (Friedman; Zimring & Zube, 1978, P.3). Michael Brill (1974, P. 135) supports this notion in building evaluation, as he indicates that building evaluation has two basic aspects that are gaining information about the significance of the building, and using that information in future designs. The new approaches will avoid the problems of previous designs, which are a major advantage of building evaluation (Mohammed, 2002, P.138).

The need for a systematic and formal assessment approach is based on its inevitable role in preserving professional architectural approaches. It is needed for assessing in all design phases.

4.2. Definition of Sustainability Assessment Method

L. Graham Smith (1993) defines Impact assessment as, "*A process for resource management and environmental planning that provides for the achievement of the goal of sustainability*". Sustainability assessment is a process to enable policy makers to integrate their decision-making on projects, plans, policies and programs so that they are consistent with sustainability principles. Sustainability assessment method identifies and measures the impacts of the project. It is characterized by (Todd, Crawley, Geissler, & Lindsey, 2001):

- a proactive approach to improving social and economic, as well as environmental, outcomes
- greater transparency, as social and economic issues need to be identified alongside environmental issues
- Creativity and innovation in seeking solutions that can resolve deep conflicts and minimise harmful impacts

Sustainability assessment method can be understood as a way or mechanism to amalgamate pole parts viewpoints and thoughts of several people with different backgrounds and ideas regarding sustainability aspects. Bebbington & Frame (2003, P. 8) boost this point:

> "*Sustainability Assessment Method was viewed as a mechanism by which people with competing views as to the impacts of a project could communicate their own concerns and interests to each other. It was believed that often dialogue between parties who have interests in a project becomes alienating because each cannot easily see the viewpoint of the other. Sustainability Assessment Method was viewed as providing a point of connection between various parties because environmental, social and economic concerns could all be articulated and accepted as being part of the same evaluation. Further, Sustainability Assessment Method provides an opportunity for technical specialists to think more broadly than their area of concern and focus. Several individuals highlighted that this aspect of Sustainability Assessment Method could be particularly helpful in the likes of consent awarding, community planning, or stakeholder engagement processes* ".

4.2.1. The Rationale between Sustainability Assessment Methods

Sustainability assessment differs from environmental impact assessment by addressing social and economic as well as environmental outcomes. At present, most sustainability assessment involves considering environmental, social and economic factors separately, as in triple bottom line (TBL) assessment. However, sustainability assessment should ideally evaluate all issues - environmental, economic and social - in a transparent way and develop integrated solutions where trade offs are minimised or non-existent.

Although the built environment has a key role to play in sustainability, there are many other important factors, e.g. natural features, natural resources (water, arable land, mineral wealth, etc.), weather patterns, local culture, etc. The sustainability assessment method has to addresses the inter-linked facets of sustainability that is the underlying environmental, social and economic concerns and principles. As Building Research Establishment (BRE, 2005), identify sustainability concerns and principles as:

4.2.1.1. The environmental factor

Environmental sustainability involves consideration of the impact of development of the built environment (existing or proposed) on the local natural environment, and its contribution to national and global environmental impacts.

4.2.1.2. The social factor

The built environment should be a healthy, attractive and desirable place for people to live and work. Agreeing on the features to achieve this is not easy, but is likely to have a high ‘quality’ built environment where the majority of people find attractive and comfortable.

4.2.1.3. The economical factor

The requirements for economic sustainability vary depending on the nature of the community. The economic health of individual communities is linked to the economic health of the surrounding region, and it is the responsibility of authority to foster the economic growth within the region.

Deakin, Curwell, & Lombardi (2002, P.13) highlighted some of the current problems with the application of and weaknesses in the environmental assessment methods:

- The need to extend the analysis beyond the matrix-based mapping and to introduce a more comprehensive grid referencing system
- The difficulty current assessment methods have in dealing with the complexity of institutional structures and associated stakeholder interests
- the tendency for the policy planning and infrastructure design stages to overshadow the assessment needs of the other stages and result in a situation where comparatively speaking, relatively little is known about either the procurement of construction, or installation of operations
- The paucity of sustainable development currently available in relation to a broader context of environmental, economic and social issues

Accordingly, to assess sustainability criteria in a building, project, community, or development a multidimensional assessment is more adequate to use. Regardless several sustainability assessment methods about built environment, most of them are environmental content. This may be referred to the tangible standards or figures that may be obtained for some environmental issue: as energy use, water consumption, toxics emissions…etc.

At this point, environmental assessment methods are going to be discussed in this chapter; social aspects are going to be discussed in chapter five. This research is not going to discuss the economical aspects for it is related to many factors that are beyond this research limitation.

4.2.2. The Difference between the Assessment Method and an Indicator

Agenda 21, which was adopted by The WCED 1992 in Rio, defined the principles that should achieve this integration. Although the principles are clear, they are sometimes not easy to implement. This is why the indicators of sustainability have been developed and measured. These indicators provide for a description of the current state of economy, environment and society. In order to measure the dynamics of change toward sustainability, these indicators describe the progress that has been made. In order to predict the future progress better indicators are required (Blinca; Aleksandereka; Ivo, 2006).

An indicator can generally be understood as a quantitative tool or information that points to a condition or analyses changes, while measuring and communicating progress towards the sustainable use and management of economic, social, institutional and environmental resources (www.ecifm.rdg.ac.uk/inofsd.htm - Last accessed 19-07-2006). Its purpose is to show how well a system is working towards the defined goals. As a result, an indicator is a tool that helps us understand where we are, which way we are going and how far we are from where we want to be (www.ew.govt.nz/enviroinfo/indicators/community/index.htm- Last accessed 19-07-2006).

An indicator can also be used in an evaluation, assessing buildings or development (Olsson; Aalbu; Hilding-Rydevik; and Bradley, 2004); it also assists in setting design – from conception to disposal- of buildings, landscapes or products (Birkeland & Lubanga, 2005, P.224). The aim of indicators for sustainable development is thus to develop a framework that attempts to bring the economic, social and environmental aspects of society together, emphasising the links between them.

Indicators have perhaps been the most commonly applied tool to help gauge progress towards attaining sustainability. Yet the use of indicators, as Simon Bill and Stephen Morse

(2003, P.29) consider, as a device for (doing) sustainable development is logical, it does present some immediate difficulties such as “What indicators do we use to measure sustainability? How do we measure them? And how do we use them?”.

Both of sustainable assessment methods and indicators aim to develop a framework or help in setting policies consistent with sustainability principles and the links between them. Yet assessment method is a process or system while indicator is a tool that points to a condition or change.

4.2.3 The Difference between the Assessment Method and a Checklist

The checklist is a tool that allows the sustainability aspects of a development to be addressed, and for reviewing organizations and decision makers to understand the level of performance that might be achieved. It aims to ensure that all construction industry players recognise the impact of new developments on natural resources, ecology and energy. It offers a common framework for all developments and allows sustainability to be understood in an everyday sense, encouraging the industry to factor key aspects into the fledgling design and planning stages (SEEDA, 2005).

For construction projects to contribute to sustainable development, key issues need to be addressed including mixed-use design, energy efficiency, renewable energy, water use, transport and social well-being.

The main difference between an assessment method and a checklist is that assessment method is a process or system for evaluation, while the checklist is an assistant tool that points the assessor or designer that all the assessed areas have been covered.

4.3. Analysis of Environmental Assessment Methods (EAM)

Building environmental assessment methods have emerged as a widely adopted way to evaluate the performance of buildings across a broad range of environmental considerations. The development and application of such methods have provided considerable theoretical and practical experience on their potential contribution in furthering environmentally responsible building design, construction and operational practices (Cole, 2000, P.949). Environmental assessment is an essential process in sustainable design to assess the design goals.

These environmental assessment methods range from very detailed life cycle assessment methods, which account for all the embodied and operational environmental impacts of building materials, to higher level environmental impact assessment methods, which evaluate the broader implications of the building’s impact on the environment.

A building environmental assessment method, as defined by Raymond J Cole (2001, P. iii), is "*a way to evaluate the environmental performance of a building against an explicit set of criteria*". Environmental assessment is important to for building sector. The British Columbia Green Buildings Ad-Hoc Committee recognizes two advantages for environmental assessment of a building (Cole, 2001, P. iii):

- Identify success at meeting an expected level of performance in a number of declared environmental performance criteria.
- Provide clear guidance on the environmental strengths or deficiencies that can offer feedback to an evolving design or provide guidance for future remedial work.

With more concerns about the environmental impacts of building and construction, several methods have been developed in the world for the evaluation of building environmental performance (Cole, 1999. PP.230-246.). The assessment of building environmental performance covers a wide range of issues and may involve a number of technological, ecological and socio-cultural factors. Although there is still lack of agreement on the scope of assessment, the building's energy efficiency or performance usually forms a key element in the assessment process. Although the general goal is similar, the specific approach and criteria taken by each method can be very different.

Deakin, Curwell, & Lombardi (2002, P.13) suggested that assessment methods in question fall into two classes: "environmental in general" and those augmenting into particular forms of "life cycle assessments". The environment in general tends to focus on assessments of eco-system integrity. Those methods augmenting into particular forms of life cycle assessment tend to focus on building environmental capacity needed to not only ensure the integrity of eco-systems, but also evaluate the equity, participation and futurity (sustainable development) of the economic, social and institutional issues underlying the city of tomorrow and its cultural heritage. Assessment methods are used to qualify and evaluate if the forms of human settlements that develop are sustainable.

Assessment methods originated in developed countries. With increased international interest, however, the cross-cultural transferability of assessment methods is of particular importance to those in developing countries. The exchange and 'borrowing' of methods has been greatly assisted through the active participation of many countries in international programmes and initiatives such as the Green Building Challenge (Larsson and Cole, 2001) BREEAM and LEED. Although there are clear benefits associated with this exchange, the dangers of homogenization and reduced sensitivity to the acknowledgement and promotion of regionally appropriate design strategies is always present. Indeed, the inappropriate cross-cultural 'importation' of specific technical strategies may, in the short-term, prove potentially detrimental to environmental progress. Similarly, since assessment methods invariably carry the implicit cultural biases of their creators, it is critical that their underpinnings be made explicit within any comparison and adoption (Cole, 2005, P.458,459).

Accordingly, it is one of this research aims to develop an environmental assessment method appropriate to the Arab World. At this point, the three environmental assessment methods were selected, analysed, and modified to develop the proposed EAM that is going to be used to assess environmental sustainability performance for the chosen case study.

4.3.1. Sustainability Environmental Assessment Methods

The primary benefit from environmental assessment method is that it can provide a structured means of incorporating performance targets and criteria into the design process (Crawley& Aho, 1999, P. 303).The experience of the existing assessment methods will form a useful background of this research. An objective and sufficiently demanding measure will be needed to design the new environmental assessment systems in the UAE and to develop relevant performance indicators and benchmarks for charting environmental and sustainability progress. It is believed that the following criteria are important for environmental assessment systems:

- Understandable and acceptable by building professionals and public.
- Practical and cost effective to implement.
- Technically sound and well supported by local research and analyses.
- Clear objectives and good considerations of local conditions.
- Efficient mechanism for implementation, capacity building and market stimulation.

To ensure successful implementation of the system, guidelines for sustainable building design should be developed to provide practical assistance to building designers and encourage wider acceptance of the assessment method. However, when developing EAM or indicators for a region it is of the utmost importance to take into consideration the specific situation of the region, both in terms of its social, economic and ecological resources and of its possibilities to influence development, (www.sustainable-euroregions.net/policy_studies.php - Last accessed 18-07-2005).

A number of existing housing related environmental assessment methods were examined, notably Eco Homes: the environmental rating for houses (BREEAM), the Green Globes Design, and LEED (leadership in Energy & Environment Design) accreditation system created by US Green Building Council. Other assessment methods and rating systems were investigated such as Green Star in Australia, LEED India, the Hong Kong Building Environmental Assessment Method (HK-BEAM), and The Green Building Tool (GBTool).

Most of these assessment methods examined provide guidance about housing design and construction but do not generally provide a comprehensive evaluation methodology to assess compliance with the guidelines. The chosen EAM provided detailed evaluation methodologies for specific issues.

4.3.1.1. Objectives for Choosing Environmental Assessment Methods

Three possible methods or systems were investigated and analyzed in order to develop of the research SEAM. These assessment systems are:

- Building Research Establishment Environmental Assessment Method (BREEAM) – UK.
- Green Globes – Canada.
- Leadership in Energy and Environmental Design (LEED)-USA

Choosing these methods was based on:

- Simplicity and practicality
- The ability to offer comparisons and benchmarking
- The organisational context within which the method operates
- The ability to be customised while retaining universality
- Its potentiality to be used in the Arab world

4.3.1.2. Assessment Methods Rating System

Each Environmental assessment method has a certain rating system. It either depends on evaluation scoring in credits (EcoHomes) or points (Green Globes and LEED). The total number of credits or points varies, so is the rating for each area of assessment. The criteria, assessed area, and rating systems are illustrated and analyzed to build a base for developing sustainability environmental assessment method SEAM that will be used to assess the case study of this research. One or multi-technique can be used to obtain results for assessing: survey, comparable figures, following certain regulations or guidance.

4.3.2. BRE Eco-home

EcoHomes is an assessment method that rates the environmental qualities of new and renovated dwellings. It is designed to help tackle climate change, resource use and impact on wildlife and balance these issues against the need to provide safe and healthy homes and a high quality of life. It helps reduce the environmental impact of a development through good design and informed decisions in the following areas (BRE, 2005):

- Energy
- Transport
- Pollution
- Materials
- Water
- Health and well-being
- Ecology and land use

Chart 4.1 shows areas of assessment for EcoHomes illustrating priority of each criterion.

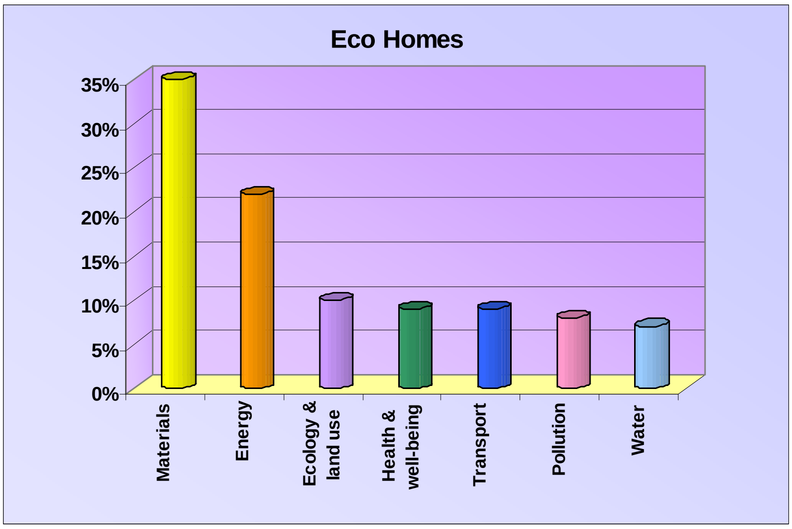


Chart 4.1- EcoHomes assessment method criteria

(Source: the author)

4.3.2.1. EcoHomes Rating System

Eco Homes rates the environmental qualities of new and renovated dwellings. Buildings are verified by independent assessors and rated on a scale of: Pass, Good, Very Good and Excellent. EcoHomes rating system depends on credits system; each area or criterion get certain credits and the total is 89 credits. Scores are given for each area of assessment as follows: energy 20 credits (22%), transport 8 credits (9%), pollution 7 credits (8%), materials 31 credits (35%), water 6 credits (7%), ecology & land use 9 credits (10%), and health & well-being 8 credits (9%). Table 4.1 shows areas of assessment and rating system for EcoHomes illustrating areas and sub-areas of assessment, credits, scores, and value of each assessment method.

Table 4.1 – *EcoHomes areas of assessment and rating system*

(Source: the author based on BRE, 2005)

Area of assessment	**EcoHomes SAM**				
	Credits 89	**Score %**	**Sub-Areas of Assessment**	**Credits**	**% score**
Energy	20	22%	Carbon dioxide	10	50%
			Building fabric	5	25%
			Drying space	1	5%
			Eco-Labelled goods	2	10%
			External lighting	2	10%
Transport	8	9%	Public transportation	2	25%
			Cycle storage	2	25%
			Local amenities	3	37.5%
			Home office	1	12.5%
Pollution	7	8%	Insulate ODP & GWP	1	14%
			NOx Emission	3	43%
			Reduction of surface Runoff	2	29%
			Zero emission Energy source	1	14%
Materials	31	35%	Timber: Basic building elements	6	19%
			Timber: Finishing element	3	10%
			Recycling facilities	6	19%
			Environmental impact materials	16	52%
Water	6	7%	Internal water use	5	83%
			External water use	1	17%
Ecology & land use	9	10%	Ecological value of site	1	11%
			Ecological enhancement	1	11%
			Protection of ecological features	1	11%
			Change of ecological value of site	4	45%
			Building footprint	2	13
Health & well-being	8	9%	Day lighting	3	37%
			Sound insulation	4	50%
			Private space	1	13%

4.3.3. Green Globes AM

Green Globes Design is both a guide for integrating green design principles and an assessment method. Green Globes is the newest addition to the BREEAM/Green Leaf suite of environmental assessment tools. The program's core premise is that environmental leadership and responsibility make business sense. BREEAM/Green Leaf tools are used in hundreds of North American buildings (ECD, 2004).

It involves answering approximately 150 questions and it takes the typical design team 1.5 days to complete. Once complete, Green Globes gives ratings in seven areas:

- Project management
- Site
- Energy
- Water
- Resources
- Emissions & effluents
- Indoor environment

Chart 4.2 shows areas of assessment for Green Globes illustrating priority of each criterion.

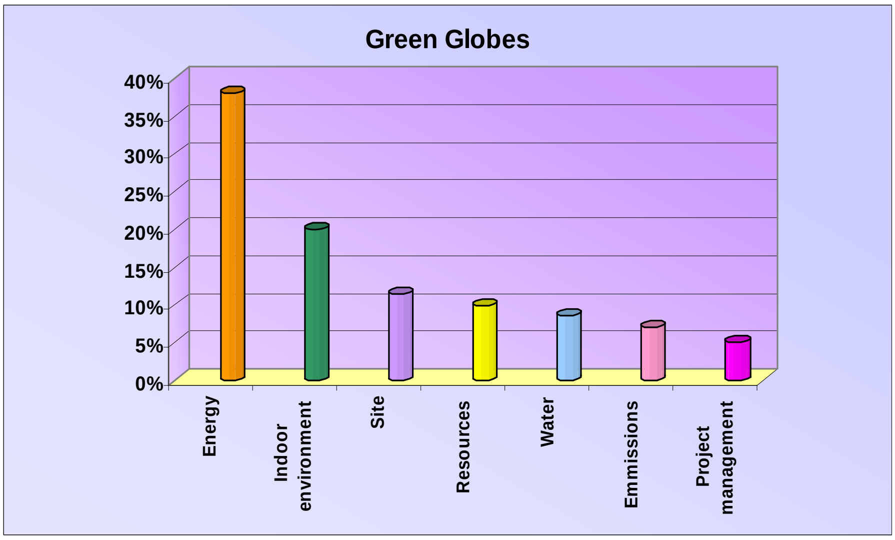


Chart 4.2 - Green Globes assessment method criteria

(Source: the author)

4.3.3.1. Green Globes Rating System

Confidential questionnaires for each project delivery stage evaluate how the best energy and environmental design practices and standards are being met. Two stages are rated, which reflect the planning and building permit approval process: A preliminary rating is given at the Design Concept Stage; which provides an opportunity to improve the design. The final rating is given at the Construction Documents stage. The program provides two kinds of ratings:

First: Scores give the percentage of points that have been awarded for meeting best energy and environmental design practices and standards. Scores are given for each area of assessment (site 11.5%, energy 38%, water 8.5%, resources 10%, emission 7%, indoor environment 20%, and project management 5%). Total Scoring is 1000 points available. Buildings receive percentage ratings for overall score, each area of assessment, each sub-area of assessment as follows:

85-100%   70-84%   55-69%   35-54%   15-34%

Second: Quintile ratings show performance relative to other buildings that have been assessed. These are provided only for building designs that have undergone third party verification. A building can be benchmarked against buildings of similar type or geographical zone (ECD, 2004).

Green Globes rating system depends on points system; each area or criterion get certain points and the total is 1000 points. Scores are given for each area of assessment as follows: Project management Process 50 points (5%), site 115 points (11.5%), energy 380 points (38%), water 85 points (8.5%), resources 100 points (10%), Emission & effluents 70 points (7%) and indoor environment 200 points (20%).

Table 4.2 shows areas of assessment and rating system for Green Globes illustrating areas and sub-areas of assessment, credits, scores, and value of each assessment method.

Table 4.2 – Green Globes areas of assessment and rating system

(Source: the author based on ECD, 2004)

Area of assessment	**Green Globes AM Method**				
	Points 1000	**%**	**Sub-Areas of Assessment**	**Points**	**%**
Project management Process	50	5%	Integrated design process	20	40%
			Environmental purchasing	10	20%
			Commissioning	15	30%
			Emergency response plan	5	10%
Site	115	11.5%	Development area (site selection, development density.	30	26%
			Ecological Impact	30	26%
			Watersheds features	20	17%
			Site ecology enhancement	35	31%

Energy	380	38%	Energy performance	100	26%
			Reduced energy demand	114	30%
			Integration of energy efficient systems	66	17%
			Renewable energy sources	20	6%
			E-efficient transportation	80	21%
Water	85	8.5%	Water performance	30	35%
			Water conservation features	45	53%
			On-site treatment of water	10	12%
Resources	100	10%	Low impact systems & materials	40	40%
			Minimal consumption of resources	15	15%
			Reuse of existing buildings	15	15%
			Building durability, adaptability & disassembly	15	15%
			Reduction, reuse & recycling	5	5%
			Recycling & composting facilities	10	10%
Emission & effluents	70	7%	Air emission	15	21%
			Ozone depletion	20	29%
			Avoiding sewer waterway contamination	10	14%
			Pollution minimization	25	36%
Indoor Environment	200	20%	Ventilation system	55	27.5%
			Control of indoor pollution	45	22.5%
			Lighting	50	25%
			Thermal comfort	20	10%
			Acoustic comfort	30	15%

4.3.4. LEED Assessment Method

LEED is an assessment method developed by US Green Building Council. It is intended to be a blueprint for the market-transformation process to be achieved through the ongoing refinement and development. It is a professional accreditation and assessment system to distinguish and recognize individual professionals for their expertise in the design, construction and operation of green buildings and achievement of LEED certification (GBC, 2004). It covers environmental actions in:

- Sustainable sites
- Water efficiency
- Energy and atmosphere
- Materials and resources
- Indoor environmental quality
- Bonus credits for process and design innovation

Chart 4.3 shows areas of assessment for LEED illustrating priority of each criterion.

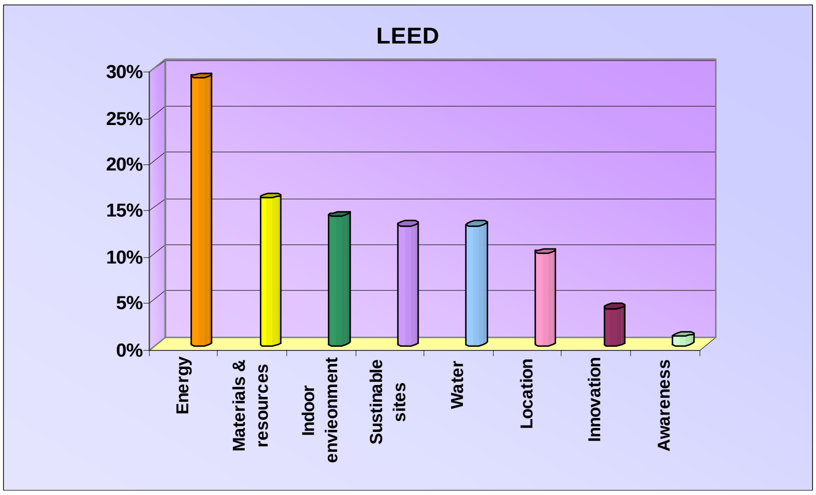


Chart 4.3 - LEED assessment method criteria

(Source: the author)

4.3.4.1. LEED Rating System

LEED rating system contains three principal types of requirements (GBC, 2004):

- **Prerequisites**: Required elements all of which must be met before a project can be considered for LEED Certification.
- **Core Credits**: Specific actions a project may take in the five areas. All Core Credits are voluntary, but each level of LEED requires that certain thresholds be met.
- **Innovation Credits**: “Extra credit” given for exemplary performance beyond Core Credit performance levels or implementation of innovative actions that confer significant environmental benefits not covered in the rating system.

LEED rating system depends on credits system; each area or criterion get certain credits and the final is 100 credits. Scores are given for each area of assessment as follows: location & linkages 10 credits (10%), sustainable sites 13 credits (13%), water efficiency 13 credits (13%), indoor environmental quality 14 credits (14%), materials & resources 16 credits

(16%), energy & atmosphere 29 credits (29%), homeowner awareness 1 credit (1%), innovation & design process 4 credits (4%).

Provided all Prerequisites are satisfied, the LEED Certification rating is determined by the numbers of credits achieved by the assessed building or project, as follows.

- **Platinum:** 82-100 points (80% of the correct credits)
- **Gold:** 64-81 points (60% of the correct credits)
- **Silver:** 47-63 points (50% of the correct credits)
- **Certified** 30-46 points (40% of the correct credits)

Table 4.3 shows areas of assessment and rating system for LEED illustrating areas and sub-areas of assessment, credits, scores, and value of each assessment method.

Table 4.3 – LEED areas of assessment and rating system

(Source: the author based on GBC, 2004)

Area of assessment	**LEED AM Method**				
	Credits 100	Score %	**Sub-Areas of Assessment**	**Credits**	**% score**
Location & linkages	10	10%	LEED certified neighbourhood **OR**	10	100%
			Appropriate site selection	2	20%
			Infrastructure efficiency	2	20%
			Ease of access	3	30%
			Land use efficiency	3	30%
Sustainable sites	13	13%	Minimize site impact	Required	-
			Resource efficient landscaping	5	38%
			Shading of home site	1	8%
			Surface water	5	38%
			Poison	2	16%
Water efficiency	13	13%	Water re-use	2	15%
			Irrigation system	4	31%
			Indoor use	6	47%
Indoor Environmental quality	14	14%	Performance	10	72%
			Combustion venting	Required	-
			Humidity	1	7%
			Ventilation	2	14%
			Containment control	1	7%

<table>
<tr><td rowspan="5">Materials & resources</td><td rowspan="5">16</td><td rowspan="5">16%</td><td>Efficiency</td><td colspan="2">2</td><td colspan="2">12.5%</td></tr>
<tr><td>Local sources</td><td colspan="2">5</td><td colspan="2">31%</td></tr>
<tr><td>Durability</td><td colspan="2">3</td><td colspan="2">19%</td></tr>
<tr><td>Improved products</td><td colspan="2">4</td><td colspan="2">25%</td></tr>
<tr><td>waste</td><td colspan="2">2</td><td colspan="2">12.5%</td></tr>
<tr><td rowspan="8">Energy & atmosphere</td><td rowspan="8">29</td><td rowspan="8">29%</td><td>HERS Rating OR</td><td colspan="2">16</td><td colspan="2">55%</td></tr>
<tr><td>Envelope</td><td>5</td><td rowspan="3">16</td><td>17%</td><td rowspan="3">55%</td></tr>
<tr><td>Comfort systems</td><td>5</td><td>17%</td></tr>
<tr><td>Water heating</td><td>6</td><td>21%</td></tr>
<tr><td>Lighting</td><td colspan="2">3</td><td colspan="2">10%</td></tr>
<tr><td>Appliances</td><td colspan="2">3</td><td colspan="2">10%</td></tr>
<tr><td>Renewable</td><td colspan="2">6</td><td colspan="2">21%</td></tr>
<tr><td>Ozone</td><td colspan="2">1</td><td colspan="2">3%</td></tr>
<tr><td>Homeowner awareness</td><td>1</td><td>1%</td><td>Guidance</td><td colspan="2">1</td><td colspan="2">100%</td></tr>
<tr><td>Innovation & design process</td><td>4</td><td>4%</td><td>Innovation in design</td><td colspan="2">4</td><td colspan="2">100%</td></tr>
</table>

4.4. Formulation of Sustainability EAM

A central issue in striving towards assessment methods, as Crawley and Aho (1999, P.300) claim, is the need for a practicable and meaningful yardstick for measuring environmental performance, both in terms of identifying starting points and monitoring progress. As for any other sector, from the construction and property sector's perspective this can be divided in two slightly different points of view: measuring the environmental impact of design, construction and property management activities (as services or industrial production processes) and the environmental impact of buildings (as products).

The first stage of the development process for the SEAM, in this research, is to develop the core module that covers the range of areas and issues needed. The development of a set of housing assessment methods is a major project, requiring considerable investment. However, it is believed that there are potentially huge benefits in developing such a system in terms of increasing the quality of housing and getting better value for the resources invested each year on housing.

The analysis of the investigated environmental assessment methods demonstrated that precedents do exist which contain elements useful to the development of the housing quality indicators and which clearly demonstrate that it is feasible to develop these indicators.

However, none of these methods can be used in the Arab World in their existing form. Accordingly, developing SEAM for assessing environmental sustainability of traditional and contemporary houses in the UAE and can be adequate in the Arab World, requires analysis of the chosen SEAM, customisation of rating system then formulation of a proposed SEAM.

4.4.1. Analysis of the Chosen Sustainability Environmental Assessment Methods

Crystallizing the sustainability environmental assessment method SEAM depended on analysing the chosen assessment methods following these steps:

- Setting principles.
- Identifying the criteria
- Categorizing the assessment areas.
- Setting the rating system.

The developed SEAM largely based on fulfilling these issues:

- The system can be anticipated to find widespread adoption in the Arab World
- The extent of experts, specialists, and policy-makers who can actively participate in their future development and evolution
- Awareness, recognition and use by the private sector and design professionals

Chart 4.4 shows a comparative analysis for area of assessment criteria for the investigated environmental assessment methods

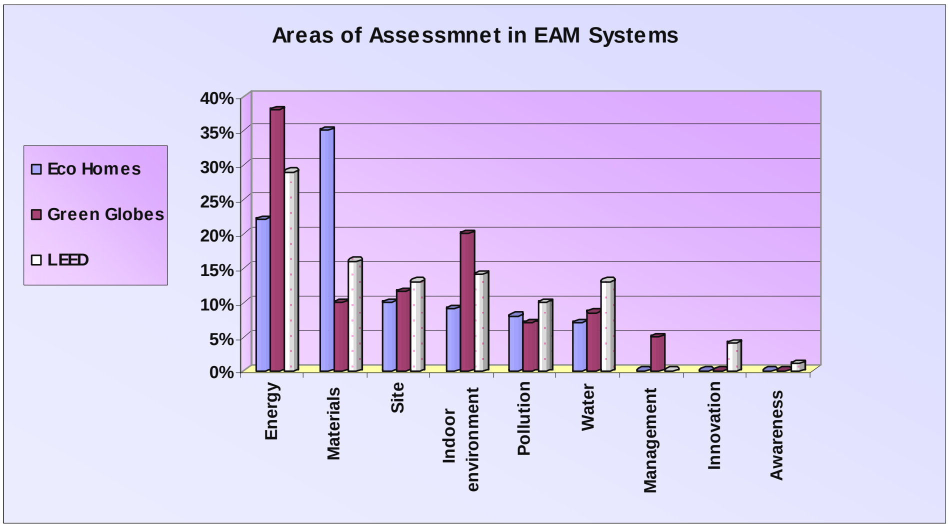


Chart 4.4 –Area of assessment criteria for the investigated environmental assessment methods

(Source: the author)

According to the analysing the investigated environmental assessment methods, it is concluded that all the investigated methods included several criteria, most of them may be categorized within the following areas: site, energy, resources (including materials and waste), indoor environment quality (human wellbeing), pollution and emissions, and water. All these issues are related to building construction practices; building design and building operation that directly or indirectly affect resource use or ecological loading. Other issues such as site linkages and transport, project management, and design innovation appeared separately in the investigated environmental assessment methods. Table 4.4 shows areas of assessment criteria and rating system score for the investigated environmental assessment methods.

Table 4.4 - Areas of assessment criteria and rating system score for the investigated environmental assessment methods

(Source: the author)

Assessment Methods Systems									
	Eco Homes	**Credits 89**	**%**	**Green Globes**	**Points 1000**	**%**	**LEED**	**Points 100**	**%**
1	Materials	31	**35%**	Energy	380	**38%**	Energy and Atmosphere	29	**29%**
2	Energy	20	**22%**	Indoor environment	200	**20%**	Materials and Resources	16	**16%**
3	Ecology & Land use	9	**10%**	Site	115	**11.5%**	Indoor Environmental Quality	14	**14%**
4	Health & well-being	8	**9%**	Resources	100	**10%**	Sustainable sites	13	**13%**
	Transport	8	**9%**				Water Efficiency	13	**13%**
5	Pollution	7	**8%**	Water	85	**8.5%**	Location and Linkages	10	**10%**
6	Water	6	**7%**	Emission & Other Impacts	70	**7%**	Homeowner awareness	4	**4%**
7				Project management	50	**5%**		1	**1%**

4.4.2. Customisation of Rating System

A major part of building environmental assessment is determining the performance levels that result from these building design strategies (Cole, 2000, P.950). In order for an environmental assessment method to form an acceptable basis for a public labelling or rating scheme certain fundamental requirements must be met, from both a philosophical and a practical point of view (Crawley and Aho, 1999, P.305). These requirements can be listed as follows:

- Assigning different credits to the performance criteria to reflect regional priorities for environmental issues
- The adaptation of point scores to reflect environmental priorities is a central issue in creating the rating system
- A greater use of prerequisites may be an effective means to get greater coverage without adding complexity
- Assigning different credits to the performance criteria to reflect regional priorities for environmental issues

Although all existing environmental assessment methods assign performance points to the various environmental criteria, there is no common basis for the way in which the maximum number of points attainable in each case is assigned between different methods. Assessment implies measuring performance against a declared scale. Raymond Cole (2001, P.6) classifies two approaches to evaluate environmental performance and set weighting of environmental criteria:

- **Performance oriented**: It is based on predicted or actual performance of measurable issues such as annual energy use; annual water use …etc.
- **Prescriptive oriented**: It is based on the presence or absence of specific features or strategies that lead to improved environmental performance. This approach is often used to describe qualitative performance issues where there is currently no widely accepted metric.

This research is going to use these two approaches of weighting for evaluating sustainability environmental performance for the chosen case studies in chapter eight according to the nature of assessed criterion.

Weightings of environmental impacts, and the building assessment criteria that affect them, have large impacts on the relative scores of buildings. Deriving rationale, defensible and credible weightings of environmental issues for the circumstances and region of use is emerging as a critical issue in the field (Cole, 2001, P.6). The number, organisation of criteria and rigour of assessment methods are influenced by both technical and practical requirements:

- The ability to make assessments repeatably and reliably by trained assessors or through self-assessment

- Whether there is general agreement over the criteria and measurement methods, and therefore confidence, as to their significance
- The ability to fully understand and react to the results of the assessment. Clearly, the comprehensiveness of an assessment is related to the number of assessment criteria that are included

The scoring options for each criterion might be single 'quality' score as (Yes, No, or N/A) as followed in Green Globes. Other scoring options might be based on tests or procedures should be referenced. For example, the evaluation of energy efficiency or CO2 emissions could include a scoring table for reliable ratings, as used in EcoHomes or LEED. The rating system may consist of a multi-point scale, with the lowest figure indicating a low level of provision, or the legal minimum of certain standards that is allowed, as used in some criteria in EcoHomes and LEED.

Depending on the evaluated criterion, the assessor or designer may select which of the multi options most accurately reflects the level of specification in the scheme being evaluated or to tick which of a list of features apply to the criteria being evaluated. According to the issues discussed and the investigated environmental assessment methods analysis, the final areas of assessment criteria score is illustrated in table 4.5. The illustrated data will be used for developing the SEAM areas of assessment criteria and rating system.

Table 4.5 - Areas of assessment score for the investigated environmental assessment methods
(Source: the author)

Areas of Assessment	**Assessment Method Systems**			
	Eco Homes	**Green Globes**	**LEED**	**Final Score**
Energy	22%	38%	29%	**29.9%**
Resources	35%	10%	16%	**20.33%**
Site	10%	11.50%	13%	**11.5 %**
Indoor Environment (Well-being)	9%	20%	14%	**14.3%**
Pollution	8%	7%	14%	**9.6%**
Water	7%	8.50%	13%	**9.5%**
Project Management	0%	7%	0%	**-**
Innovation & Design Process	0%	0%	4%	**-**
Homeowner Awareness	0%	0%	1%	**-**
Total				**95.33%**

4.4.3. The Proposed SEAM Rating System

According to the quantitative analysis for assessment areas rating for the chosen environmental assessment methods, final scores are illustrated in table 4.6. Results were modified to be used appropriately for evaluating sustainability environmental performance of the chosen case studies and the region's conditions. Environmental criteria that will be adapted are the common ones that have appeared in all the three investigated EAM: energy, site, resources, indoor environment, water, and waste. Criteria that appeared in one of the environmental assessment methods were neglected such as "Transport" in EcoHomes, "Project management" in Green Globes, and "Innovation" and "Homeowner awareness" in LEED.

Table 4.6 – Proposed SEAM area of assessment score
(Source: the author)

Areas of Assessment	Actual Score	Final Score
Energy	29.9%	**30%**
Resources	20.33%	**21%**
Site	11.5%	**15%**
Indoor Environment (Well-being)	14.3%	**15%**
Water, Pollution & Waste	19.1%	**19%**
Management	0	**0**
Innovation	0	**0**
Awareness	0	**0**
Total	95.33%	**100%**

Clearly, some environmental issues are more significant than others such as priorities that change over time, from building type to building type, and from region to region. Weighting of environmental criteria is an accepted method for assigning relative significance to the environmental performance criteria. Aggregate performance scores are profoundly influenced by the weightings assigned to the constituent criteria (Cole, 2001, P.5).

Based on the previous discussion, a rating system is formulated according to the importance of each criteria and its priority in the investigated EAM and the region conditions. Energy got the priority (30%); this is appropriate to this research region (The UAE and the Arab World), where air-conditioning consumes a great amount of energy. Other assessment criteria are resources (21%), site (15%), and indoor environment (15%). As discussed in chapter one, water is a sacred resource in the Arab World, thus water along with waste got 19% of scoring. Chart 4.5 shows SEAM area of assessment criteria and rating score.

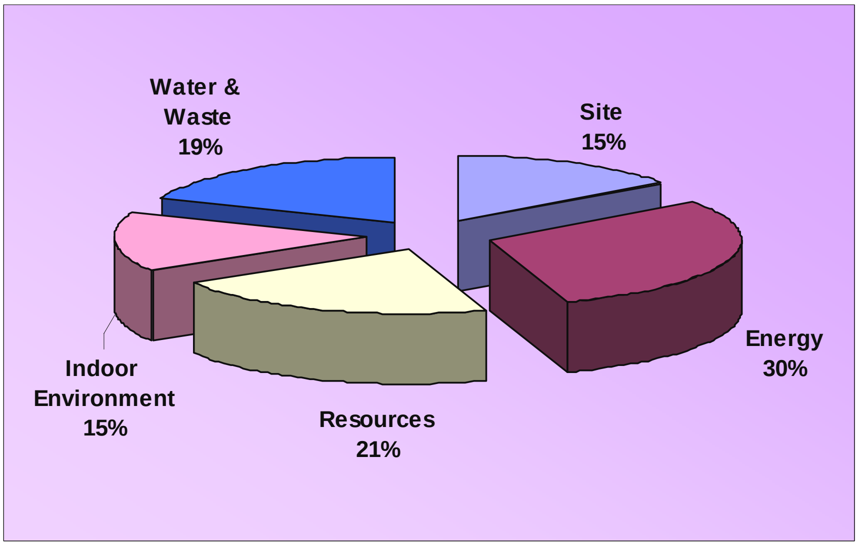


Chart 4.5 - SEAM area of assessment rating system score

(Source: the author)

The rating system employed in the investigated environmental assessment methods varied, 89 credits in EcoHomes, 1000 points in Green Globe, and 100 credits in LEED. These credits or points were divided into areas and sub-areas of assessment according to the importance of each criterion and assessment aim. For this research, the rating system is proposed to consist of 100 credits divided according to each criteria priority. Each assessed criteria is divided into several sub-areas of assessment that has its own credits according to its relevance and effect on the main criteria performance. Each sub-area of assessment will be assessed according to certain architectural features that are affectively relevant to the assessed criteria. .

Table 4.7 illustrates the proposed SEAM area of assessment criteria, sub-area of assessment and the assessed architectural features for each criterion. Furthermore, this table illustrates credits given and scoring for each criterion.

Table 4.7- The proposed environmental assessment method criteria and rating system

(Source: the author)

Areas of Assessment	Credits (100)	%	Sub-area of Assessment	Credits	%	Architectural features
Site	15	15%	Site selection	6	40%	Architectural planning Orientation Access to plot Plot size
			Site planning	6	40%	Site organization Outside-inside relationship Building mass Building form
			Building footprint	3	20%	Brown field
Energy	30	30%	Carbon Dioxide	10	33.3%	Energy consumption
			Renewable energy resources	10	33.3%	Energy source
			Building envelope	10	33.3%	Building materials Construction system
Resources	21	21%	Building materials	9	43%	Sustainability features of materials
			Recycling and Reuse	7	33%	Building lifecycle Building flexibility
			Materials lifecycle	5	24%	Materials durability
Indoor Environment	15	15%	Natural Ventilation	5	33.3%	Ventilation system
			Indoor air quality	5	33.3%	Building materials properties
			Thermal comfort	5	33.3%	Building envelope Spaces flexibility
Water & Waste	19	19%	Water consumption & recycling	11	58%	Water consumption rate
			Waste output & recycling	8	42%	Domestic waste production

For evaluating each area and sub-area of assessment criteria, a performance evaluation range has to be set. The Sustainability Checklist set by SEEDA suggested ranges of performance or standards. These range from 'good practice' to 'best practice'. In some cases, therefore, the checklist adopts an approach called the 80/20 rule. This means that Best Practice can be achieved provided more than 80% of the development meets the particular standard. Sustainability Checklist also refers to the certainty of assessment criteria control. The risk column has been included to allow the risk element to be included in the assessment (SEEDA, 2004). The figure to be used ranges from 0-1. Table 4.8.shows certainty levels according to each figure. This range is going to be modified to be adapted in assessment process that will be discussed in chapter eight.

Table 4.8- Sustainability Checklist certainty range

(Source: the author based on SEEDA, 2005)

1	**0.8**	**0.5**	**0.2**	**0**
○	○	○	○	○
Total Certainty	High Degree of Certainty	Medium Degree of Certainty	Low Degree of Certainty	Not considered

At this point, it is important to determine the evaluation process. Evaluating each criterion is going to be the sum of credits obtained by each sub-area of assessment according to certain indicators appropriate to the assessed criteria. Evaluation methods and indicators will be discussed thoroughly in chapters seven and eight. Instead of the (0-1) certainty range adapted by SEEDA Sustainability Checklist, this research suggests using (1-10) evaluation range. Each sub-area of assessment will be evaluated and given a score ranging 1-10 depending on degree of relevance the assessed criterion is compared to certain standard. This score will be multiplied by the sub-area of assessment credit to obtain the final credit of this part. Then all sub-area of assessment credits will be summed to get the total credits of the assessed criteria.

Sub-area of assessment credit = *Score (range 1-10) X criteria credit / 10*

Total area of assessment credit = *Sub-area$_1$ credit+ Sub-area$_2$ credit+…+ Sub-area$_n$ credit*

Table 4.9 shows a typical form for assessing environmental sustainability criteria for traditional and contemporary houses. This form is going to be used for testing appropriateness of the proposed SEAM in assessing the environmental sustainability performance for traditional and contemporary case study houses in chapter eight.

Table 4.9- Typical form for assessing environmental sustainability criteria for the chosen case studies

(Source: the author)

<table>
<tr><th>Area of Assessment</th><th colspan="15">Sub-areas of Assessment</th><th>Total Credit</th></tr>
<tr><th></th><th>Crds.</th><th colspan="4">Sub-area of Assessment</th><th>Crds.</th><th colspan="4">Sub-area of Assessment</th><th>Crds.</th><th colspan="4">Sub-area of Assessment</th><th></th></tr>
<tr><td rowspan="3">Traditional House</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td rowspan="3"></td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Credit=score X credit/10</td><td colspan="5">Credit=score X credit/10</td><td colspan="5">Credit=score X credit/10</td></tr>
<tr><td rowspan="3">Contemporary House</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td rowspan="3"></td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Credit=score X credit/10</td><td colspan="5">Credit=score X credit/10</td><td colspan="5">Credit=score X credit/10</td></tr>
</table>

Conclusions

This chapter has investigated and analyzed the some of the existing environmental sustainability assessment methods and formulated SEAM that will be used for assessing environmental sustainability performance for chosen traditional and contemporary houses that will be the empirical study of this research. The main conclusions of this part can be summarized as follows:

- Environmental sustainability assessment method is a framework for analysis and assessing sustainability potentiality in buildings.
- Analysing existing environmental assessment methods provides an objective base to develop a set of assessment method appropriate to the UAE and the Arab World.
- The investigated methods included several criteria; most of them may be categorized within the following areas: site, energy, resources (including materials and waste), indoor environment quality (human wellbeing), pollution and emissions, and water.
- Formulating SEAM appropriate to the Arab world necessitates modifying the chosen assessment criteria in priority and rating system.
- The developed SEAM is likely to cover the following areas: site, energy, resources, indoor environment, and water and waste.
- The SEAM proposed rating system consists of 100 credits divided according to each criteria priority. Each assessed criteria is divided into several sub-areas of assessment that has its own credits according to its relevance and effect on the main criteria performance.

Formulation of SEAM is the first step in developing sustainability environmental assessment method appropriate to the Arab World, which is one of this research aims. In chapter five, this approach will continue to formulate sustainability social assessment method for assessing social sustainability in architecture. The proposed SEAM will be adapted in analysing environmental sustainability dimensions in private houses in the UAE in chapter six, and in assessing environmental sustainability performance of certain chosen case studies in chapter eight.

Part Two

Formulation of Sustainability Assessment Method

Chapter 5

Formulation of Sustainability Social Assessment Method

Main Headings

- 5.1. A framework for understanding Social sustainability
- 5.2. Analysis of Social Assessment Methods
- 5.3. Formulation of SSAM

Chapter Five: Formulation of Sustainability Social Assessment Method (SSAM)

Introduction

Since the Brundtland Report and the 1992 Rio Conference defined the social aspect as the third dimension of sustainability, along with the environmental and economic dimensions, interest in social compatibility and the assessment of social aspects has been rekindled. Developing sustainability social assessment method adequate to the Arab World is one aims of this research. This necessitates investigating social criteria of houses design that go along with the social values of Muslim societies. These issues are discussed in this chapter.

This chapter investigates the sustainability social assessment methods through examining existing social assessment methods and analysing the main indicators of these methods to create a basis for the formulation a Sustainability Social Assessment Method (SSAM). The proposed SSAM will be used to assess social sustainability performance of certain chosen case studies (traditional and contemporary houses) in the UAE that will be discussed in chapters seven and eight. Moreover, analysing social sustainability dimensions in domestic buildings (traditional and contemporary houses) in the UAE, in chapter six, is going to be according to the proposed SSAM criteria.

5.1. A Framework for Understanding Social Sustainability

Sustainability assessment focuses on the probability of continuation of activities without negatively affecting the environmental, social or economic systems (Boyle www.icser.auckland.ac.nz/graduate/BoyleSA.doc- Last accessed 20-07-2005). The integration of the social dimension into the processes of decision making, planning and problem solving, requires an innovative and interdisciplinary approach.

An understanding of social issues is imperative for effective planning and policy development. Furthermore, integrating human needs in planning, along with environmental and economic considerations, is fundamental to foster sustainable development. In particular, social sustainability, or well-being, of communities is integral to any assessment of sustainability since it reflects and affects environmental and economic sustainability (www.regional.org.au/au/countrytowns/strategies/pepperdine.htm - Last accessed 19-07-2006).

Indicators of sustainability have largely been developed by consultancy firms to serve large companies by helping them to arrive at indicator systems for their tripartite corporate reporting. Social sustainability is far more difficult to quantify than economic growth or environmental impact. Further, all-purpose indicators of social sustainability are too general to be useful, and specific indicators need to be developed for particular companies, meaning that their usefulness to academic discourse in particular contexts of social sustainability is questionable (McKenzie, 2004, P.7).

5.1.1. The Need for Sustainability Social Assessment Method

Since the notion of sustainability embraces environmental, economic and social issues and the complex interdependence between these dimensions, a broad approach needs to be adopted at the planning and management level to shed light on this multi-dimensional picture. However, a systematic approach for considering the social dimensions of sustainability is not well developed locally or internationally (www.regional.org.au/au/countrytowns/strategies/pepperdine.htm- Last accessed 14-07-2006). Some of the most important aspects of social impacts involve not the physical relocation of human populations, but the meanings, perceptions, or social significance of these changes (The Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment, 1994).

There is a dearth of available literature on ways in which social sustainability may be implemented, and *the precise causal relationships between its various aspects*. The focus is on defining and measuring social sustainability in part, because it is a relatively new field, and researchers are naturally keen to know precisely what it is that they are discussing (Polése & Stren, 1999, P.3).

An assessment of social aspects – however it is carried out – and the inclusion of this dimension in every decision making process is necessary, because decisions concerning external environmental effects always have external social consequences. There are already tried, tested and approved methods and instruments for evaluating the environmental and economic dimensions of activities, projects, developments, products and organisations in terms of their sustainability. However, such methods and instruments are conspicuously lacking when it comes to the social dimension (Carabias-Hütter & Winistörfer, 2003, P.2).

Assessing social criteria of buildings is a vital process of evaluating sustainability potentiality in architecture. Furthermore, developing sustainability social assessment method is essential to be modified according to each society conditions and cultural values.

5.2. Analysis of Sustainability Social Assessment Methods (SSAM)

In order to pursue social sustainability, it must first be defined as distinct from environmental or economic sustainability, in order for it to develop its own models of best practice. Once this process of definition has been completed, parameters can be established to measure the effect of equitable social policies and institutions on environmental outcomes. This will result in a truly interdisciplinary model of sustainability. Many current discussions of social sustainability are structured around a definition of the condition, a measurement framework and/or a series of case studies (McKenzie, 2004, P.10).

The basic issue that must be considered when assessing an activity for sustainability is if the activity can be continued or sustained indefinitely, without damage to the fundamental global system of the environment and human social condition (Boyle www.icser.auckland.ac.nz/graduate/BoyleSA.doc- Last accessed 20-07-2005).

Social sustainability is a positive condition marked by a strong sense of social cohesion, and equity of access to key services (including health, education, transport, housing and recreation). The definition already contains within some of the indicators by which it could be measured. This can create a sense of indeterminacy in precisely what is being measured. Stephen McKenzie (2004, PP.12, 13) identifies several principles and features, as indicators of social sustainability and steps towards their establishment and implementation are aspects of the process:

- **Equity**: the community provides equitable opportunities and outcomes for all its members including equity of access to key services (including health, education, transport, housing and recreation). This principle includes equity between generations, meaning that future generations will not be disadvantaged by the activities of the current generation
- **Diversity**: the community promotes and encourages diversity where a system of cultural relations in which the positive aspects of disparate cultures are valued and protected and in which cultural integration is supported and promoted when it is desired by individuals and groups.
- **Quality of life**: the community ensures that basic needs are met and fosters a good quality of life for all members at the individual, group and community level.
- **Democracy and governance** where the widespread political participation of citizens not only in electoral procedures but also in other areas of political activity, particularly at a local level

- **Future awareness** for transmitting awareness of social sustainability from one generation to the next where a sense of community responsibility for maintaining that system of transmission is required
- **Interconnectedness** within community to collectively identify its strengths and needs and identify mechanisms for a community to fulfil these own needs where possible through community action

The Community Sustainability Assessment (CSA) that was developed by Global Ecovillage Network to assess sustainability dimensions identifies social sustainability in specific aspects: openness, communication, networking outreach & services, diversity & tolerance; education, health care, sustainable economics and healthy local economy (www.ecovillage.org - Last accessed 21-05-2007).

A systematic approach to the consideration of social issues in planning is vital to both inform the social context for decision-making and provide feedback on policy outcomes. Stakeholder input is necessary to gain insight into the needs and concerns held for the relevant social system. It can assist in decision-making by ensuring the inclusion of locally significant issues (www.regional.org.au/au/countrytowns/strategies/pepperdine.htm - Last accessed 30-07-2006).

Despite its inclusion in the triple bottom line, the role played by the social is rarely equal to the economic and environmental concerns. The Global Reporting Initiative (GRI, established in 1997) has reported "…*in contrast to GRI environmental indicators … reporting on social performance occurs infrequently and inconsistently across organizations*" (Global Reporting, 2000, P. 33.)

The same tendency is also described in a recent major study by the Western Australian Council of Social Services (WACOSS), which noted that "*while there has been considerable work done on the environmental and economic aspects, the social has tended to fall off the sustainability agenda*" (Leanne & Gauntlet, 2002, P.4).

5.2.1. Social Assessment Methods

An understanding of social issues is imperative for effective planning and policy development. Furthermore, integrating human needs in planning, along with environmental and economic considerations, is fundamental to foster sustainable development. In particular, social sustainability, or well-being, of communities is integral to any assessment of sustainability since it reflects, and influences upon environmental and economic sustainability (Pepperdine www.regional.org.au/au/countrytowns/strategies/pepperdine.htm - Last accessed 30-07-2006).

5.2.1.1. Objectives for Choosing Social Assessment Methods

Three possible methods or systems were investigated and analyzed in the formatting of the research EAM. These assessment systems are:

- Social Impact Assessment (SIA)
- Social Compatibility Analysis (SCA)
- Beneficiary Assessment (BA)

Choosing these methods was based on:

- Simplicity and practicality
- The ability to offer comparisons and benchmarking
- The organisational context within which the method operates

5.2.1.2. Assessment Methods Rating System

Areas to be investigated in Sustainability Social Assessment vary according to the assessment method and the purpose of the assessment. Guidelines and Principles for Social Impact Assessment (The Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment, 1998) identified some of these areas. Taylor (1990) and the US Forest Service manual and handbook use the four major categories of population change, life style, attitudes, beliefs and values, and social organization. Brudge (1994) uses the five categories of population impacts, community and institutional arrangements, conflicts between local residents and newcomers, individual family level impacts and community infrastructure needs. Branch (1984) uses four categories of social impact assessment variables in the social organization model: direct project inputs, community resources, community social organization; and indicators of individual community well-being.

As suggested by Boyle (www.icser.auckland.ac.nz/graduate/BoyleSA.doc- Last accessed 20-07-2005), the major issues that need to be considered are derived from Agenda 21 and include:

- Poverty
- Civil unrest
- Consumption patterns
- Demographic dynamics
- Human health conditions
- Human settlement development
- Incorporation of environment and development in decision-making

However, assigning values for sustainability (especially social and economic aspects) cannot be a hard science. One reason for this is that the social and economic value of development to a region is very much dependant on the starting position and local priorities. The values given are for a 'typical' case but as no case is ever 'typical', the scores can be altered and weighted differently by the user to reflect local circumstances.

Since social issues cannot be measured qualitatively, social assessment methods rating systems are mostly weighed according to the relevance of the assessed factor is to the assessment criteria. This research is going to suggest a rating system for the proposed SSAM according to the social values priorities in the Arab World. At this point, three social assessment methods will be discussed, assessment areas will be analysed, and rating systems will be illustrated. Through discussion, the research will develop a SSAM appropriate to be used to assess sustainability potentiality in traditional and contemporary houses in the UAE.

5.2.2. Social Impact Assessment (SIA)

Social Impact Assessment is a method for assessing or estimating, in advance, consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society. The term also includes cultural impacts involving changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves and their society (The Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment, 1994).

SIA identified the basic social dimensions that can be measured which reflect fundamental and important characteristics of a community. Studied over time, these characteristics give us insight as to how social structure will be altered when change occurs (www.socialimpactassessment.net - Last accessed 22-07-2005).

Social Impact Assessment (SIA) and community involvement processes have the potential to facilitate a proactive strategy towards mining and the social environment. Fundamentally, both the SIA and the community involvement process can be regarded as providing direction in the identification and prediction of the likely impacts stemming from project development (www.srk.co.uk/pages.asp?pagename=socialimp – Last accessed 22-07-2006). The purpose of an SIA is to provide decision-makers and managers with a competent assessment of the social consequences of proposed actions.

SIA is done as part of the planning process and therefore alerts the planner and the project proponent (through the social assessor) to the likelihood of social impacts. Like a biological, physical, or economic impact—social impacts have to be pointed out and measured in order to be understood and communicated to the impacted population and decision-makers. Social impact assessment provides a realistic appraisal of possible social ramifications and suggestions for project alternatives and possible mitigation measures (www.socialimpactassessment.net/ - Last accessed 22-07-2005)

Effective SIA and community involvement requires recognition and understanding of the relationships of people's perceptions, their realities and the structures within which they exist. Key principles that are adhered to through the design and effective implementation of the SIA and community involvement process include:

- Recognition of social differentiation
- Respect for the diversity of different values and interests of the parties involved
- Integration of indigenous and scientific or professional knowledge
- Recognition that community involvement is linked to broader social power relations and dynamics
- Inclusivity, transparency and accountability
- Capacity building
- Active engagement

To predict what the probable impact of development will be, assessors seek to understand the past behaviour of individuals and communities affected by agency actions, development, or policy changes. a comparative SIA method is used to study the course of events in a community where an environmental change has occurred, and extrapolate from that analysis what is likely to happen in another community where a similar development or policy change is planned (www.socialimpactassessment.net - Last accessed 22-07-2005). For SIA, it is required to identify probable undesirable social effects of development before they occur in order to make recommendations for mitigation. Because social impacts can be measured and understood, recommendations for mitigating actions on the part of the agencies can be made.

5.2.1.1. Social Impact Assessment Rating System

Social impact assessment variables point to measurable change in human population, communities, and social relationships resulting from a development project or policy change. After research on local community change, rural industrialization, reservoir and highway development, natural resource development, and social change in general, The Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment (1994) suggest a list of social variables under the general headings that can be listed as follows:

Population Characteristics: mean present population and expected change, ethnic and racial diversity, and influxes and outflows of temporary residents as well as the arrival of seasonal or leisure residents.

Community and Institutional Structures: mean the size, structure, and level of organization of local government including linkages to the larger political systems. They also include historical and present patterns of employment and industrial diversification, the size and level of activity of voluntary associations and interests groups, and how these institutions relate to each other.

Political and Social Resources: refer to the distribution of power authority, the interested and affected publics, and the leadership capability and capacity within the community or region.

Individual and Family Changes: refer to factors that influence the daily life of the individuals and families, including attitudes, perceptions, family characteristics and friendship networks. These changes range from attitudes toward the policy to an alteration in family and friendship networks to perceptions of risk, health, and safety.

Community Resources: Resources include patterns of natural resource and land use; the availability of housing and community services to include health, police and fire protection and sanitation facilities. A key to the continuity and survival of human communities are their historical and cultural resources. Under this collection of variables, possible changes for indigenous people and religious sub-cultures are considered.

Assessments obtained via using SIA are utilized to identify and quantify significant impacts, thereby providing decision makers and the affected publics with information that is both as complete and as accurate as possible. In cases where the desirable goal cannot be met, it is better to be roughly correct on important issues than to be precisely correct on unimportant issues. Within the context of the social impact statement, there are two important differences between impact identification (what are the general categories or types of impacts that are likely to occur and SIA evaluation (precisely how significant and those impacts likely to be).
Table 5.1 shows areas and sub-areas of assessment used to assess social aspects with SIA method.

SIA can identify plausible and potentially significant impacts relatively quickly and efficiently. On the other hand, an accurate evaluation is a resource-intensive process and deals with the question of significance. The use of qualitative and quantitative measures of social impact assessment variables is essential; nevertheless, the evaluation of significance has an important judgment component.

Table 5.1 – Social Impact Assessment areas of assessment criteria

(Source: the author based on The Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment, 1998)

Social Impact Assessment	
Areas of Assessment	**Sub-Areas of Assessment**
Population Characteristics	Population Change
	Ethnic and racial distribution
	Relocated populations
	Influx or outflows of temporary workers
	Seasonal residents
Community and Institutional Structures	Voluntary associations
	Interest group activity
	Size and structure of local government
	Historical experience with change
	Employment/income characteristics
	Employment equity of minority groups
	Local/regional/national linkages
	Industrial/commercial diversity
	Presence of planning and zoning activity
Political and Social Resources	Distribution of power and authority
	Identifications of stakeholders
	Interested and affected publics
	Leadership capability and characteristics
Individual and Family Changes	Perceptions of risk, health, and safety
	Displacement/relocation concerns
	Trust in political and social institutions
	Residential stability
	Density of acquaintanceship
	Attitudes toward policy/project
	Family and friendship networks
	Concerns about social well-being
Community Resources	Change in community infrastructure
	Native American tribes
	Land use patterns
	Effects on cultural, historical, and archaeological resources

Social impact assessment is predicted on the notion that decision-makers should understand the consequences of their decisions before they act, and that the people affected will not only be apprised of the effects, but have the opportunity to participate in designing their future. The social environment is different from the natural environment because it reacts in anticipation of change, but can adapt in reasoned ways to changing circumstance in part of the planning process. In addition, persons in different social settings interpret change in different ways, and react in different ways.

5.2.3. Social Compatibility Analysis (SCA)

The Social Compatibility Analysis (SCA) is a social assessment method. It looks for including social compatibility in planning processes as a tool similar to that of the environmental impact assessment. This method is used to record and evaluate the social aspects with respect to any given project, in as much as this approach would best serve the public interest. SCA may be considered as a tool to facilitate the consideration of social aspects within different projects by producing comparable outputs depending on the users' assessments. This method is more related to assess social dimensions of a project by users' or people response to that projects and how it may affect their way of living.

SCA is a particularly valuable method when the social dimension of a project is concerned, when the clarification of differing stakeholder opinions is needed or when sets of solutions are to be negotiated (Ludwig, 2003).

In contrast to the subjective evaluation method with which the acceptance of those directly affected is estimated, this proposed method defines objective criteria according to which social compatibility is evaluated. Therefore, objects under assessment are the intended as well as the unintended, the positive as well as the negative impacts on the fulfilment of human needs and the cohabitation of human beings, with particular attention given to psychological, social and cultural needs.

The SCA method is applicable in the analysis or assessment of many systems, such as projects, processes, products, organisations. The user of the SCA method divides the system into a number of subsystems. The results achieved through this method reflect the semi-quantitative assessment of the user. If more than one stakeholder is involved, the result of the evaluation may represent the consensus of a user group (Carabias-Hütter & Winistörfer, 2003). Table 5.2 illustrates general criteria for social compatibility analysis.

Table 5.2 - Social Compatibility Analysis areas of assessment criteria

(Source: the author based on Carabias-Hütter, Winistörfer, & Joos, 2003)

Social Compatibility Analysis	
Criteria	**Explanation & examples**
Participation	Participation opportunities for affected parties
Information & Communication	Understanding the decision-making process; transparent information policy
Compliance with social laws	Adherence to constitutional rights and principles; adherence to social rights
Occupation	Quantity (Employment level in Industry and Business; I&B); Quality (Required educational standard in I&B); etc.
Education & Training	Availability, accessibility and quality of educational facilities and information channels (nursery, elementary, public, private, and other educational institutions)
Material well-being	Level of income; distribution of wealth; social security (senior citizen provision, medical provision, unemployment benefits, etc.); cost of living; etc.
Working conditions	Exploitative work practices, such as child and forced labour; working with dangerous substances
Protection against discrimination	Gender; racial; religious; disability; lifestyle; etc.
Protection of minorities	Minorities in democratic decision-making processes
Public security	Presence of law & order representatives; surveillance and lighting of public utilities; guaranteed safe disposal; etc.
Protection against health hazards	Evaluation of toxicology; evaluation of radiation; damage duration; etc.
Protection against nuisance	Noise; odour; vibration; landscape; etc.
Living space	Quantity (encroachment or destruction of living space); quality (proportion of green/recreational areas, view, sunlight, social infrastructure, rent regulations, opportunities for development, etc.)
Handling of risks for the population	Prevention; damage limitations; liability/insurance; communication; etc.

5.2.3.1. Social Compatibility Analysis Rating System

The Social Compatibility Analysis is based on the ABC method embodied in business administration and already applied in the assessment of environmental impacts. The central concept of the Social Compatibility Analysis is based on a general set of objective criteria for social compatibility, which, in respect to specific assessment problems, can be adapted (Carabias-Hütter, Winistörfer, & Joos, 2003, P.2).

The SCA is applicable in the analysis or assessment of many systems, such as planning, projects, processes, products, organisations. The user of the SCA divides the system into a number of subsystems. A product, for example, could be divided into subsystems by choosing the life cycle phases preproduction, production, use and disposal. The user then chooses several of the above mentioned evaluation criteria and assigns all subsystems to classes A (highly relevant social problems), B (of medium relevance) or C (of low relevance) for all the chosen criteria.

As mentioned, the SCA is a derivative of the ABC Analysis, which is based on the premise that a small number of (A) components contributes in only a minor way. All those components of medium relevance are assigned to class (B). Since (A) components are highly relevant to a problem, they are the focus for improvement. Since (B) is limited, there is a need for further measures, (C) is evident, which means further action is not required (Carabias-Hütter & Winistörfer, 2003). The results achieved through this method reflect the semi-quantitative assessment of the user. If more than one stakeholder is involved, the result of the evaluation may represent the consensus of a user group (Carabias-Hütter, Winistörfer, & Joos, 2003, P.4).

The various subjective assessments of different stakeholder groups concerning the social consequences of a problem can be compared and clearly documented. The result is subjective in that the evaluation criteria and the categorisation into A, B or C are dependent upon the user. On this basis, comparisons between different problem areas are not possible. However, comparisons with assessment periods within a problem/project completed earlier are possible if the individual classifications were clearly defined and substantiated from the very beginning. Similar to an environmental life cycle assessment (LCA), the SCA is not only suitable for comparing several variants, but also for performing an in depth analyses of one particular aspect under evaluation, with the aim of identifying specific areas for potential improvement (Carabias-Hütter, Winistörfer, & Joos, 2003, P.5).

5.2.4. Beneficiary Assessment (BA)

Beneficiary Assessment (BA) is a tool for managers who wish to improve the quality of development operations. This is an approach to information gathering that assess the value of an activity, as its principal users perceive it. The approach is qualitative in that it attempts to derive understanding from shared experience as well as observation, and gives primacy to the centrality of the other person's point of view (Salmen, 1995, P.1). Beneficiary assessment is a systematic inquiry into people's values and behaviour in relation to a planned or ongoing intervention for social and economic change.

The ultimate goal of beneficiary assessment is to reveal the meaning people give to particular aspects of their lives so that development activities may better enhance people's ability to improve their own living conditions, as they see fit. It provides reliable qualitative, in-depth information on the socio-cultural conditions of a beneficiary population that is intended to be of immediate use to policymakers responsible for improving people's lives (Salmen, 1995, P.2).

5.2.4.1. Beneficiary Assessment Rating System

Beneficiary assessment plays an important role in Social Action Programs (SAP) and other projects after the project selection phase. It enables the implementing agency to monitor and address any change in beneficiaries' attitudes or unanticipated adjustment that may be necessary to complete the project effectively. Regarding evaluation, the qualitative techniques used in this approach can be used to measure the success of the project in responding to the communities' needs and in gauging their level of satisfaction with the project (Salmen, 1995, P.2).

5.3. Formulation of Sustainability Social Assessment Method

In an attempt to provide information of the social sustainability at the community level, a system to represent local issues, which are locally relevant while also broadly applicable, is required. Hence, a system of subjective social indicators is necessary; this can be used in conjunction with objective measures to provide a broader picture (Pepperdine, www.regional.org.au/au/countrytowns/strategies/pepperdine.htm - Last accessed 30-07-2006)

The first stage of the development process for the SSAM is to develop the core module that covers the range of areas and issues needed. It is of the utmost importance, in developing SSAM for a region, as the Arab World in this research, to take into consideration the specific situation of the region, and cultural values of the society. The analysis of the chosen social assessment methods is essential for developing the SSAM. However, none of these methods can be used in the Arab World in their existing form. Accordingly, developing SSAM for assessing social sustainability of traditional and contemporary houses in the UAE that can be adequate in the Arab World requires analysis of the chosen SSAM, customisation of rating system then formulation of a proposed SSAM.

5.3.1. Analysis of the chosen Social Assessment Methods

According to the discussed issues and social assessment methods analysis, the researcher concluded that none of these social assessment methods is appropriate to be adapted as the SSAM for this research for the reasons listed below:

- Areas of assessment are mostly concerned about social concerns related to the community as a whole such as employment, safety, equity, democracy, public security, and people's opinion about the quality of development operation. Most of these concerns are not related to the discussed issues and beyond the limits of this research.
- All the discussed social assessment methods are developed in regions different from the Arab World where the assessment areas priorities are not appropriate to the Arab and Muslim societies.
- The discussed social assessment methods are not developed for housing that is the main area of this research.
- Social sustainability dimensions of this research are concerned with social values related to housing sector. These issues are not implemented in the discussed social assessment methods. Issues related to the case study region ((UAE) and nature of the society (Muslim society) are of special concerns of society beliefs and social values. Issues such as privacy, segregation between genders, family and social relations, and neighbours' rights are of unique characteristics adhered to the way houses are designed in the Arab World. These issues are needed to be taken in account for any sustainability social assessment method for houses in the UAE and the Arab World, which is one of this research aims.

Table 5.3 shows assessment criteria and rating systems for the chosen social assessment methods.

Table 5.3 - Overview of the chosen social assessment methods criteria and rating system
(Source: the author)

Social Assessment Methods	**Criteria**	**Rating system**
Social Impact Assessment (SIA)	Population Characteristics	Qualitative and quantitative measures of social impact assessment
	Community and Institutional Structures	Judgment based on evaluation of significance
	Political and Social Resources	
	Individual and Family Changes	
	Community Resources)	
Social Compatibility Analysis (SCA)	Participation	Based on the ABC method
	Information & Communication	A (highly relevant social problems)
	Compliance with social laws	B (of medium relevance)
	Occupation	C (of low relevance) for all the chosen criteria
	Education & Training	
	Material well-being	
	Working conditions	
	Protection against discrimination	
	Protection of minorities	
	Public security	
	Protection against health hazards	
	Protection against nuisance	
	Living space	
Beneficiary Assessment (BA)	Improving the quality of development operation	Qualitative techniques to measure the success of the project
	People's values and behaviour in relation to development	Qualitative techniques to gauge communities' level of satisfaction with the project
	Enhancing people's ability to improve their own living conditions	

According to the conducted analysis, the researcher concluded that the investigated sustainability social assessment methods are not appropriate to be adapted in this research because of nature of the aims and objectives of this research, area of study, and the type of society the research is devoted. As a result, this research is going to develop a SSAM based on Islam main source of legislation, *Shari'a* that depends on Quran and the Prophet *Sunnah*. Areas of assessment and rating systems are chosen according to priorities of Islamic legislations.

Social values in Muslim societies have been discussed in several studies from different standpoints. A previous study carried out by the author (Al-Zubaidi, 2004) asserts that social issues in traditional architecture are derived from Islamic Shari'a and materialized in house design that reflected the social values. Although there are differences in cultural and social interpretations of religious norms in Islamic societies all over the world, nevertheless there exist great similarities in the social aspects and spatial organization of the dwellings due to a common faith.

Hisham Mortada (2003, P.17) asserts the role of Islam in forming social principles in Muslim societies. In this aspect, he indicates:

> "*In every society, there is a set of ethics and morals which is clearly expressed in the daily practice of life. Islam is no exception as it includes a social framework with a complete set of principles. It combines religious, political, social, legal, and economic aspirations in a unity which illustrates order for all aspects of Muslim life*".

Mortada (2003) identifies several principles of the Islamic social framework that are commitments and responsibilities, which Muslims should practice in their lives. These principles, with reference to house design, can be identified as follows: privacy, strong social interaction, neighbourhood, family, humility, and avoidance of self-advocating and wealth wasting.

Yasser Mahgoub (1997), through discussing psychological, social and cultural sustainability, recognizes several principles as dimensions of social sustainability in traditional architecture. These principles are privacy, individuals and society desires, identity, religion, family, and community lifestyle.

Based on the previous discussion, this research proposes a SSAM appropriate for assessing social sustainability for houses in the Arab World. A suite of social indicators were constructed, and subsequently validated, to reflect the key factors identified. This provides a comprehensive tool which can not only offer a framework to integrate social values to monitor trends in the social dimensions of sustainability more broadly, but also can be used as a locally meaningful guide to assist community planning. The proposed SSAM will be used to assess social sustainability potential for chosen case studies that will be discussed in chapters seven and eight. The proposed SSAM criteria are derived from Islamic principles and social values priorities; they can be listed as follows:

- **Privacy:** Islam recognises the right of each person to enjoy his privacy within the society and inside his house. Thus, privacy is considered the most important social value in Muslims' lifestyle and it should be well-reserved in house design. It includes social privacy, visual privacy, and acoustical privacy.

- **Social relationships:** Islam sets rules for social relations within Muslim community that keeps their strength and coherency. For houses design, hospitality and guest honouring are of great importance as part of society unity and cooperation.
- **Neighbourhood**: Islam considers neighbourliness as the backbone of the Muslim society and sets ethical rules to control relations between neighbours. These rules are evident in strong neighbourhood relationships and preservation of neighbours' rights.
- **Family:** Islam considers family as the basic unit of building a healthy society. It devotes much attention to the issues related to the relationships between the family members (Mortada, 2003, P.32). Thus, family relations are well considered in Muslim society; this includes strong family ties and appreciation of extended family that keep strong and kindly relation with others.
- **Identity & Social status:** Islam requires the Muslim to be humble in all aspects of his life (Mortada, 2003, P.41). It also encourages equity, social justice, and balanced wealth consumption between people; thus, Islam calls for avoiding self-avoidance and wealth wasting.

5.3.2. Customisation of Rating System

Taken literally, evaluation means determining a value or establishing what something is worth. In the world of architecture, evaluation is mainly concerned with establishing the value of all or part of the built environment (*product evaluation*) or the process of construction and management (*process evaluation*) (Voordt & Wegen, 2005, P.141).

All assessment systems use some form of weighting, even if it is 'no weighting'. A system that asserts that it does not weight criteria actually assigns all criteria equal weight or assigns implicit weights by the number of points possible. Weighting is fraught with difficulty since it cannot be accomplished with complete, or in some cases, any, scientific objectivity (Todd; Crawley; Geissler; & Lindsey, 2001, P. 331).

In the absence of scientifically based weights, some organizations use 'consensus-based' weighting. In this approach, groups of experts or users rank various elements in terms of their relative importance or assign points to these elements. This ranking or scoring is then used to establish weights (Dickie and Howard, 2000). As noted previously, all assessment systems incorporate weighting, even if it is implicit and equal among criteria. Those that do not provide explicit differential weightings among criteria or categories of criteria generally base the rationale for their 'un-weighted' approach on the lack of a consensus based scientific method for deriving the weights (Todd; Crawley; Geissler; & Lindsey, 2001, P. 333).

Weighting is a subjective issue and has been considered because no scientific method exists to rate the relative importance of different environmental impacts (www.bre.co.uk/greenguide - Last accessed 20-07-2005). Social aspects relate to issues such as working conditions, social security, political oppressions, and job creation. The problem of assessing social issues is that the issues at stake are wide-ranging and often difficult to quantify in a meaningful way (SimPro, 2004, P.17).

5.3.3. The Proposed SSAM Rating System

In evaluation process, not all factors are perceived as equally important; some factors weigh more heavily than others do. It can therefore be useful to assign weights to different factors, making it possible to reach a weighed conclusion based on a number of qualities each of which is given the importance it deserves (Voordt & Wegan, 2005, P.160). Weightings can be based on several criteria:

- Relative weightings of criteria can be based on sound scientific evidence as to their equivalent impacts or consequences. Since this is often not possible, weightings are typically based on expert judgement.
- Implicit in all assessment methods are the social values of the society or groups that have produced them. These can be established by soliciting input on priorities by knowledgeable representatives from a broad range of sectors.

Although not always intended, allocating a different number of maximum assessment points available to different criteria (without separating performance from priority with explicit weightings) implies an expression of significance or weighting.

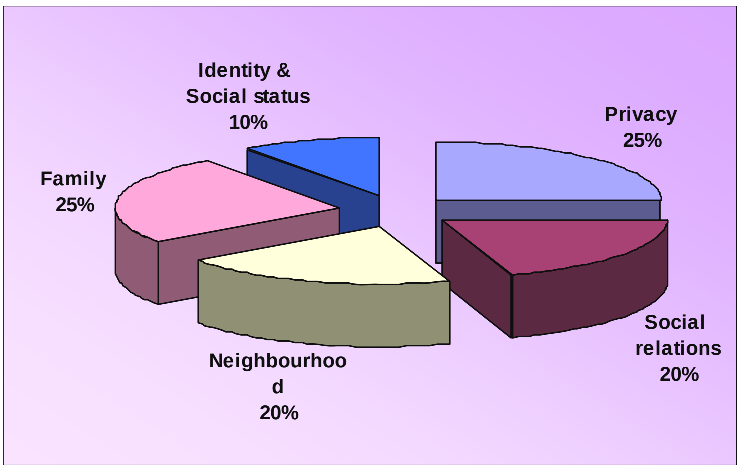


Chart 5.1 –SSAM area of assessment rating system

(Source: the author)

Based on the previous discussion, a rating system is formulated according to the importance of each criteria and its priority within social values – Chart 5.1. Table 5.4 illustrates the proposed SSAM area of assessment criteria, sub-area of assessment and the assessed architectural features for each criterion, and each criterion rating system.

Table 5.4- The proposed social assessment method criteria and rating system

(Source: the author)

Areas of Assessment	Credits (100)	%	Sub-area of Assessment	Credits	%	Architectural Criteria
Privacy	25	25%	Urban planning and design concept	13	52%	Site organization Design philosophy Building form Outside-inside relation Spaces organization
			External facades	7	28%	Elevation treatment House entrance Openings
			Acoustical privacy	5	20%	Building envelope Spatial zones
Social relations	20	20%	Hospitality	10	50%	Spatial organization Guest room (Majlis) Entry levels
			Guest honouring	10	50%	Guest room (Majlis) size Interior design
Neighbourhood	20	20%	Strong neighbourhood relationships	8	40%	Organic compact planning Attached dwellings Public spaces within neighbourhood
			Preservation of neighbours' rights	12	60%	Main entrance Roof parapet Walls height
Family	25	25%	Strong family ties	15	60%	Spatial organization Flexibility in space use
			Extended family	10	40%	House area No. and size of rooms Interior spaces design
Identity & Social Status	10	10%	Humility & self-advocacy	5	50%	House size Elevation treatments
			Revealing social status	5	50%	Building materials Architectural details

As most of the social values are of the same importance, credits were set almost equally with an additional weighting for “Privacy” and “Family” (each got 25%) then “Social relations” and “Neighbourhood” (each 20%), while “Identity and Social status” got 10% because of its relevant importance compared to social and family issues. Table 5.3 illustrates the proposed SSAM area of assessment criteria, sub-area of assessment and the assessed architectural features for each criterion, and each criterion rating system.

As discussed in chapter four, the proposed rating system will consist of 100 credits divided according to each criteria priority. Each assessed criteria is divided into several sub-areas of assessment that has its own credits according to its relevance and effect on the main criteria performance. Each sub-area of assessment will be assessed according to certain architectural features that are affectively relevant to the assessed criteria. Each sub-area of assessment will be evaluated and given a score ranging 1-10 depending on degree of relevance the assessed criterion to the community social values. This score will be multiplied by the sub-area of assessment credit to obtain the final credit of this part. Then all sub-area of assessment credits will be summed to get the total credits of the assessed criteria.

Sub-area of assessment credit = *Score (range 1-10) X criteria credit / 10*

Total area of assessment credit = *Sub-area$_1$ credit+ Sub-area$_2$ credit+…+ Sub-area$_n$ credit*

Table 5.5 shows a typical form for assessing social sustainability criteria for traditional and contemporary houses. This form is going to be used for testing appropriateness of the proposed SSAM in assessing the social sustainability performance for traditional and contemporary case study houses in chapter eight.

Table 5.5- Typical form for assessing social sustainability criteria for the chosen case studies houses (Source: the author)

<table>
<tr><th>Area of Assessment</th><th colspan="15">Sub-areas of Assessment</th><th>Total Credits</th></tr>
<tr><td></td><td>Crds.</td><td colspan="4">Sub-area of Assessment</td><td>Crds.</td><td colspan="4">Sub-area of Assessment</td><td>Crds.</td><td colspan="4">Sub-area of Assessment</td><td></td></tr>
<tr><td rowspan="3">Traditional House</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td rowspan="3"></td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Credit=score X credit/10</td><td colspan="5">Credit=score X credit/10</td><td colspan="5">Credit=score X credit/10</td></tr>
<tr><td rowspan="3">Contemporary House</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td rowspan="3"></td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Credit=score X credit/10</td><td colspan="5">Credit=score X credit/10</td><td colspan="5">Credit=score X credit/10</td></tr>
</table>

Conclusions

This chapter has investigated and analyzed the some of the existing social sustainability assessment methods and formulated SSAM that will be used for assessing social sustainability performance for chosen traditional and contemporary houses that will be the empirical study of this research. The main conclusions of this part can be summarized as follows:

- Social sustainability assessment is systematic approach to the consideration of social issues in planning is vital to both inform the social context for decision-making and provide feedback on policy outcomes
- Analysing existing social assessment methods provides an objective base to develop a set of assessment method appropriate to the UAE and the Arab World.
- The investigated social assessment methods included several criteria; most of them are related to the community social concerns such as employment, safety, equity, democracy, public security, and the quality of development operation.
- The investigated sustainability social assessment methods are not appropriate to be adapted in this research because of nature of the aims and objectives of this research, area of study, and the type of society the research is devoted.
- Formulating SEAM appropriate to the Arab world necessitates investigating social criteria of houses design that go along with the social values of Muslim societies.
- The proposed SSAM criteria are derived from Islamic principles and social values priorities; they include privacy, neighbourhood, social relations, family, and identity and social status
- The SSAM proposed rating system consists of 100 credits divided according to each criteria priority. Each assessed criteria is divided into several sub-areas of assessment that has its own credits according to its relevance and effect on the main criteria performance.

The proposed SSAM will be adapted to assess social sustainability potential in certain chosen case studies in chapter eight. Domestic buildings in the UAE, which is the area of study of this research, will be investigated in chapter six. Discussing and analyzing social sustainability dimensions in private houses in the UAE will depend on the SSAM criteria proposed in this chapter.

Part Two

Formulation of Sustainability Assessment Method

Chapter 6

Domestic Architecture in the UAE

Main Headings

Chapter Six: Domestic Architecture in the UAE

Introduction:

Domestic architecture in the UAE is representative of society norms with all its social values, doctrines and traditions. Traditional houses in the UAE contained many values of how people lived in that area and fulfil their physical and social requirements in a unique character within the available resources in their environment.

Since the declaration of federation in 1971, the housing sector in the UAE was exposed to rapid revolution in design and building techniques along with economical and social development the country witnessed. This led to adapt new planning policies and design methods different from the traditional ones. This new trend neglected the ambient environment and many of the social values for the sake of modernity and rapid growth.

This chapter Investigates the domestic architecture in the UAE: traditional and contemporary and how the house design responded to environmental conditions and social values. Houses analysis will be according to environmental and social sustainability criteria that was developed in chapters four and five and will be used in the testing sustainability assessment methods in the third part of this research.

6.1. Types of Domestic Buildings in the UAE

Domestic buildings in the UAE, especially traditional houses, varied to accord to different climatic and geographical regions. Types of houses, design concept, building materials, and construction system were distinguished for each region. This is due to the response to environmental factors, yet each type fulfilled social needs and society values and traditions.
This research aims to study sustainability potential in traditional architecture compared to the contemporary; it will illustrate types of traditional and contemporary domestic buildings in the UAE with special reference to traditional courtyard houses and contemporary private houses (villas).

6.1.1. Traditional Houses

The UAE enjoys a rich architectural heritage. The traditional architecture, especially houses, evolved from the need to make life secure and tolerable in a region with a harsh climate and scarcity of resources. In discussing the factors affecting traditional houses design in the UAE, Ahmed Al-Rostomani (Al-Rostomani, 1991, P.167) commences his discussion with few questions wondering about the reasons behind traditional houses success. He concludes that this architecture was fit to its environment and society:

> "*When one cast a look at the old houses one is amazed at the twisted entrance leading to the inner court and many questions arise in one's mind without answers perhaps. Upon entering the inner court which is surrounded by Verandas, one wonders why is the Majlis (Sitting Room) is placed exactly at the entrance, how the wind catching towers operate? Why is it that the Walls are beautifully decorated here on the interior left blank on the extensor . . . etc? Without doubt, these old houses were tailor-made to the needs of those people that lived in them, it suited their style of living, their environment and their cultural and spiritual aspects, and the result is a unique architecture, which is entirely theirs"*.

Traditional architecture in the UAE is a direct result of the impact of the mixture of nationalities of people with different cultural motivations. Therefore, the architectural character distinguishes by its simplicity, durability, and adaptability to cite elements from different cultures. Some elements that were added to the local concepts in order to define its style and character were developed to cope with the specific traditions and demands of the society under the umbrella of Islamic thoughts and philosophy (Bukhash, 2000, P.34).

Traditional houses varied according to environmental conditions, geographical sites with response to social values and doctrinal traditions. Consequently, we find winter houses were built near coastal areas, while summerhouses were mainly around palm tree farms. Some settlers built their summerhouses over their winter houses with special openings to help natural ventilation. Generally, traditional houses, in the UAE, can be divided into these types:

6.1.1.1. The Tent

The tent was the traditional dwelling for nomads (Bedouin) in the Desert region. The Bedouin tent was the most famous kind of house that people used long ago. It was a useful and adaptable structure made of goat hair, sheep wool, or camels' hair made not by professional weavers but by the women of the family as required. Thus, the tent is called "*Bait al Sha'ar*" meaning "the House of hair". The tent is designed in a way that can fit both hot and cold weather.

Being a tensile structure, the typical tent uses very little wood for its supporting frame. The tent's frame is unstable without the stayed tensile cover. Its poles are mere compression members supporting the weight of the tent cover, and all tensile stresses and lateral wind forces are borne by the cover and its stays. Using very little wood for its structure, the tent was adaptable to regions where wood is a scarce commodity as UAE. For privacy, the tents long rope stays are only allowed to cross another tent's stays if their respective households are related in some way (Schoenauer, 2000, PP. 45, 46).

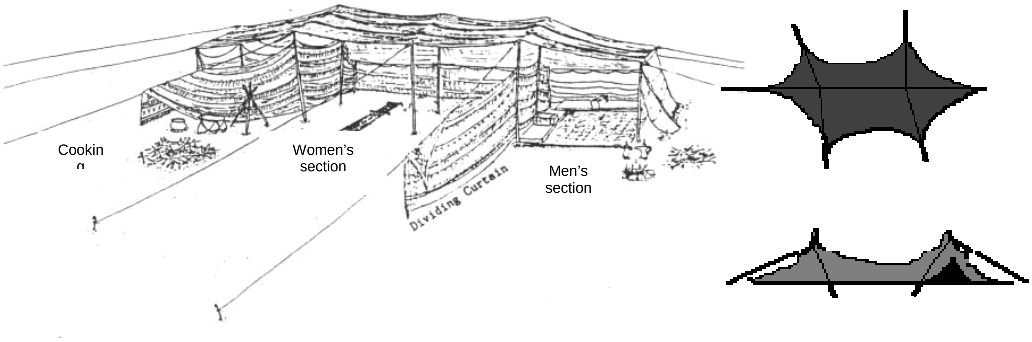


Figure 6.1 - Separate zones to provide privacy in a Bedouin tent
(Source: Schoenauer, 2000)

The tent was divided into two parts; one for men and one for women. Another tent was used for cooking and storage- Figure 6.1. The tents were arranged around the herding area or the oasis forming a circle or square with the *Sheikh'*s (the head of the tribe) tent in the middle so that guests could recognize it. During the winter season, the tribe spread over the area wherever food and water were available sometimes half an hour apart (Mahgoub, 1997, P.8).

6.1.1.2. The Palm-frond House (Arish, Barasti or Khaimah)

Arish, *Barasti* or *Khaimah* is a house, which was usually built in the desert regions with palm fronds that served people in a hot climate. *Barasti* houses could be occupied on a temporary basis for the date harvest, or the fishing season, and moved as required. In some instances, these cool houses were developed into more sophisticated establishments, taking on some of the features of permanent homes, such as wind towers made from wood and canvas. The Palm-frond house was well situated to climate, quick and cheap to erect then it could be moved easily– Figure 6.2. Yet it was extremely susceptible to fire and some districts were totally ruined by fire as the Bastakia district in Dubai in 1930s.

In the past and before oil wealth, palm-frond houses accounted for most of the houses in villages and were common in towns as Dubai, Sharjah, and Abu Dhabi. Palm-frond house consisted of two parts: the main area (usually 2m * 4m) used for sitting and sleeping, and a small area (usually 2m * 2m) used for cooking, storage and raising animals. Sometimes the Arish is surrounded by small open space or yard that forms an all-purpose buffer zone in front of the house, but is not enclosed by dwelling units. This type found in rural areas with little pressure on building space (Ragette, 2003, P.49).

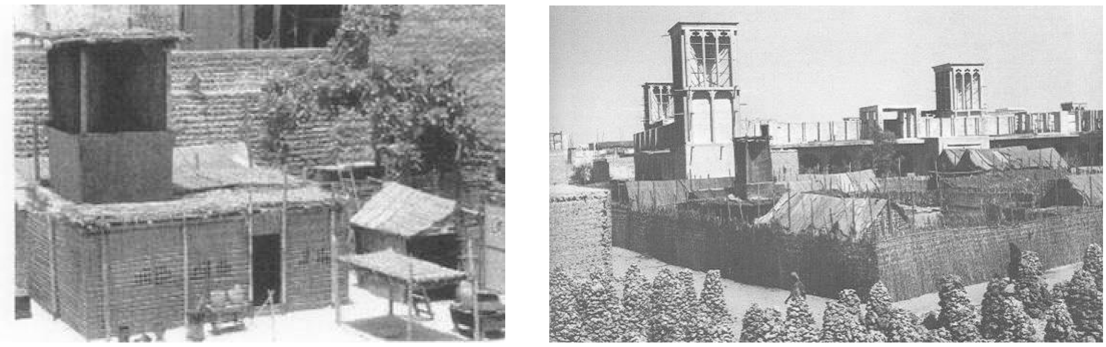


Figure 6.2 - The Palm-frond house (Arish) in traditional architecture in the UAE
(Source: Dubai Municipality, 2004)

Any passing breeze blowing through walls and lattice screens cooled palm frond house, which was comfortable in summer, but not ideal during the occasional heavy winter rains. The Bedouins considered the *Arish* or *Barasti* their second home after the tent; they used to live in palm-frond houses during the summer season. Often an *Arish* or two stood in the open courtyard of stone permanent courtyard houses of sheiks and wealthy merchants because *Arish* provided comfortable conditions in hot seasons – Figure 6.3.

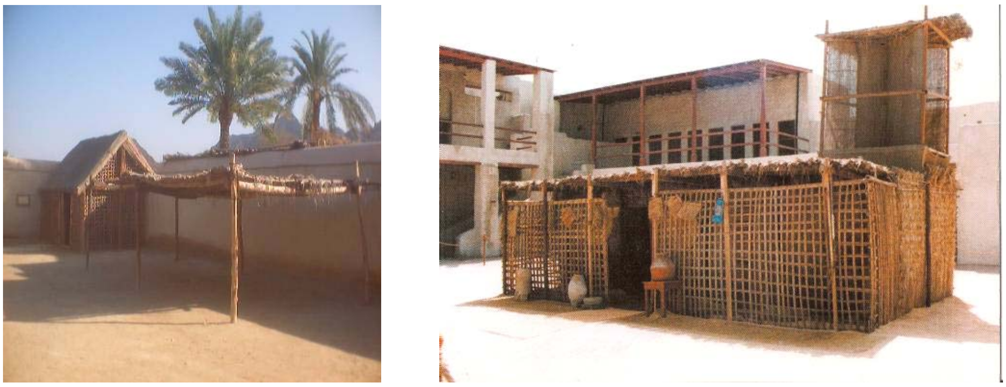


Figure 6.3- The Palm-frond house (Arish) inside the courtyard for summer use
(Source: The author, 2004)

The house was based on a framework of palm fronds, mangrove poles and cord, palm trunks or any other straight wood sometimes with foundations of stone. This framework usually gave a rectangular building with a flat, rounded or pitched roof. In the UAE, some of these houses were round with a dome roof. The main structure was made from palm tree trunks and the walls and ceilings were made from "daen", dried palm tree fronds tied together with kombaar, rope made from coconut tree fibres. In some cases, the fronds were cleaned of leaves to give more beauty and stability (Karim, 1999). These walls were made by a group of men who laid the palm fronds in order on the ground, then tied three or four rows of cord all along the line of fronds. They could be strengthened with cross bars of further palm fronds, laid at right angles to the original ones (Kay and Zandy, 1991, P.65). The framework structure of palm-frond house allowed fresh breeze to pass through the latticed walls providing comfortable conditions through natural ventilation – Figure 6.4.

Figure 6.4 - The framework structure of palm-frond house (Arish) in the UAE
(Source: The author, 2004)

Some of the houses had a portable wind-tower over the main room, the skeleton of which was made from palm tree trunks covered by a sack. The wind-tower was used in summer and in winter it was dismantled and the opening in the ceiling was covered with palm fronds (Karim, 1999).

6.1.1.3. The Village House (Kareen)

Sometimes called "Al Makhzan", the Kareen house is considered a winter house and mostly built in mountains. Unlike the Arish, Kareen is built of materials that are more permanent as mud in coastal regions and stone in mountains. The Kareen is usually rectangular, consists of one or two rooms for living and sleeping surrounded by a small open space or yard.

Figure 6.5- The stone Kareen house in the UAE mountains regions
(Source: the author, 2004)

The Village house walls are solid, stone or mud, with small ventilation openings called "*Masabeh*" that allow light and breeze to pass through (Dubai Municipality, 2004, PP. 40, 87). Roofs are flat or pitch, built of palm trunks and fronds. Sometimes the floor level of an oblong building with rounded corners was dug down perhaps half a meter into the ground and its walls lined with rounded wadi (valley) boulders. These were then built up a little above ground and supported a steeply pitched roof thatched with palm fronds (Kay, 1993, P.33).

Most of the Kareen houses were small, although the same family might own several such houses grouped around a walled enclosure. This design pattern was even more flexible than that of town houses, making it easy for an adult son to add a house of his own to the family complex when he married (Kay, 1991, P. 53). Many daily activities were done outward within the house walled yard as cooking, sitting and even sleeping on raised shaded platforms in hot weather - Figure 6.5.

6.1.1.4. The Courtyard House

The courtyard houses were mostly built on coastal regions as permanent residences using durable materials such as coral stone or *Guss* (mud mixture made as blocks). During the summer season, many settlers left their coastal settlements because of heat and humidity, pending trading activities and pearl catching trips. They used to go to the oasis in the desert where they collected dates, which was their main crop stored for the winter season. During the winter season, they used to go back to the settlements by the Gulf and resume their normal activities of traveling, fishing, trading and pearl catching (Mahgoub, 1997, P. 9) - Figure 6.6.

Figure 6.6 - Arish and courtyard houses in coastal settlements in the UAE
(Source: Jumah Al-Majid Centre, 2006)

The courtyard house type is called sometime “*Bait*” indicating the arrangement of rooms around a courtyard, as well as the family unit living in it. Intermediate yards may lead to adjacent *baits,* housing an additional wife (polygamy) or an extended family group (Ragette, 2003, P.49). The courtyard house is commonly used in hot regions, including the Arab World, for its environmental and social advantages. This type was adequate for buildings in the UAE harsh climate; it was used in castles, rulers’ residences, and houses.

According to the issues discussed earlier, it is concluded that traditional domestic buildings in the UAE varied according to the ambient environment and social values – Figure 6.7. They sustained natural resources through responding to climatic conditions, using natural building materials, and fulfilling society needs through utilising available indigenous materials.

Figure 6.7 –Types of traditional houses in the UAE

(Source: arranged by the author)

Since area of our research is limited within the permanent domestic architecture in urban coastal settlements in the UAE, the courtyard house will be discussed thoroughly in this chapter from environmental and social sustainability standpoint.

6.1.2. Contemporary Domestic Buildings

In their path to modernity, most developing countries, as well as UAE, have dropped their history and traditional products to import those that created and developed from the west, inserting them in an un-matching environment. That insertion creates separation between individuals and their built environment especially their own houses; the most intimate spaces; in addition to the high cost of related services and systems needed to overcome the differences between inserted buildings an and their natural context (Gamal & Loehlein, 2007, P.196) .

The building construction business that flourished in the UAE, led to the construction of different types of houses to accommodate the continuous influx of expatriates into the country and nationals' expectations for new contemporary houses. The level of housing development was viewed from the standpoint of the size of houses (Balkir; Hassan & Al-Segini, 2006, P.25).

According to the latest census held in the UAE in December 2005, statistics showed that the number of buildings was 1392922 including public buildings, establishments and housing units (Ministry of Economy, 2006, P.5). The total number of housing units is 863,860, composing 62% of total buildings in the country. More than 83% of the housing units are in the emirates of Abu Dhabi, Dubai, and Sharjah -Table 3.1.

Table 6.1- Number of housing units in the UAE
(Source: the author based on Census 2005 statistics, 2006*)*

Emirate	**Abu Dhabi**	**Dubai**	**Sharjah**	**Ajman**	**Umm Al Qaiwain**	**Ras Al Khaimah**	**Fujairah**	**Total**
No. of Housing Units	287,189	237,728	201,033	50,237	10,988	50,321	26,364	**863,860**
%	**32.24%**	**27.51%**	**23.27%**	**5.81%**	**1.27%**	**5.82%**	**3.05%**	**100%**

These figures are not conclusive, yet they give an apparent idea about the role that domestic buildings play in the built environment in the UAE. Meanwhile, huge development projects are under construction in the country especially in Dubai; most of them consist of residential buildings that consume massive resources and produce great amount of waste. All these buildings will form a massive pressure on environment and natural resources. Generally, contemporary domestic building in the UAE can be divided into several types.

6.1.2.1. Private Houses (Villas)

After long years of poverty and despair, the citizens of the United Arab Emirates were eager to have all the luxuries of modern life enjoyed by other countries. During the last thirty years, social, cultural and economic changes occurred very rapidly in ways never known to the citizens before. No changes could have happened without an impact on architecture, especially houses. People of the UAE wanted to live in new places where they can experience modern lifestyle with all its luxury, thus contemporary houses conformed a drastic transition compared to the traditional and did not follow the natural evolution that domestic buildings went through in other countries.

In contradiction to traditional courtyard houses, the majority of UAE nationals preferred to own a nice single or double storey private houses (villas). This trend was enhanced with the affordable government facilities. According to the federal government regulations, each Emirate citizen has the right to get a residential plot when he reaches the age of twenty. The government provided the new residential districts with modern infrastructure, streets and urban services. Moreover, the government offered financial support as funds or non-profit loans to be paid back within 25 years (Dubai Municipality, 2001, P. 242). All these factors encouraged building private houses for nationals. This type of houses will be discussed thoroughly in this chapter.

6.1.2.2. Government Housing Projects

After 1971 and the formation of the UAE, the government took the responsibility of providing houses for the citizens. The government constructed several public housing projects in different parts of the country – Figure 6.8. Houses were built and handed to citizens after completion of construction (Magoub, 1997, P.9). The government development policies intended to improve the housing situation. It carried the entire costs of planning, construction and allocation of the new houses. In addition, living standards have been vastly improved, as well as improvement in housing and other building (Balkir; Hassan & Al-Segini, 2006, P.26).

The design of these houses was not suitable for the inhabitants' cultural values and needs, especially Bedouins who were forced to settle in these projects. Some men married more than one woman, which doubled and tripled the number of inhabitants in the same dwelling. The owners had to make additions to the houses to satisfy their changing needs. The additions were informal according to the needs of each family (Magoub, 1997, P.9).


Figure 6.8 –Government housing projects in the UAE

Government housing projects were so useful; they solved the need for finding adequate shelter for thousands of UAE people within a short time – figure 6.9. Yet several social, environmental, and economical disadvantages have appeared. Gehan Selim and Somya Abouelfadl (2004) have cited some of these problems as follows:

- Inappropriateness of planning to accommodate to environmental conditions and occupants' social needs,
- Total disregard for climate that led to uncomfortable internal spaces and total dependency on artificial air-conditions,
- Shortage in houses spaces and area that led occupants to build more spaces in the open spaces within plot and even outside,
- Inflexible design led occupants to use spaces in functions were not designed for,
- No future expansion or modifications are possible.

All these disadvantages led to several environmental, social and economical problems (Selim & Abouelfadl, 2004, PP. 110, 113, & 114).

First Floor Plan **Ground Floor Plan** **External Perspective**

Figure 6.9 – Sample for a government house designed by Dubai Municipality
(Source: Dubai Municipality, 2005)

Evaluating government housing projects is beyond this research, yet several studies have discussed and evaluated these projects from different standpoints (Al-Mansouri, 1997; Falah & Bederdin, 1999; Selim & Abouelfadl, 2004; Balkir; Hassan & Al-Segini; 2006).

6.1.2.3. Multi-family High-rise Buildings

Along with the economical boom UAE witnessed since 1970s, the growing number of foreigners working in the country required new types of housing especially multi-family housing that caused dramatic change in the built environment and the cityscape. High-rise apartment buildings were built to accommodate the accelerating need for houses. Some cities such as Sharjah are dominated by the presence of high-rise buildings mostly for residential purposes. These apartment buildings became the modern vertical replacements of the traditional horizontal residential districts – Figure 6.10.

Figure 6.10 – High-rise residential buildings in Sharjah - UAE
(Source: the author, 2006)

The housing sector in the UAE that was dominated by government housing in the 1970s, gave space for the private sector developers to bring in their flavours to this sector that, until the 1980s, was in its infancy. In 1990s, demand took off again and more professionals and families moved in because of massive investment, the expanding economy and the arrival of new companies (Rahman, 2006). The big investment projects and real state development in the UAE produced different kinds of housing – Figure 6.11. This construction boom, especially in Dubai, attracted new type of occupants with multi cultural and social backgrounds consuming massive resources with unpredictable environmental sequences. These development projects became new phenomena in the Gulf region that deserves an intensive study. The environmental and social dimensions of these projects require comprehensive studies, which is beyond the limits of this research.

Figure 6.11 – Contemporary *housing development projects in the UAE*
(Source: www.aqarat.com)

6.2. Environmental and Social Sustainability Dimensions in Traditional Houses in the UAE

Rappaport (Rappaport, 1969) identifies four objectives for the house to be successful: it needs to be socially and culturally valid, it should be sufficiently economical to ensure that the greatest number can afford, it should ensure that the maintenance of health of the occupants, and there should be a minimum maintenance over the life of the building.

According to Rappaport, the house has to fulfill social needs (social sustainability), affordable to all people (economical sustainability), and provide livable indoor environment along building life cycle (environmental sustainability). If we apply these objectives to any house, we conclude that for the house to be successful it has to be a model of sustainability.

In this research for sustainability potential in traditional architecture, an analysis will be made of the traditional house and the contemporary, according to sustainability dimensions, with special reference to environmental and social dimensions. This analysis is essential to justify the assessment that will be drawn in the next chapters to identify the environmental and social sustainability in traditional and contemporary houses in the UAE.

6.2.1. Environmental Sustainability Dimensions

Perhaps the most important thing to say about the origins of sustainable buildings is that they lie in ageless traditional architecture. This approach relies on simple, renewable, and naturally insulating materials and passive strategies like sitting, thick walls, and natural ventilation to keep houses cool in summer and retain heat in winter (Stang & Hawthorne, 2005, P. 13).

Environmental factors such as the wind movements, its directions, humidity, rain, sun path and resulting heat or cold play an important role in formation of architecture responding to its environment. In addition, there are the physical features and natural resources such as the site, topography, soil type, flora and fauna, and building materials available in the ambient environment. Environmentally sustainable building has to take these factors in account: site conservation, resource efficiency, energy efficiency, environment conservation, indoor air quality, water treatment, and waste management.

According to SEAM area of assessment criteria proposed in chapter four, environmental sustainability areas that traditional houses in the UAE will be discussed and analyzed will be site, energy, resources, indoor environment, water and waste.

6.2.1.1. Site

Choosing the site is an essential step for sustainable design. It is of great effect on building environmental performance along the building lifecycle. This is affected by several planning and design factors such as site architectural planning, orientation, access to plot, plot size, and building mass & form.

a. Site selection

Through history, people of the UAE tried to find the most suitable ways to control wind and climatic conditions. Through long trials, they concluded several solutions; one of them was site selection that was of great effect on control air movement and its direction. Urban settlements were chosen in a way that help to avoid unpleasant winds (dusty or humid) by planting trees near the houses or choosing sites in valleys surrounded by mountains in undesired wind direction. In coastal areas, houses back elevations were placed against the highly humid winds while high walls and fences surrounded the internal courtyards (Al-Abdouli, 1989, P.48).

Selecting places for settlements was based on geographical location, topography and resources, especially water, availability. Site selection for residential buildings had to fulfil the occupants' requirements environmentally and socially.

b. Urban Fabric & Architectural planning

The high temperature and humidity levels within a harsh ambient environment necessitate planning fabric and house forms well adapted to the prevailing climate - Figure 3.8. Climate was one of the most important factors that affected the UAE urban fabric, architectural planning patterns, and buildings features such as compact urban fabric, attached houses, narrow passageways, adaptable houses design, and building materials. These solutions proved their success through generations.

Orientation: The most important planning feature for hot humid zones, as coastal regions in the UAE, was protection from direct sun radiation to minimize the thermal load and allowing prevailing winds to pass easily to eliminate high humidity effect that become unbearable aligned with high temperature during summer time. Thus, all planning and design features were based upon sun protection and natural ventilation.

As in most Islamic cities, buildings in coastal cities in the UAE as Dubai, Sharjah, and Abu Dhabi, were constructed close to each other. This type of high-density structure created narrow alleys, known as *Sikkas or Fareej*, which were shaded for most of the day (Karim, 1999). Houses were situated in a way that let air movement (wind) pass easily through urban fabric and between houses. *Sikkas* or alleys tended to run from north to south or northeast southwest and ended at the creek, permitting the prevailing north winds to pass through. The narrowness of the alleys caused the wind to increase in velocity as it breezed through, creating a comfortable pedestrian zone – Figure 6.12.

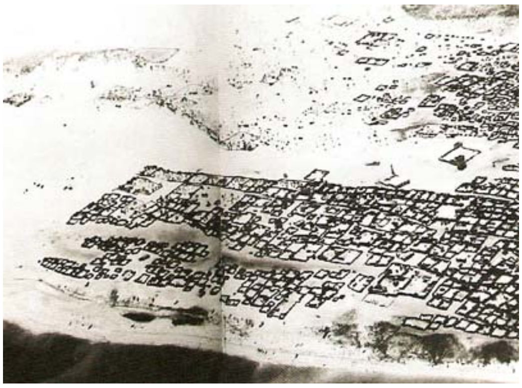



Figure 6.12 – Organic urban fabric orientated towards prevailing wind in coastal settlements in the UAE

(Source: Dubai Municipality, 2007 B)

Plot size : Plots size was limited in traditional turban fabric for different environmental, social and economical reasons. Inward design made the courtyard the focal point as the central design element and the main open space in traditional house. Plot size was related to the house boundaries. Accordingly, the plot size was determined with the built-up area and the open area (courtyard); this was mostly dependent on the owner's economical level and social status. In Bastakia district in Dubai, for instance, plot areas varied between (150 -600) m² for ordinary people, reaching to more than1000 m² for rich merchants. However, each plot was designed according to its owners' needs within the same design principals adequate to the ambient environment.

c. Site planning

Wind movement and humidity were important factors and were considered simultaneously with the direct and indirect effects of the sun. The main objective is to establish the optimum orientation of the building with regard to prevailing wind and the sun taking into account its direct and indirect effects (Hinrichs, 1987, P. 176).

Utilising an introverted design where most of openings can be opened to the central courtyard, directly or indirectly, allowed flexibility in openings orientation. In the UAE coastal region where humidity is so high, especially in hot summer season, houses were usually built along the main movement lanes in a way that allow maximum wind access to building.

In any orientation, the central court inherently gives good protection from dust and sand laden winds. This is particularly helpful in regions where there is more than one major wind direction as the Gulf region including UAE (Hinrichs, 1987, P.178).

The residential districts and clusters were made up of a dense composition of dwellings. Houses often shared walls. The sharing of walls promotes a lesser surface to volume ratio and can be a possible environmental solution to the common problem of heat gain in buildings (Khawaja, 2002, P.2). The almost solid walls within the organic urban pattern made houses so close to each other where alleys and passageways were few meters wide, especially within the residential sector. This closeness made the walls act as sun-shading devices through creating shadow on each other during the daytime to fade sun heat effect and create shaded alleys for pedestrians - Figure 6.13. The contrast between light places and shaded surfaces helps to create different pressure zones, which causes air movement from high-pressure zones to low pressure ones, which enhanced natural ventilation around and inside houses.

Figure 6.13 – Shaded alleys for sun protection providing shadow for pedestrians
(Source: the author, 2007)

Building Orientation: To plan any site, the position of the sun must be determined for all hours of the day at all seasons as well as the direction of the prevailing winds, especially during the hot season. In selecting a suitable building orientation for hot climate, the object is to minimize the internal daytime temperature and to produce shaded exterior living space (Hinrichs, 1987, P. 176).

The main objective is to establish the optimum orientation of the building with regard to the sun and the prevailing wind. The optimal orientation with respect to wind cooling is to locate a long building facade of a narrow building as normal to the wind as possible. This would be correct if the fenestration is to serve as wind inlets and wind outlets to ensure air movement indoors. However, people in the hot arid and humid zones devised the barjeel, or wind catcher, whereby air high above a building can be captured and forced through the interior. With the wind problem solved with the Barjeel, the house can be aligned east west, which is optimal for the sun. This innovation permits flexibility in design with regard to the wind factor and makes it possible for the designer to concentrate on orientating the building with respect to the sun factor (Hinrichs, 1987, P. 176).

Since the house boundaries took the plot layout, the main house elevations had the same plot orientation that was determined in respect to prevailing wind to allow easy access to air movement. Unlike most of the urban fabric in the Arab cities, houses in coastal regions in the UAE were not totally attached to each other; they were slightly detached to allow air movement between houses blocks.

Design Concept: Organic urban planning that characterised the traditional cities in the UAE enhanced by attached houses where introvert design was used utilising internal open courtyard. Privacy and ventilation were important influences in the layout of the houses. A central interior courtyard onto which all the rooms opened was restricted to family use – Figure 6.14.

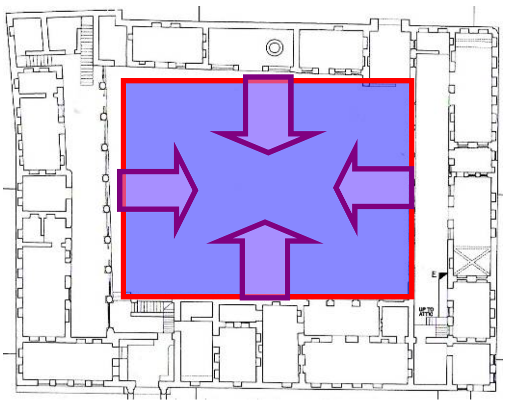


Figure 6.14 – Courtyards the basic design element in traditional houses in the UAE
(Source: the author, 2006)

An appropriately planned courtyard house offers the best solution to meet most of the house criteria environmentally and socially. Courtyard houses provide multiple use spaces climatically and functionally. To accommodate to climatic diurnal and annual fluctuation the courtyard house may quite often have a division of summer and winter living quarters. Courtyard mechanism as thermal regulator was discussed in chapter 2. The court would have a tree(s) to keep the environment pleasant in some cases there would even be a *baghichih* (garden) with fruits and vegetables - Figure 6.15.

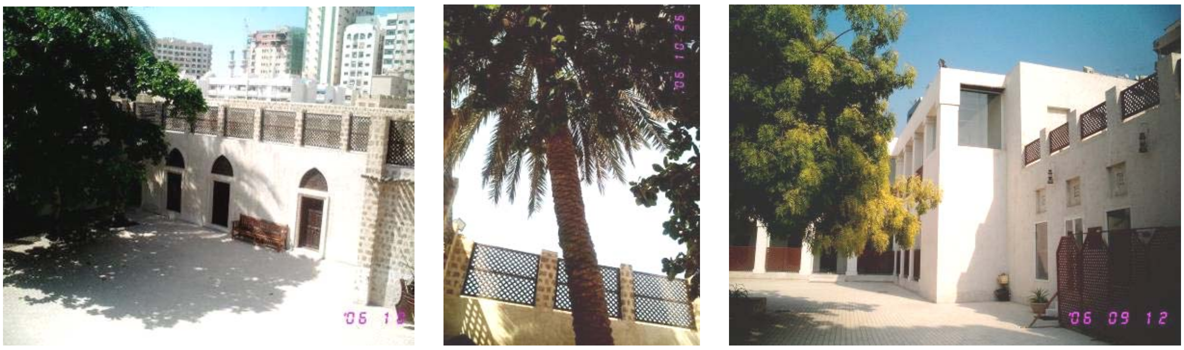


Figure 6.15 – Trees in courtyard to provide shade and pleasant environment

(Source: the author, 2006)

All the elements of the house, the only exceptions are the Majlis and the guests' suits surround the central court; otherwise, the windows and doors of all rooms are opening on the *liwan* that surrounds the court. The *liwan, sabat* or veranda usually is a covered semi-open passageway or space surrounding the central court and connecting the various rooms that opened in it together, with an arcade of an ornamental nature. Hence, every room enjoyed equal connection to the courtyard– Figure 6.16.

The *liwan* acted as a transitional covered outdoor space between the fully open sunny courtyard and the closed dim internal space softening the transition from very bright to dark. Internal spaces openings (doors and windows) open on to the *liwan* as no windows are open to external elevations especially in the ground level except the Majlis. It also acted as a transition between the individual living units or *baits* and the courtyard.

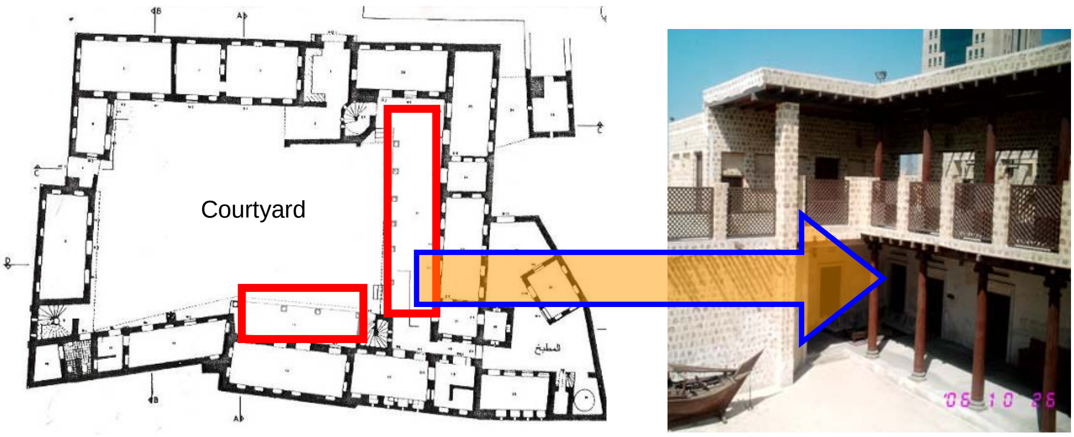


Figure 6.16 – Liwan: the covered semi open space surrounding the courtyard

(Source: the author)

The liwan provides protection to the internal spaces from the hot summer sun and yet it maintains the internal spaces' warmth in the winter (Al-Rostomani, 1991, P.166). The winter spaces normally have fewer windows where as the summer spaces that have more windows to get natural ventilation between the barjeel, windows, and upper openings (*Masabeh*).

Being a space connecting the rooms together, the *liwan* was ideal so that a person does not have to step into the relatively hot courtyard to get to the other spaces, although this was not always possible but was preferred (Khawaja, 2002, P.12). The *liwan* oriented to give maximum shade and protection from the prevailing winds, which engender sand and dust hazards. Because of many variables, as the sun, winds, topography, vie and privacy, many aberrations of the *liwan* have evolved.

Building mass: Most of the urban settlements in the UAE were located along the coast. Being located within the desert region facing the Gulf, they have very hot and humid climate particularly in the summer months when the temperature reaches 50 C°. In winter, the climate becomes moderate. Consequently, builders designed the house accommodated to the long hot summer months and their solution was based on that fact. Accordingly, building mass was solid, exterior openings were very small protecting the interior spaces from the harsh climate. Besides climatic conditions, traditions and social values were of great effect on size, numbers, and location of openings in building external treatments– Figure 6.17.

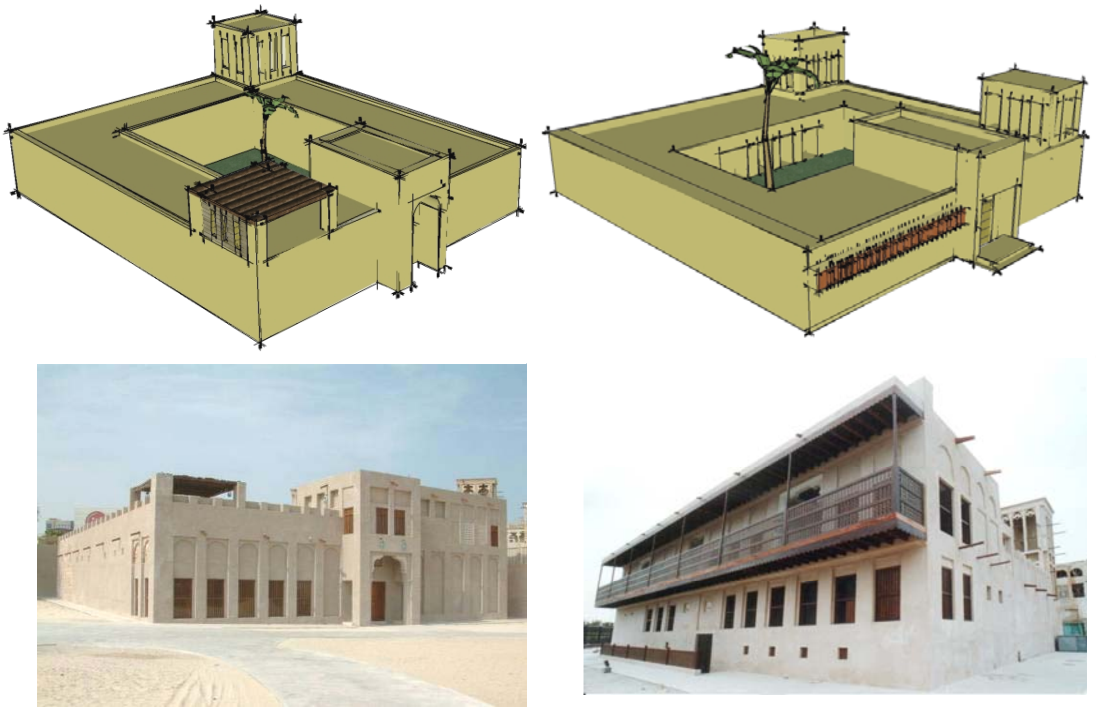


Figure 6.17 –Solid building mass with small openings to eliminate sun exposure
(Source: the author)

One of the ways to minimize the heat and solar gain is to minimize the envelope surface area, which involves the building basic form, scale and simplicity of surfaces (Guide to Energy, 1982). While the sphere presents the least surface area for a given volume, a rectilinear building that is square in plan not only more practical to build than a sphere, but also provides a better ratio of useable floor area to envelope surface area. That is noticeable in planning the traditional houses in the UAE, where the average of plot size is 230 m² (Dubai Municipality, 2001, P. 242), which are the dimensions of the house itself, and the height of the house is usually one or two floors (5 -12) m. This means that the house form is rectilinear and the plan is often square, except big houses for merchants or rulers, which were bigger with more surfaces exposed to the external climatic conditions, especially solar heat.

Complex surfaces can double or even triple the envelope surface area as compared to a building of similar size and form with flat surfaces (Fethi, 1988, P.45). Masses of traditional houses in the UAE are simple and flat, that means they have minimum envelope surfaces area, which minimize heat transference through the buildings envelope.

6.2.1.2. Energy

Energy is an essential issue in building lifecycle whether the consumed energy during the construction process or occupancy during the buildings' lifetime. Even the energy required to produce building materials are taken in account; which is called the embodied energy. The embodied energy of a material refers to the total energy required to produce that material, including the collection of raw materials, processing, transportation to site, construction, and maintenance during building lifecycle, then materials reuse or deposing. The greater a material has embodied energy, the greater the amount of energy required to produce it (Kim & Rigdon, 1998, P.6.).

Traditional houses in the UAE, like traditional houses in the region, depended on natural energy resources whether in building materials or providing comfortable indoor environment.

a. Carbon dioxide and Energy Consumption

Traditional building materials and construction systems are based on low use of energy and sources, and work in harmony with the natural environment (Cain, Afshar, & Norton, 1975, P.207).

The Impact of a given material can occur at all stages of the material's lifecycle. It is not just the energy consumed during the life of a building that has to be considered. Energy is involved in the extraction, manufacture and transportation of building materials and this is known as "embodied energy" and directly relates to the gross carbon intensity of a material (Smith, 2002, P. 73)

Since traditional house were built of natural sustainable materials and renewable energy resources, they did not release any Carbon dioxide or pollutants. They were sustainable and friendly to environment because they were energy efficiency, which is an important feature in making a building material environmentally sustainable.

b. Renewable energy sources

In traditional architecture, the building envelope was the main element utilised to protect occupants from the harsh climate depending on passive energy by getting use of natural and renewal resources. Passive energy strategies utilize natural resources as sun, wind and ambient environment components, to create healthy comfortable internal spaces without damaging the nature or affecting the environment. Traditional house, in the UAE, represents a living witness passive energy building that corresponded to the ambient environment, which incorporated the essence of sustainable architecture.

Passive energy can be divided to passive heating and passive cooling. Passive heating system is one in which the thermal energy flows naturally by radiation, conduction, or natural convection without mechanical assistance, and it is related to solar energy. Passive cooling system means utilizing several heat sinks and a variety of climatic influences to create thermal comfort in warm and hot regions. It is defensive against solar gain and heat transference through building envelope and it requires the evacuation of heat from the building to natural heat sinks (Moore, 1993, P.52). Passive cooling system, which mostly needed in countries as the UAE, can be divided to four major strategies: ventilative cooling, radiative cooling, evaporative cooling and mass-effect cooling.

In hot humid regions as the UAE, the most preferable passive cooling strategies were ventilative cooling, radiative cooling, and sometimes evaporative cooling when humidify was not so high. All these strategies utilised natural renewable energy resources, which make the traditional house sustainable from energy standpoint.

c. Building Envelope

The main function of the building envelope (walls and roof) in the hot climate regions is to resist the transference of heat, reflecting sunrays as much as possible. In addition, it had to minimize the heat and solar gain to create cool conditions inside and counteract excessive solar gain, through well-studied house form, size, scale and simplicity of geometric shapes and surfaces.

The building envelope of the houses in the UAE forms an effective barrier against the extremes of the external climate. It provides a filtering that modifies the climate sufficiently for the internal conditions to be more acceptable. The building envelope acts as a passive modifier to the external climate, depending on the materials, the characteristics of each material and how they are put together determines the way the external climate influence on the internal conditions (Collier, 1995).

The building envelope environmental performance to deal with hot harsh climate in the UAE depended on minimizing the internal temperature fluctuation and delaying the effect of maximum afternoon temperature several hours as it travels through the thick wall, until night when the outside temperatures drops and the open spaces (the roof) can be used. To achieve this and counteract excessive solar gain to keep the internal microclimate within comfort zone inside the buildings especially houses, thermal properties of buildings materials as heat capacity, thermal conductivity and resistivity, reflectivity and emissivity, must resist heat transference and reflect solar radiation as much as possible. Thus, choosing building materials were of great importance in determining building envelope environmental performance.

To improve envelope thermal performance to extreme climate conditions, external walls were of light colours of the brownish and pale colours of coral stone. Light colours are good reflecting surfaces, for their reflectivity is about 80-90% (Fethi, 1988, P.56). They reflect most of the solar radiation that strikes the surface, which minimize thermal loads on the outside surfaces, to improve the inside microclimate within comfort zone. The colours used for the elevations are the natural ochre of the earth while the paintings are light especially white for the interior walls and the covered passageways.

Building materials: The building envelope consists of different building materials. Each of these materials has its own physical properties that, combined with the way they are assembled, determine how that part of the envelope will act towards the heat transference through it and modify the indoor environment of the building in reaction to the outside climate (Collier, 1995).

In coastal regions in the UAE, building materials were taken from available resources adequate to ambient environment. Walls were usually built with coral stone, bonded with *sarouj*, a blend of red clay and manure that is not affected by humidity, or a lime mixture derived from seashells, and plastered with chalk and water paste (Dubai Municipality, 2004, P.45). Additionally, limestone, sun dried clay brick, and palm products (trunk, fronds and leaves) were used in construction traditional houses. These materials are ideally suited to the hot and humid coastal climate because their thermal properties– Figure 6.18.

These natural materials are sustainable because they are generally lower in embodied energy and toxicity than manufactured materials. They require less processing and are less damaging to the environment and most of them are theoretically renewable.

Palm-frond wall | Mountain-stone wall | Coral-stone wall | Plastered wall

Figure 6.18-Buildingmaterials used in walls in traditional architecture

(Source: the author, 2005, 2006)

Walls were thick with very low thermal conductivity because of the porous nature of the coral stone and the low density of the bonding "*sarouj*" which provided good insulation for interior spaces. Walls average thickness was of 0.60 m and reaches 1 m sometimes to get use of the time lag of a thick masonry wall. Time lag for natural masonry materials is about 12 hours that delays the heat transference of maximum temperature of the outside air until the evening, when the outside temperature is low and comfortable and the outdoor spaces are adequate to be used. Walls were plastered with gypsum plaster that helps to increase the thermal properties of the coral stone.

Construction systems: Simple construction methods were used to build traditional houses, easy to implement and manipulate; they were adhered to the needs of the society and climate (Mahgoub, 1997, P.11). Thick bearing walls were used to support roofs made of trees' trunks. The roofing materials were varied from the palm-tree fronds to the Chandal wood joists according to building importance also due to the impact of the economical factor (Bukhash, 2000, P.35) – Figure 6.19

The roof materials were timber joists; (with the bark still on) mattes palm-date leaves finished with clay on gypsum from the top. The timber joists together with the matting will be finished with colourful paints and beautiful ornamentations (Al-Rostomani, 1991, P.166). At the beginning of the century, palm tree trunks were replaced with sandalwood joists imported from east Africa. In the 1920s and 1930s when trade with India flourished rectangular wooden joists, known as *morrabaa*, were imported from south India. *Morrabaa* was the preferred wood as it was longer and stronger than sandalwood joists. In some cases, the roof was laid with a layer of burned mud "sarooj", which was introduced from Iran and proved to be waterproof (Karim, 1999)

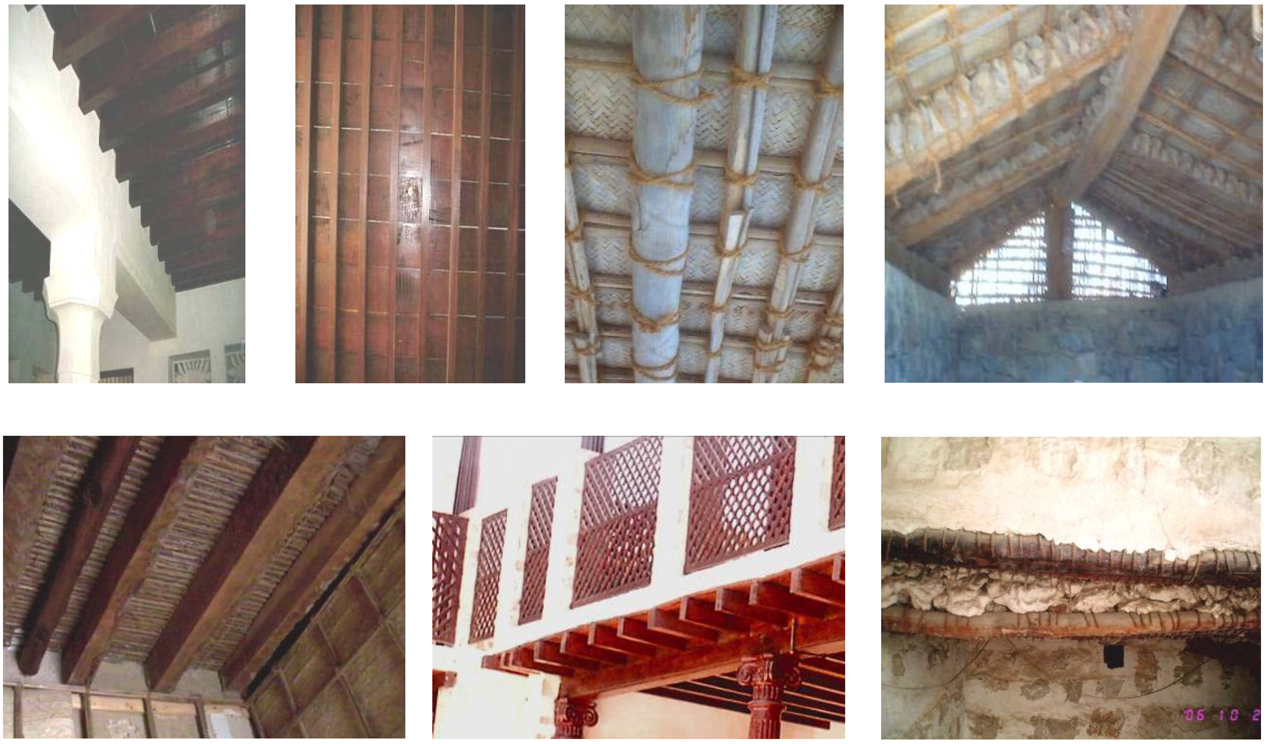


Figure 6.19 - Building Materials used in roofs and ceilings in traditional architecture

(Source: the author, 2005, 2006)

Most of the material used were available in the ambient environment ; the exceptions are the white gypsum used for internal plaster which were imported from Iran; timber joists, teak beams, carved timber for doors, windows and steel bars were imported from India or from East Africa.

6.2.1.3. Resources

Economy of resources is one of the principles of sustainability; it is concerned with the reduction, reuse, and recycling of the natural resources that are input to a building. By economizing resources, the use of non-renewable resources is reduced in the construction and operation of buildings along the building lifespan (Kim & Rigdon, 1998A, P.10). Traditional architecture was a live evidence of economy in resources whether in energy, materials, and water.

Resources consumption in traditional architecture based on Islam call for economy in resource, as discussed in chapter three. Being an Islamic society, UAE people dealt with available resources rationally and sustainably. Traditional houses in the UAE, accommodated to harsh ambient environment through: protection, modifying & adaptation.

Protection was from dense solar radiation, high temperatures and dusty wind. Modification was through getting adapted to these harsh conditions, in order to create a comfortable internal microclimate. This was achieved through sensitive and conscious solutions, construction technologies, well-studied planning, and design by utilising natural resources and using suitable building materials of certain thermal properties that corresponded to the ambient environment.

6.2.1.4. Indoor Environment

Dwellings are built to serve a variety of functions, but one of the most important is to create living conditions that are acceptable to their occupiers, particularly in relation to the prevailing climates. Buildings do not control climate, they can modify the internal climate, even though it is affected by the external conditions. The materials that are used, the forms they take, the volumes they enclose may all contribute to the (microclimate) that a house generates (Oliver, 2003, P. 130).

Traditional houses in the UAE, by using available local materials; were designed to provide maximum comfort in a hot and trying climate. Coral stones, limestone, and mud brick provided good insulation, preserving a cool, often dark interior, while any passing breeze blowing through walls and lattice screens cooled palm frond houses (Kay, 1993, P.33). Natural ventilation and natural building materials were of great effect in providing comfortable indoor environment.

a. Natural Ventilation

Ventilative cooling strategy was the best method to provide comfortable indoor environment in hot humid region as UAE coastal regions. Thus, natural ventilation was essential for houses in the UAE. The ventilation concept can be perhaps best illustrated by examining the Bedouin tent dwelling. It seems to be the general rule to erect tent with their long axis facing the West or southeast, and to leave the leeward side open. As the wind changes, the tent face is re-oriented to prevent the tent from the blowing away. In order to take advantage of the slights breeze during very hot days, and if there is no expectation of sudden wind, the black wall is either rolled up or unpinned. Likewise, the permanent dwellings are oriented with respect to prevailing wind. Blank facades are oriented to shield the outdoor living spaces from the hot winds while allowing adequate winter sunlight to penetrate the living zones (Hinrichs, 1987, P. 176).

Courtyard performance, as thermal regulator, played an essential role in creating natural ventilation within the house during different hours of the day. In the coastal regions, this was achieved through utilising temperature fluctuation, difference in pressure zones, and land and sea breeze direction change between day and night – Figure 6.20.

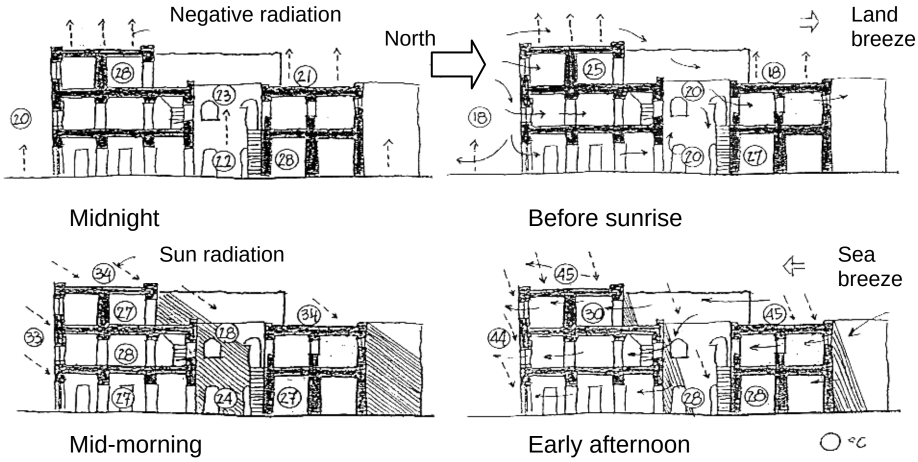


Figure 6.20 - Utilising prevailing wind to obtain natural ventilation during different hours of the summer day in a typical traditional house in the UAE
(Source: Ragette, 2003)

Wind catcher or *barjeel* was one of the main architectural elements to get natural ventilation especially in coastal regions of the UAE. Iranian immigrants introduced *barjeels* to the UAE architecture in the nineteenth century. However, they became significant features of traditional houses where barjeels, as Bourgeois describes, "*can be seen studding a distant horizon or looming above a street or roof. Singly, in small groups, or as skyline legions, barjeels have the lovely power of evoking moods like abstract sculpture.*" (Bourgeois, 1983, P. 54).

Being essential strategy to obtain natural ventilation and creating accepted comfort level in internal spaces, some houses may have more than one barjeel due to the house size, number of rooms, and owner's social and economical status. Barjeels differ in design, size, height, and decoration according to its location and function, as being in a living space, children bedroom, or master bedroom, where the barjeel was higher and more decorative (Al-Abdouli, 1989, P.79).

Barjeels designed to increase air movement in the rooms below; they rose as tall angular structures as shaft with the top commonly open to four directions and with two septum partitions placed diagonally across each other. However, the main function of *barjeel* or wind catcher is to capture air high above a building and force it to get through the interior (Hinrichs, 1987, P. 177). The great advantage of the barjeel is that it solves the problem of screening resulting from the blocking of buildings in an ordinary town plan– Figure 6.21.

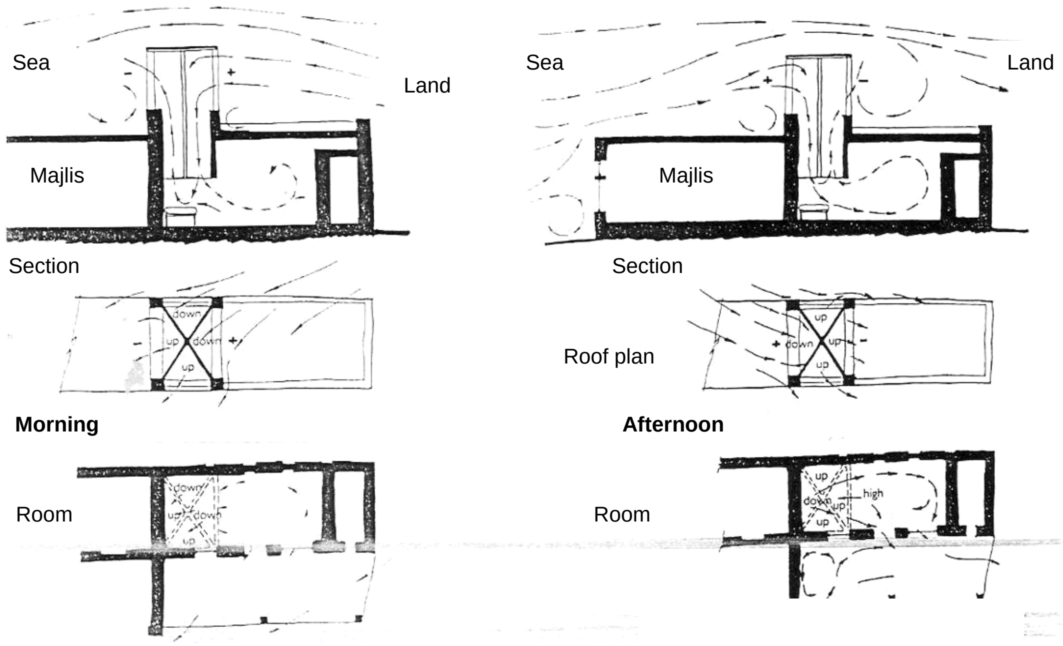


Figure 6.21 - Ventilation patterns through a courtyard house in costal region in the UAE
(Source: Ragette, 2003)

The barjeel performance is affected by variables as height, plan form, orientation of the barjeel, location, and the cross sectional plan area. The plans of barjeels vary and can have between one to eight sides. Each side may have up to twelve separate vent openings that may or may not be separated by plastered partitions, which are supported where they continue inside the barjeel shaft on timber members. The vents trap and channel air into the shaft and decrease turbulence in the tower by regulating the direction of the incoming air.

Some houses had barjeels with different number of openings as in the Western House “Sheikh Sultan Bin Saqar Al-Qassimi House” in Sharjah that had one, two, and four sided barjeels. The barjeels differ in location, size, and orientation (Al-Azzawi, 2004, P.23). The more sides of the tower, the greater is its ability to respond to changes in wind direction but the smaller is intake of air direction of the predominate prevailing winds. In the UAE, four-sided barjeel are commonly used to capture the pleasant wind in any direction; other sides are closed in the face of unpleasant winds. Circular barjeels were rarely used; few examples are found in the UAE as Ibrahim Madfa’a *Majlis* barjeel in Sharjah. The vents of the wind tower can be shut when cool air is not required especially in winter.

The cross-sectional area of the shaft influences the total volume of air that can pass down the shaft and the speeds at which it travels. There is a wide variety in dimensions of the shafts, ranging from (0.4m* 0.8m) to (7 m * 11m). The relationship between the proportions of the cross-sectional areas of the shaft to the area of the vent openings is critical, for there comes a stage at which, by increasing the shaft proportions, air travelling down the shaft is slowed down to such a degree that the structure becomes inefficient (Hinrichs, 1987, P. 259).

Barjeel mechanism: Tomkinson eloquently describes the mechanism of barjeels, which he called (fuel-free air-conditioners) (www.uaeone.com – last accessed 14-07-2005):

> *"…Every face of the four-square tower is hollowed, usually into a concave V-shape. Many wind-towers are like medieval louvers, each facet a series of recesses fronted by a squat colonnade. The wind, from whichever quarter hits one of the walls and is deflected down the hollow shaft to the rooms below."*

A wind tower operates in various ways according to the time of the day and the presence or day and releases it to the cool air at night, where the diurnal temperature variations exceed 18° C. Because of the changeable winds in the coastal regions, and to get maximum use of the preferable prevailing wind, barjeels were multi-directional. They were able to catch the breeze from whichever direction it might come through forcing it downward to the inside of the house rough four vertical openings in the four directions. Along with the barjeel, wall openings provide adequate cross ventilation.

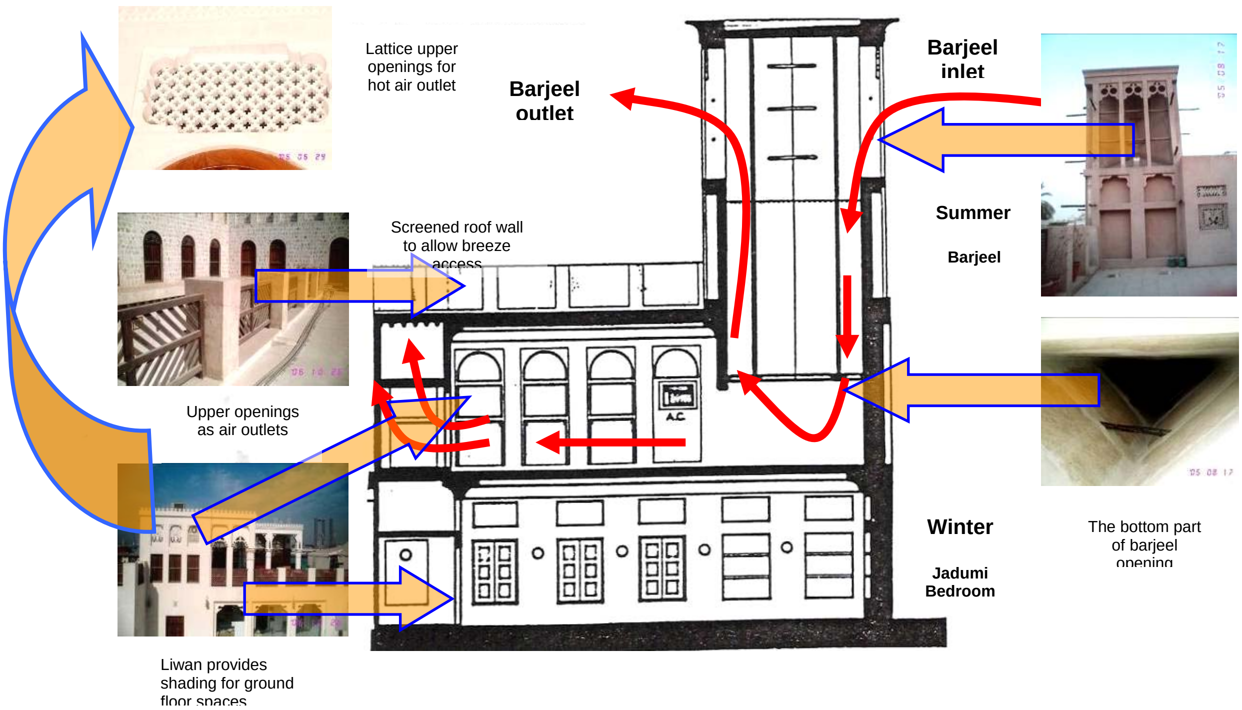
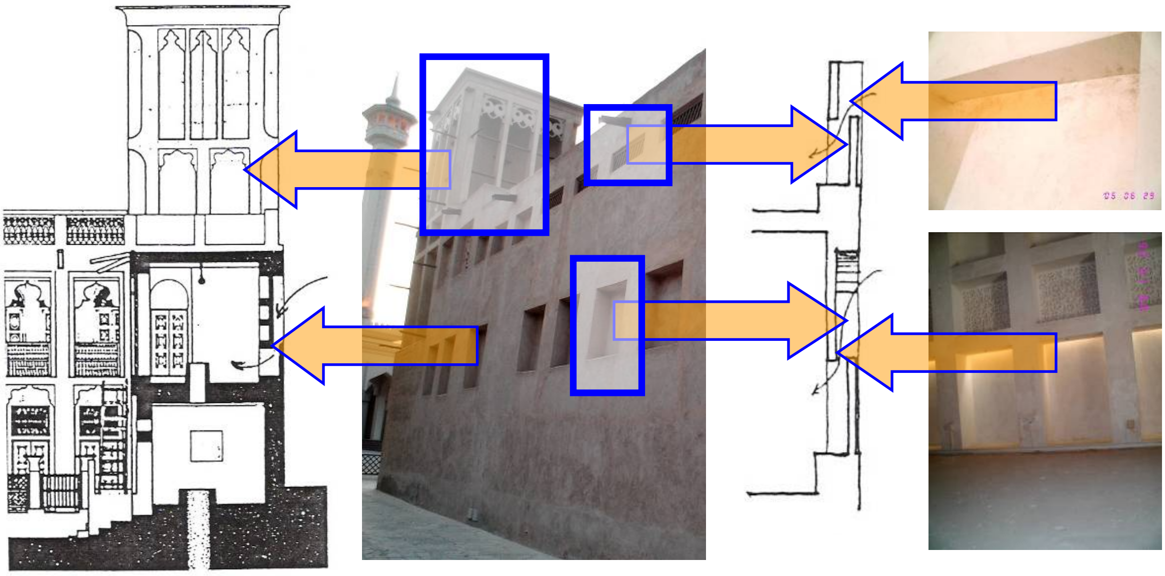


Figure 6.22 – Natural ventilation through upper spaces in a traditional house in the UAE
(Source: The author)

Barjeels were placed about fifteen meters above the ground. At this height, wind velocity is about one and half times greater than at one meter above ground level. At least half the length of the barjeels was an enclosed funnel and air passing down it increases considerably in velocity. When the breeze enters the tower through an opening, it collides with the wall within the tower and is therefore forced to travel downwards through relatively a long neck. The function of the neck is increase the speed of the breeze and at the same time it looses partly its heat, accordingly the breeze reaches the inside of the room at some appreciable speed and with a lesser temperature than normal one outside (Al-Rostomani, 1991, P.166).

The wind tower descends vertically into a room beneath, terminating at just over two meters above the floor – Figure 6.22. Much of the flow of air from the wind tower was confined to the area immediately below the tower, for the draught down one side of the tower is matched by a strong up-flow of air in the side opposite, but the wind tower also creates some air movement in the room as a whole. Traditionally, cushions were placed beneath the wind tower and people sat there for eating and entertaining (Mahgoub, 1997, P.10).

Air pullers are additional ventilation features. They are another solution to force breeze to the inside of the room through high-level openings located at wall upper level on external recesses in walls. To avoid opening windows to the exterior, the opening of the window was replaced with two thin parallel walls with a distance of about 10 centimetres in between them. This design enabled the wind to strike the upper wall, be deflected into the opening and then pass though the lower wall into the adjacent room, providing both air and privacy to the occupants (Karim, 1999) – Figure 6.23.



Ventilation through barjeels and air-pullers

Openings in a solid elevation that allow natural ventilation for rooms and roof

Ventilation through Air-pullers

Air pullers

Figure 6.23 – Natural ventilation features in a traditional house in the UAE
(Source: The author)

b. Indoor air quality

Natural materials are generally lower in embodied energy and toxicity than synthetic modern materials. They require less processing and are less damaging to the environment (Kim & Rigdon, 1998B, P.16). Traditional building materials used in the UAE architecture as coral stone, limestone, wood, and clay mortar are all natural, thus they are not toxic and do not emit pollution or gases that may affect negatively on air. They are environment-friendly and sustainable. Accordingly, indoor air quality was free of toxicity or polluted gases.

c. Thermal comfort

A desire for well-being, as Utzon believes, must be fundamental for all architecture if we are to achieve harmony between the spaces we create and the activities to be undertaken in them (Utzon, 2004, P. 11). Indoor environment provided comfort levels for occupants passively utilising natural resources. Thermal comfort in traditional houses in the UAE, as discussed earlier, achieved through protection, modification, and adaptation.

One of adaptation methods to different seasons throughout the year was occupants' life style and flexible use of spaces along the day and during seasons. In cold seasons, the barjeels and ventilations were closed to prevent cold wind from getting inside spaces. Because the climate tends to be comfortable in winter, simple heating devices as stoves or canons were used in cold nights where the family gather in one room. Unlike most of the dwellings in the Islamic World, the basement was not found in the UAE houses because of soil type and humid climate.

In hot season, the well-ventilated spaces were used, besides the roof. In the early hours of the day when most of the courtyard is shaded and cool air is still captured there, the family uses courtyard for different facilities as cooking, eating, domestic facilities, and children playing. In the afternoon, the indoor spaces were used; these spaces were ventilated naturally through barjeels and air pullers. Shaded outdoor spaces were also used as *liwan* and covered spaces in the roof. In the evening, the occupants used the roof for sitting and sleeping.

Use of the roof in the UAE is encouraged by the provision of screened high walls (*Warish*) that provides privacy, yet allows breezes to pass through screened roof walls. The temperature film of air above a flat roof will vary according to the air temperature fluctuations and the intensity of solar radiation emitted to the sky. The temperature of the surface film of air may drop below the air temperature at night, and can be utilized to cool internal and external spaces (Evans, 1980, P. 104). To trap this air and utilize it, a wall is needed to capture the cooler air and prevent it flowing off the edge of the roof. The wall also reduces air movement that would limit the formation of cool air "pools" by mixing the cooler surface air film with air at normal temperature. The simplest way to achieve that is the use of the courtyard so that the cooled air flows down to the interior spaces to ventilate the house interior at night in order to cool the internal thermal mass, which is called " night flushing" (Moore, 1993, P.210). That is one of the functions of the courtyard in the UAE. It acts as a thermal regulator to flush the heat emitted to the inside spaces after sunset to the outside during night, in order to cool the internal spaces and walls to be comfortable in the next day.

6.2.1.5. Water & Waste

In a region, which is characterised by very limited precipitation, the judicious use of fresh potable water is of utmost importance. In the past people of UAE depended on wells to get fresh water by digging a vertical shaft to reach the water below the ground (groundwater). The well capacity depended upon porosity of the soil and the ambient supply of water. Water was lifted by means of rope and bucket. Wealthy people's houses usually had their own wells; other people had to fetch water from the nearest well using containers or jars. Sometimes water was brought by water peddlers called (*Saqqa'a*).

Water was stored in big water jars that were placed in on hollowed-out stands or part of palm fond cut to fit the jar base. Water jars were put in shaded airy spaces to cool water inside, and then water was sparingly dispensed with cups and pitchers. Small water jars were placed on alcoves near air pullers to be cooled by the cold breeze coming through the air pullers openings – Figure 6.24.

House wells

Public well

Pottery jar to keep drinking water

Figure 6.24- Different traditional ways to get fresh water in the UAE

(Source: The author, 2005, 2006)

a. Water consumption

According to Islam, washing for Muslims has a spiritual significance beyond mere physical cleaning, yet scarcity of water in the region has dictated the manner of cleaning and of disposal of liquid and solid waste. This need for economy in water consumption is enhanced with Islamic regulations that embodied well-established hygienic principals with the prescription of regular cleaning before praying and meals and after meals or defecation, taking into account economical use of water even proposing the use of sand in the absence of water or any liquid. For washing at meals, water was poured from a jug (*ibrik*) over the diner's hands into a basin (*tisht*). Only fresh flowing is considered fit for cleaning, therefore washing basins or bathtubs were not used (Ragette, 2003, P 71).

Most wealthy merchants' houses had their own toilets and baths. Even the parents' sleeping unit was provided with a private corner for washing, using a basin (*tisht*) for bathing. Because of limited population and simple lifestyle, UAE cities did not have public baths that were available in most of the Islamic cities, as in Baghdad, Damascus, or Cairo. Laundry is generally done in public washing places near water sources, the sea in coastal regions, the well or *falaj* in mountain and rural settlements

Because of water scarcity and difficulty to obtain, water was used rationally and rarely discarded immediately; it was recycled and reused more than once. It was collected in further receptacles for secondary use, finally for irrigation. Water distribution within the community was subjected to a strict hierarchy; first came drinking water and mosque supply, then washing and irrigation (Ragette, 2003, PP.68, 69).

b. Waste

Traditional society in the UAE produced a negligible amount of waste as compared with affluent times. Furthermore, most waste was bio-gradable and natural scavengers picked up the remains. Traditionally the public realm is not much of a concern for people who close themselves in. While inside each house everything is spick-and-span, garbage may be simply thrown over the wall. In addition, the expanded desert was seen as a natural dump, but it swallows little and wind will scatter rubbish over large areas. Very belatedly this problem of pollution was recognized (Ragette, 2003, P.71).

One of materials sustainability criteria is being recyclable. Recyclability measures a material's capacity to be used as a resource in the creation of new products. Traditional building materials, as brick, wood and stone, are of recycled content. These materials are durable, require less frequent replacement, fewer raw materials, and will produce less landfill waste (Kim & Rigdon, 1998B, P.12).

6.2.2. Social Sustainability Dimensions

As previously discussed in chapter one, social sustainability includes several dimensions as quality of life, satiability, empowerment, safety, equity, accessibility, and cultural identity. Since this research is concerned with residential buildings in the UAE as an identical product for the occupants, the social sustainability dimensions in the house that was a symbol of cultural identity of the UAE society will be discussed. The issues that will be discussed are based upon the conceptual context of “house” in Islam and the basic principals of the society values and traditions derived from Islam, the main source of legislations that regulated traditional society in the UAE.

The local Muslim is immersed in his religion that regulates his life and gives it meaning. The doctrines of Islam are not only concerned with the spiritual life but encompass man's entire life and his relationship with his fellow men and with God. As important as the tribal structure of the local society is its Islamic tradition (Heard, 1978). The definition of a house, in Islam, is the place of rest for the body and relaxation for the mind. It is the place in which an individual is protected from the climatic elements and in which he finds freedom from the restrictions and pressure of society (Mortada, 2003, P.94). The word “house” in Arabic is the denotation of “*Sakan*”, which means rest and quietness, as mentioned in several Quran verses as ﴿It is Allah Who made your habitations homes of rest and quiet﴾ (16 Al Nahal: 80).

Concerning architectural design of the house, neither the Quran nor Sunnah have set up specific rules or regulations for house design or construction. Yet, Islam contains conventions how the Muslim should live his life and practise everyday activities within Islam legislations. Thus, house design was the reflection of Islamic doctrines, tribal traditions and social values that revealed society identity and fulfilled occupants’ physical and social needs.

Analysing social sustainability dimensions in the traditional houses in UAE necessitates understanding the social aspects of Islam and its influence on Muslims’ society. Islam asserted on the human identity as an individual within the wholeness of society. According to SSAM area of assessment criteria proposed in chapter five, social sustainability areas that traditional houses in the UAE will be discussed and analyzed will be privacy, social relationships, neighbourhood, family, and identity and social status.

6.2.2.1. Privacy

Islam recognises the right of every individual to be free from undue encroachment on the privacy of his or her life. Therefore, the privacy of the house is significantly stated in many placed in the Quran, ﴿ *O you who belive1 Enter not houses other than your own, until you asked permission and greeted those in them; that is better for you, in order that you may remember*﴾ (24 al-Nour: 27).

The Islamic principal of house privacy is an affiliation of the principal that calls Muslim to segregate his or her secluded private life from public intercourse. Meanwhile, it is a part of the Islamic system of gender segregation. As this system aims to protect the family and keep social health and well-being that contributes to the stability of the society (Mortada. 2003, PP.95, 96)

Within the context of housing, privacy, of the family is the main concern, in particularly the importance of protecting female members from the eyes of male strangers. Accordingly, a context that facilitates visual overlooking is considered harmful, is therefore an offence in Muslim law, and should be avoided (Hakim, 1986, P.33). Privacy in traditional houses was achieved according to a certain hierarchy: city planning, neighbourhood unit, street width, entrance, doors location, house design, almost solid walls, high fences, openings form and location and even tiny details of louvers and screens.

a. Urban Planning and Design philosophy

Residential districts in the traditional urban fabric were composed of residential clusters. The entrances to the residential districts usually were located on the main streets of the *souqs*, where in between shops a gate would lead into a district. These districts would have a main lane onto which gates to smaller residential clusters would open. The residential clusters were made up of a maze of winding alleyways leading to cul-de-sac dead-ends. Doors to various dwellings would open up into these cul-de-sacs, forming a small neighbourhood sometimes even marked with a gate. Hence, one would move horizontally through a sequence of spaces varying in levels of privacy, each change marked with a distinct threshold (Khawaja, 2002, P.2).

Placement of the entrance house’s doors should come within the principle of maintaining privacy and ensure that no offence is caused to neighbours’ privacy. Thus doors should not be opened opposite or near each other and they should be offset in order to prevent the person standing at an entrance from looking directly into the house opposite or adjacent (Mortada, 2003, P.97)

Houses, being someone's place to have privacy and their own property, the traditional houses arrangement took privacy as an important factor in design. The introvert courtyard design was the best solution to provide privacy. The courtyard was restricted to family activities and women’s socialisation. Women used the courtyard to move between house parts and perform daily activities. It provided privacy for women to conduct their social activities, eating, and sleeping during the hot summer season. It was where the *harim* (women quarter) began. Thus, courtyard had to be adequately protected from unwanted visual intrusion. Being a multipurpose family space, the courtyard had to be flexible to accommodate various facilities. It enjoys a central location and must be well protected visually from the public spaces. It should be ideally equidistant from the other private rooms. If not, it should have easy access from the other rooms (Khawaja, 2002, P.11).

House spaces were divided into three zones according to privacy level needed - Figure 3.20. The public zone that includes as main entrance, *dehrez,* and *Majlis*; these spaces did not need privacy and was related to public life including reception of male guests. Semi-public zones as kitchen, stores, and servants quarters; theses spaces were located as intermediate between public and private spaces and used by all the house occupants including family members, servants, and female guests. Private zone that includes spaces as women and family living and bedrooms; these spaces were restricted to family members within certain hierarchy as parents' bedroom. Movement between the three zones happen through transitional spaces as liwan – Figure 6.25.

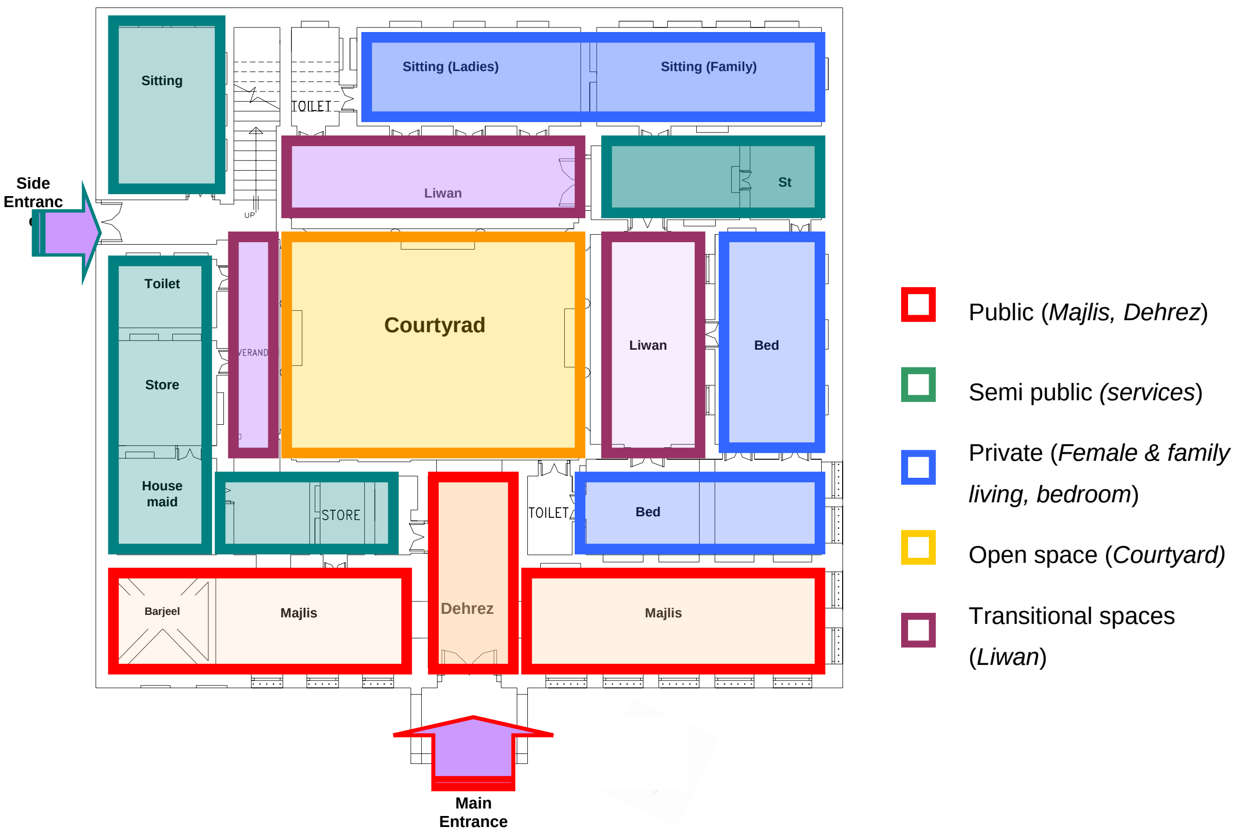


Figure 6.25-Schematic analysis for space organization in a traditional house in the UAE

(Source: the author)

Sleeping spaces in Islamic vision are regarded as sacred places (Mortada, 2003, P.105). Thus, sleeping spaces were carefully designed and located in a place that keeps its privacy and isolation from other spaces in the house. The sleeping unit is called sometimes *bait*; it was designed as a sleeping quarter for parents with corners for sleeping, sitting, bathing, and coffee making.

The transition between *bait* as a private space and courtyard as public was carefully designed. The *bait* was more private than the courtyard and therefore there was a layer of transition in between them. The transition was through the *liwan*. The *Liwan* sometimes had screens to create a layer of privacy from the courtyard because servants for maintenance sometimes occupied the courtyard (Khawaja, 2002, P.10). The *liwan* with its screens provided a private open shaded living space to the family for sitting, eating, and taking tea - Figure 3.26.

Figure 6.26- Liwan and upper logia were provided with screens to keep privacy for external activities
(Source: the author, 2005, 2006)

b. External facades:

The elevations were almost plain without any projecting surfaces, with some openings arranged in a rhythm to provide a certain relation between solid and voids especially in the absence of proportions (Bukhash, 2000, P.35).Windows in the ground floor, should be high enough to prevent street passers-by seeing inside the house. According to traditional jurists and judges' rulings, ground floor windows must be placed above eye level on the street side. The windowsill should be seven *shibers* (abut 1.75m) above the ground level and if a bed or deck is beside the window then the height may reach 2.5m (Hakim, 1986, P.34) – Figure 6.27.

Figure 6.27- Solid elevation with small openings to keep privacy of the indoor spaces

(Source: the author, 2005, 2006)

Even upper windows, balconies, and roof parapets should not be a source of visual intrusion to nearby houses, thus they were often fronted by elaborately carved bays and protected from the harsh sun and prying eyes by carved wooden louvers – Figure 6.28.

Figure 6.28- Balconies, projections, and parapets were well screened to keep privacy

(Source: the author, 2005, 2006)

House Entrance: The main house entrance, called Bab Al-Kabir (the big door), was used to welcome guests and visitors, especially men. The main entrance was characterized by being bent or twisted in a certain way to protect the houses from the intruders' eyes, and not to lead straight to the courtyard of the house, so as not to expose what is inside, despite the fact that the doors were kept open. This is a common feature of Islamic house entrances- Figure 6.29.

Big houses usually had two entrances, one on the front side and one on the other side or backside. The private entrance, called *Bab Al-Saghir* (the small door), was more private and used in handling the daily affairs and needs of the house, and often as women's entrance. The *Bab Al-Saghir* was the back or private entrance of the house used exclusively by the family. The *Bab Al-Saghir* discretely opened up into a back alley and women would usually use this entrance to go to visit the neighbours. The *Bab Al-Saghir* provided the family with a private way to leave and enter the house without being seen by visitors. This allowed the women to be more mobile and the *harim* spaces to be more independent. The *Bab Al-Saghir* did not have to have indirect entry sequences and screens to protect the *harim* as it was an exclusive entry, but sometimes-visual barriers were used (Khawaja, 2002, P.8).

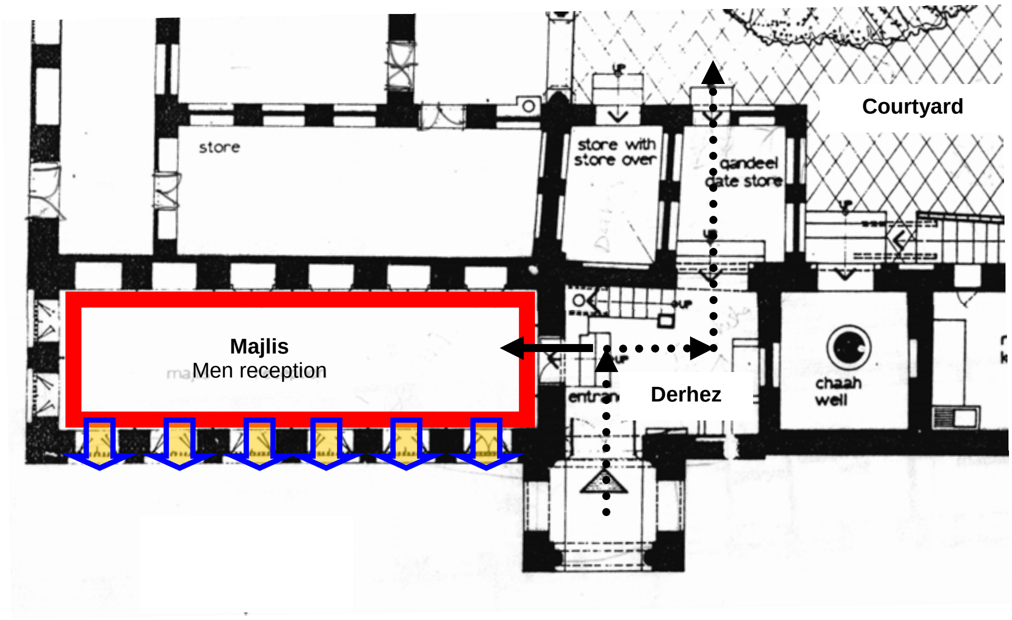


Figure 6.29- Direct access to Majlis and indirect courtyard access to conserve privacy (Source: the author)

The main entrance, usually for male visitors, leads to *dehrez,* which is the main entrance lobby that almost never provided a direct view of the private spaces of the house – Figure 3.20. Privacy was provided by using a turn in the entrance, a screen or a door. If the screening door opened to a courtyard, it was called *Bab-Al-Hosh*. The *Dehrez* led male visitors to the *Majlis*. The *Dehrez* was usually equipped with a *Mawqed* (a place to prepare coffee) from where guests were served coffee from a *Dallah* (coffee pot) – Figure 3.25. The *dehrez* also had easy access to the *Matbakh* (kitchen) and a *Zaweya* (washroom). The washroom was important not only because it provided a place to wash before eating but also provided a place to perform ablution before praying. If access to a kitchen is not possible then a place to prepare at least coffee for the guest must be located in the vicinity. This ensures that the *dehrez* with its own self-sufficiency in serving the guest and causes less trouble for women work (Khawaja, 2002, P.8) – Figure 6.30.

Main entrance lobby (Dehrez) Main entrance door Arched entrance

Figure 6.30-Main entrance designed to welcome guest and keep family privacy

(Source: the author, 2005, 2006)

To ensure a visual connection for women to street life various devices were used. Some devices such as peek-downs provided a place to peek down into the street from above and maybe lower a basket to buy goods from a street vendor. Instead of normal windows, a special window niche space called *qbu* was used on the upper floors. These qbus allowed women to sit and look down onto the street and maybe catch a breeze. Projecting bay windows such as *Rawshans* functioned in a similar fashion and provided breezes, views and controlled light (Ragette, 2003, P.77).

The use of roof was an important part of living in traditional houses, especially if courtyards were not available or not private enough. The roof also provided a vital connection to the street life below. The parapets were usually high and decorated with screens. Women would often flock to the top and peek down at the activities taking place. The roof was also used as a place to play when the courtyard may be unavailable. Sleeping on the roof was a ritual in hot and humid summer nights when the inner rooms may be unbearable.

c. Acoustical privacy

Keeping acoustical privacy was as important as the visual privacy. Thus, building envelope (walls, roofs, and floors) should not allow the penetration of the inhabitants' voices, particularly females', to streets and neighbours. This principle is based on the Prophetic prohibition of listening clandestinely to people's conservation without their knowledge (Mortada, 2003, P.106).

The acoustical privacy was achieved through house design that was composed of three spatial zones: public (male), semi-public (service), and private (female & the family) that were connected through the courtyard. This layout guarantees acoustical privacy between zones, as well as the outside and nearby buildings. Building envelope was good acoustical insulation by its massive materials as stone and brick

6.2.2.2. Social Relationships

Islam recognises that humankind cannot live without social intercourse. Therefore, it values social relationships in order to limit isolation of people from each other, and strongly encourages social life on a wide or communal scale (Mortada, 2003, P.20). Clan loyalty supersedes loyalty to the state, it is the clan which assures individual's security and hence the physical grouping of families and clans. However, the merging of religious and temporal matters, the importance it places on unity, the concept of *ummah*, which transcends tribe and race, result in a unifying effect on Muslim society (Ragette, 2003, P.19).

The city urban fabric and residential clusters were set in a way that greatly contributes to the accomplishment and enhancement of the social interaction and strong neighbourhood relationships. This was demonstrated in attached and nearby houses and close clusters (Mortada, 2003, PP.80, 81). Social coherent relations in the UAE society reflected in the appearance of houses and the way they were built. They were linked together, separated only by narrow lanes (*Sikka*) (Ghubash, 2003, P.5).

a. Hospitality

Hospitality and guest honouring is one of the distinguished characteristics of UAE people. This was driven from the original qualities of Bedouin and tribal norms. Wealthy merchants' houses were open to guests, even passing travellers and even strangers where people could stay for days or weeks on the owners' expense. Thus, the guests' quarter was essential part of traditional houses in the UAE and was provided with all the possible facilities the guest may need for eating, sleeping, washing, and bathing.

The *Majlis* is a key element of hospitality in the traditional house. Male visitors of the house are redirected from the *dehrez*, received, and served by their host in the *Majlis*. A separate room exclusively for the male visitors ensures that they are not exposed to the *harim* spaces. Usually located on the ground floor, the *Majlis* is one of the few rooms in the ground level of the house that has windows to the outside. Rich families of UAE national hold public receptions on special occasions such as *Eid* (religious festival) or a wedding and anyone can attend gatherings at this reception (Khawaja, 2002, P.9) – Figure 3.31.
Some rich merchants' houses may have two *Majlis'*, one on top of the other. The one on the ground floor, the winter *Majlis* was directly accessible from the *dehrez* and the one on top, the summer *Majlis* could be reached through a special staircase inside the *dehrez*. Creating

two, one on top of the other solved an environmental problem and at the same allowed access to the top *Majlis* to remain with in the *dehrez* without comprising privacy. Such design solution show the how sustainable the traditional house is; it attained environmental and social sustainability dimensions in a creative practical and simple way.

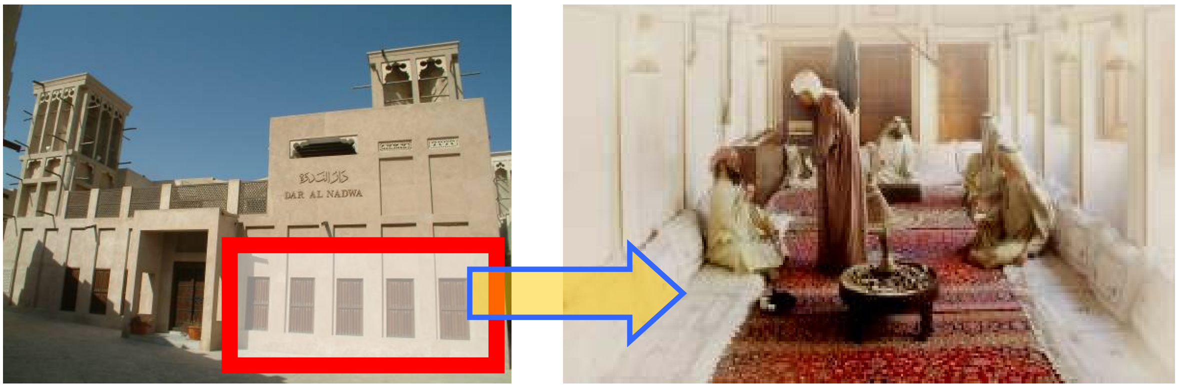


Figure 6.31- Extrovert looking openings o f the Majlis where male guests are welcomed
(Source: Dubai Municipality, 2005)

b. Guest honouring

As a tradition to guest honouring, the housemaster serves the meals himself and does not partake in the meal until his guests have finished eating. Food is served on large metal trays placed on low stools or on the ground and is consumed while the diners sit on carpets. This arrangement affords greater flexibility than if a dining table and chairs are used (Hinrichs 1987, P. 134, 135).

Usually, the *Majlis* was the biggest space in the house, about (3.9m* 6m) (Bani Essa, 1999, P.27). It was also the most well decorated room of the house as it was a status symbol for the owner. The *Majlis* is the perhaps the most public domain of the house and therefore requires to be treated as such (Khawaja, 2002, P.9).

6.2.2.3. Neighbourhood

Islam exceptionally looks at neighbourhood as the backbone of *ummah*. Islamic *ummah* refers to the group of people who accept the principals of Islam with coherent and clear, symbolic universes embodying Islamic values and rules regardless of any radical, social, geographic, or other differences (Mortada, 2003, P.19). This is exhibited in the provision of a set of ethics which themselves are obligations that enhance and control neighbourhood. Theses ethics are found in two main principals: strong neighbourhood relations and the preservation of neighbour’s rights (Ibid, P.27).

a. Strong neighbourhood relations

Islam asks Muslims to establish strong social closeness in which each one can depend upon the other and regards his life, honour, and property as safe among his neighbours.

Neighbourhood planning and design was the product of social relationships and cultural evolution. The organic pattern of neighbourhood planning provided different spaces and atmospheres for living. Public and private spaces were clearly defined and respected. This type of planning provided environments according to human needs and evolution of human relationships. Residential districts were spread apart allowing different tribal clans to cluster together and expand their territory as needed. The streets were narrow, 3 to 4 meters in width, providing a convenient space for people to walk and interact. Public spaces were provided away from the houses for tribal gathering and activities to take place. Each clan of a tribe used to cluster together in neighbourhoods providing alliance and territoriality for its members. These were important aspects of group relationships with status and power implications (Mahgoub, 1997, P.12).

The clustering of the houses reflects the strength of the social fabric that binds neighbours in the one street. Our Prophet, Mohammed (PBUH) said: “JIBRAIL continued to emphasize to me the necessity to mind and care for the neighbour till I thought he will be a pointed as one of the heirs “. The door should not be set aside from the opposite door at an adequate distance to eliminate the harm created by direct overlooking (Hakim, 1986, P.38).

b. Preservation of neighbours’ rights

In Islam, an individual must not overlook a neighbour’s property nor is he allowed to interfere wilfully with a neighbour’s right of access to his property even though the street fronting each house is private up to the centre line of the alley or the street. In addition, he cannot deny the use of an external wall by his neighbours and must even allow them to place a load-bearing beam into it, as long as the builder does not physically damage the property in question. Islamic laws favour neighbourhood interests rather than the interest of the community at large. For, example, a citizen must ensure free passage in front of his house to his immediate neighbour, but he is not required to make allowances for through traffic to ease accessibility from one neighbourhood to another (Hinrichs, 1987, P. 132). As a Muslim society, preserving neighbours’ rights was evident in traditional neighbourhoods in the UAE.

6.2.2.4. Family

According to Islam, the relationship between family members is not temporary, but permanent and enduring. Family members are expected to make serious and sustained efforts to live together and plan their role in society (Mortade, 2003, P.32). Therefore, extended families were common in traditional Muslim societies where respect and care for elder people is essential within the family border.

Traditional communities in the UAE were nuclear, they expand as the communities grew and new families formed. Thus, houses were close to each other within the neighbourhood unit upon family, social, and tribal relationship. This social solution was of great climatic advantage for creating a durable comfort environment within the harsh climate.

a. Strong family ties

The residence would include accommodation for the grandfather and the grandmother which will be a suite comprising a living room, bedroom, children room, bathroom & store. Married sons and daughters would also have their own suites and which would be similar to those of the Grandfather. Expansion of these houses will take both a horizontal and a vertical pattern to provide an additional accommodation for children, their wives and for the grandchildren. It was not common for a son to leave the family after marriage and for this reason; the house was made up of many sections according to the numbers of the family. The Grandfather would be the head of the family and would enjoy the love and respect of all. He would play an influencing social role and would normally direct and advise his sons on various aspects. Upon the travel of one of the sons, the Grandfather would normally take care of his son's family. This in itself gave a sense of security to the family (Al-Rostomani, 1991, P.167)

Strong family ties allowed related families to live together as one big family. This required flexibility in spatial arrangements and multifunction spaces. When one compares the various spatial elements of the courtyard house with those of occidental house, a great difference in their spatial origination is realised. This difference is largely attributable to the different perception of the house's function. The traditional house does not have a bedroom or dining room, but most principal spaces have multi-functional uses. The Muslim urban dweller does not perceive the various space of his house but views each space in the light of its optimum usefulness with respect to season of the year and time of the day (Hinrichs 1987, P. 134, 135). As a result, the particular area of the house, including the roof space that offers maximum comfort at a given time is utilised. A room that is used in winter as a bed-sitting room become in summer only a living room since roof terraces are cooler and more desirable for sleeping. Family meals are not taken in the occidental manner but, as mentioned before, food is served on large metal trays where family members can be close together while having their meals. In extended families, the grandfather, his sons, and the old grandsons used to have meal first then women and children.

House area and number of spaces varied according to family size and the social changes that occur during family growth. House form changed through years to fit to family needs, thus flexibility was evident in traditional house to accommodate to future expansion and spatial modification. Flexibility and adaptation is one of sustainable house design principals to extend the building lifespan through expansion and reuse.

The flexibility in using spaces includes open outdoor spaces as well as internal. The court known by many other names such as *hosh* and *hawiyah* from the Arabic word "*Hawa"* that means "contain" resembling the courtyard as the house container where house spaces are open. The courtyard is the centre of the family daily activities being the only open space the family had. The children would play there and the women would do the domestic work while supervising them. The family even took meals on pleasant days and it also proved to be a good reservoir of cool air and hence was preferred for sleeping. Thus, the courtyard is considered the heart of the family life; it is similar to lungs through which all the house elements breathe.

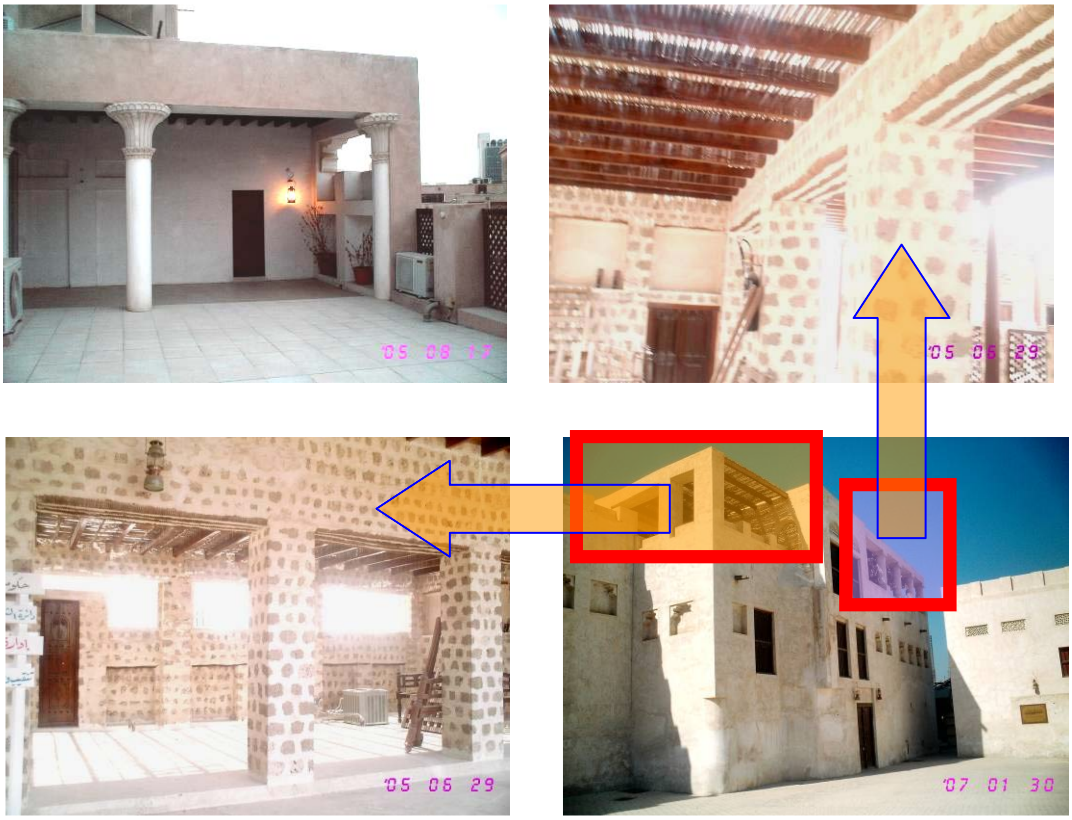


Figure 6.32- Roof is covered partially to be used as an outdoor space in summer

(Source: the author, 2005, 2007)

In the cold season, occupants used a room called "*Makhzan*"; it is considered the winter residence. The room is without windows to prevent cold breezes, yet it is provided with roof openings that, along with the wall upper *masabeh*, provide natural ventilation and to get rid of toxic gases that are released from wood stoves used for heating (Bani Essa, 1999. P.29).

In hot season, the roof was used for different functions. The use of the roof was an important part of living in traditional houses, especially if courtyards were not available or not private enough. Sometime there is a room called *Ghurfah*; it was used in hot periods, with walls opened from the top to provide natural ventilation along with air pullers (Bani essa, 1999, P.30). The roof also provided a vital connection to the street life below. The parapets were usually high and decorated with screens. Women would often flock to the top and peek down at the activities taking place. The roof was also used as a place to play when the courtyard may be unavailable (Khawaja, 2002, P.13). In hot and humid summer nights when the inner rooms may be unbearable, people change the sleeping area to upstairs or the rooftop in order to obtain a cool night breeze during the hot summer season – Figure 6.32.

b. Extended family

The traditional tribal system even makes a young man's choice of his bride largely unnecessary because he had in any case a first option for the daughter of his paternal uncle. Most marriages formerly were between close relatives to guarantee the continuity of the economic unity of the family (Heard, 1978).

Traditionally nationals of the country have lived in a joint family system. To keep family privacy, each nuclear family has its own quarter called *bait*. The *bait* may be considered as the basic living unit of the house where, each *bait* becomes the living unit of the smaller families within the larger family. Bait can be sub-divided in the following components:

1. *Tidumi* (dayroom)

   Sometimes the *bait* was divided into a separate room called a *tidumi* this was used at daytime as a multipurpose room. The *tidumi* opened into the *sabat*. Women might even receive guests there in the absence of separate women's *majlis.* Smaller houses did not have *tidumis* but it was always preferable to have one.
2. *Jadumi* (sleeping room)

   The inner room after the *tidumi* was called the *jadumi* this was a more private room where one would sleep and keep a chest with personal belongings. In a sense the *tidumi* would act as a transition to the *jadumi*.
3. *Zaweyah* (bathing room)

   Each living unit preferably had an attached room for bathing called *zaweya*. Sometimes a *mostarab* or toilet would be added as well but due to the lack of extractor systems available at that time this was usually avoided. The reason for doing so was not just for the sake of convenience but also for self sufficiency. The *zaweya* ensured that a married son and his bride living with his parents could live independently in their living unit (Kjawaja, 2002, P.12).

The *bait* should not be thought of as a mere bedroom in the modern context, but should be looked at as a unit where one can live – Figure 3.33. It must therefore be able to accommodate a place to sleep, work, sit, wash and perhaps relax. The zones should be clearly defined or if space constraints prevail, the room should be transformable to adapt to various functions.

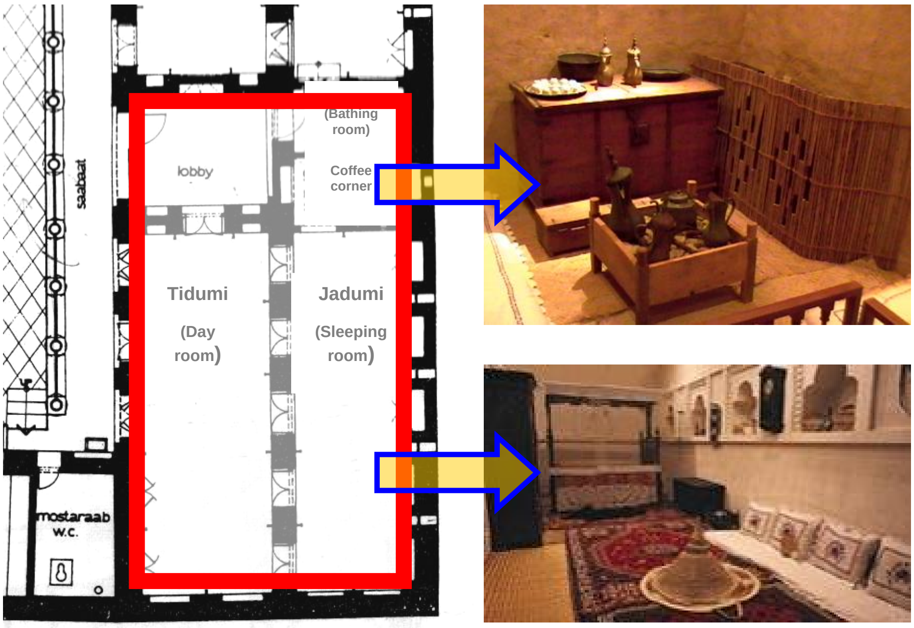


Figure 6.33 – Bait is the basic living unit t in the traditional house in the UAE

(Source: the author)

6.2.2.5. Identity & Social Status

Islam is a faith born in a limited resources environment; it calls for understanding of human frailty within God's creation, thus it abhors waste, ostentation, and superfluity (Ragette, 2003, P.19). Humility, as a social principal in Islam, is not just applicable to the personal behaviour of the individual Muslim, but also to his house. Thus, Islam forbids self-aggrandisement and extravagance in al matters of living (Mortada, 2003, P.116).

In Islamic norms there are no differences between rich and poor; the only difference is based on the degree of piety and how near and mindful of God man is (Al-Rostomani, 1991, P.67). The notion of *ummah*, fellowship of all believers, leads to an egalitarian society. Although there are differences between poor and rich, everybody is equal before God and has to submit to His will. The individual should only act as member of a group; here is no notion of the autonomous individual (Ragette, 2003, P.19).

a. Humility and Self-advocacy

The Islamic prohibition of self-advocacy or conceit via exaggerated spending on the house is driven from the Islamic point of view on the purpose of housing, which is providing shelter from climate and provide security, privacy, and safety (Mortada, 2003, P.117).

Modesty dictates that wealth is discretely displayed to the outside, maybe just by an ornate door design. Although rich people were able to afford for imported materials and skilful artisans, and their houses were decorated with stylish design and ornaments; this advocating of richness was not seen in external elevation treatments or overall design. The rich men's large houses can be observed amongst the clusters of houses and beside the humbler small houses and without any distinctions whatsoever. The sophisticated decorations and ornamentations were only found in interior spaces, columns, windows, doors, and architectural details. This attitude was a response to Islam call for humility, simplicity and equity between Muslim society members.

Generally, traditional houses were not to exceeded two stories, for luxurious and multi-storey buildings were considered symbols of pride and arrogance and represented homage to material things (Hinrichs, 1987, P. 132).

b. Revealing social status

To reveal their social status, Sheikhs and merchants were able to employ well-known artisan and craftsmen; they exhibited their skill in the decorations and ornamentations of various internal and external' corners of the house (Al-Rostomani, 1991, P.166). The richness of inner spaces via the external ones was the main trend in dealing with spaces in term of decorative issues. The flat geometrical or floral panels poured on flat surface were the basic elements for decorating the walls and over the doors of the main functional spaces (Bukhash, 2000, P. 34). Elaborate sculpted plasterwork was often used as a decorative device but wood ornamentation is thought to be an even older art form. Both wooden and plasterwork screens give a certain amount of protection and privacy but also diffuse and deflect the harsh sunlight so that a pleasing pattern of light and shade is achieved (www.uaeone.com – last accessed 14-07-2005).

Islam forbids the imitation of any figurative or life-like forms; therefore, the Muslim builder and artisan in the UAE were totally committed to the teaching of Islam and concentrated on other fields that did not conflict against their beliefs. This is evident in the Islamic art found in all-building types including houses, in crockery and household utensils, in the decorations on their ornaments, in carpets, furniture and in various aspects of their life. Decoration was directed into ornamentation depicting orthodox geometric patterns (circular, squarest, hexagonal, octagonal shapes), floral design (branches, leaves and flowers), and the Arabic calligraphy. Decorations were mostly done with gypsum (Claustra) and wood (Mashrabyahs); they were used in the decorations of doors, windows, verandas; also in columns bases in arches where geometrical and botanical decorations are used. Decorations were also used in wooden doors and windows, in the internal and external corners of rooms, and in parapet walls. Ceilings and house corners were decorated with circular and pointed arches; and stalactite ornaments of colourfully differing shapes and sizes (Al-Rostomani, 1991, P.166). Even the *barjeels* were normally decorated and figures prominently in the ornamentation of the building – Figure 6.34.

Figure 6.34– Decoration are added for different features in traditional houses in the UAE

(Source: the author, 2005, 2006)

The main door is an important element in traditional architecture because it is the first threshold from the public street to the private realm of the house (Khawaja, 2002, P.6). The door symbolized the status of the owner and therefore had to be big and beautifully decorated. At the same time in the densely packed urban surroundings, there was no difference between the house of the poor and the house of the rich from the outside. The entrance had to be small for privacy and protection, and in the same time had to be welcoming and indicates the owners' status; this dilemma was solved by creating multi-leafed doors. These doors were composed of two large leaves opened only on special occasions and a small one incorporated in to one of the large leaves, used as the normal door called *Rawzanah* (Dubai Municipality, 2004, P.57). To enhance the status of the owner, the doors were further framed in decorative work to make them appear visually larger utilising woodcarving or elaborate ironwork. Often the interior plaster finish is simply carried to the outside like a doorframe for accentuation. The door can be magnified with masonry designs around it, involving frames, friezes, and arches (Ragette, 2003, P.75) - Figure 6.34.

6.3. Environmental and Social Sustainability Dimensions in Contemporary Houses in the UAE

The successful selling of western ideas, in the Arab World, as well as the UAE, depended on the assumption that western methods are superior to their own. Thus, the traditional social and cultural validity is lost in the transition of form from the family cluster to the rigid layout. The change of materials decreases the climatic performance of the new house and increases its costs beyond the range of most people. It also places the building of the house out of the owners' control (Cain, Afshar, & Norton, 1975, PP.208 -209).

Unfortunately, contemporary houses in the UAE followed imported design trends that were not adequate to natural environment or nationals' social values. The main conflict appeared in trying to accommodate extrovert design to privacy doctrines that are essential to UAE society. Analysing contemporary houses in the UAE from a sustainability standpoint will be accorded the same methodology followed for the traditional houses.

6.3.1. Environmental Sustainability Dimensions

According to SEAM area of assessment criteria proposed in chapter four, environmental sustainability areas that contemporary houses in the UAE will be discussed and analyzed will be site, energy, resources, indoor environment, and water and waste.

6.3.1.1. Site

Site treatment within modern urban planning or archliberal design concept did not take the importance it used to have in traditional urban fabric. Building regulations, new building materials, artificial air-conditioning, and modern lifestyle were of great effect in site treatment.

a. Site selection

As one of the federation government goals, providing an appropriate house for all nationals required great areas of lands for residential use. Each emirate citizen has the right to receive a residential plot by reaching the age of twenty. All these residential sites were new and were not used before. Definitely, this expansion was necessary because of the limited population and area of the traditional urban settlements in the UAE. The economical and social boom and the high demand for housing can validate this policy; yet the exaggerating in plots size was not justified and unsustainable because it consumed the natural resources in within limited time. Sustainable development strategies tend towards Brownfield use in an attempt to keep Greenfield sites as long as possible.

b. Urban Fabric & Architectural Planning

Since the affluent educated class (the economic boom) are generally the first to adopt foreign customs, many *mahallahs* (neighbourhoods) have lost their wealthier residents, who have long since moved to better sectors of the city. Furthermore, the housing policy for new residential areas favours the open-ended street pattern of occidental cities and suburbs in spite of the land use efficiency of the indigenous neighbourhood. The upper income residential districts, are made comfortable even in extreme climatic conditions with the help of air conditioning systems and water which enables a degree of lush landscaping unaffordable to the average urban dweller(Hinrichs, 1987, P. 138).

The large modern residential districts accommodate the new inhabitants' life style. Private cars, the main transportation mean, became an essential part of the culture, replacing the organic urban fabric. The organic nuclear urban planning became an imported gridiron. Attached courtyard houses became detached rows of houses in modern urban planning systems. These new suburbs are usually designed by well-respected Western architects and town planners to incorporate new and wider streets that provided no relief from the intensive heat.

The open-ended street pattern and occidental urban spatial standards, along with the segregation of income groups, is contrary to the Islamic principles of environmental harmony and is incongruous with the climatic realities of the Gulf region as well as the Arab World (Hinrichs, 1987, P. 139). The modern urban planning was characterised with excessive land use especially for streets and open spaces; sometimes they exceeded 50% of the residential districts while they are not utilised efficiently (Dubai Municipality, 2004 December, P.30).

Orientation: Plot orientation is not related to any environmental considerations. The gridiron-planning pattern was based on expansion towards available sites. Thus, the plot orientation varied according to its location in any direction regardless of any climatic constrains.

Plot size : The plot sizes are higher than the world standards; the plots area varied between 630 m^2 (7000 ft^2), 900 m^2 (10000 ft^2), 1350 m^2 (15000 ft^2), and even reached 1800 m^2 (20000 ft^2). This excessive land use led to high consumption of the urban plots, which caused to great shortage in land supply. According to a study held by Dubai municipality, the plot size policy consumed about 8.5 hectare to the current built-up area in Dubai. By 2015, Municipality has to look for new lands beyond the city urban zone, if the plots area and housing policies remained the same (Dubai Municipality, 2004 December, P.29).

c. Site planning

According to building regulations set by local municipalities, the plot coverage had to be no more that 40- 60% with compulsory set back from the four sides no less than 3-6 m (Dubai Municipality, 2001, P.83). These regulations led to building the main house mass at the plot centre leaving open spaces all around the built-up area. The open spaces were usually paved to fit the several cars each family owns and to eliminate the high cost of garden maintenance in such a hot climate as the UAE.

Design Concept: Contemporary houses in the UAE are almost the direct opposite to traditional ones. They no longer look inward to the open central courtyard, but are built in a solid block in the middle of their plot surrounded with paved open spaces and gardens. Large windows let in the light without letting out the heat, and the walls are painted brilliant white since the glare is no inconvenience (Kay, 1993, P.34).

Because of the large-size plots, sometimes the plot coverage area is only 20% for two-story houses and 35% for one-story house (Dubai Municipality, 2004 December, P.52). These big open spaces were mostly paved causing environmental disadvantages as light reflectance and heat emission. If these spaces were planted, they cost a lot and require continuous maintenance especially in the long hot season.

Building Orientation: The building orientation is not taken into account; especially with the setback from the four sides allow the building to be exposed to the sun from all sides.

Building Mass: Introvert attached courtyard houses became outward detached houses. The freestanding house has likewise displaced the courtyard house type that went along with the older pattern. Despite its unsuitability for the climate and the lack of privacy and related inconveniences following on from the loss of the traditional internal open space, the single-family house is the preferred status symbol for old and new generations alike in the Gulf region including the UAE (Abel, 2000, P.175)

6.3.1.2. Energy

Contemporary houses, designed as blocks with large glazed openings, are completely dependent on air-conditioning and artificial ventilation because they were not designed to accommodate to the local climatic conditions. Thus, these houses are consuming large amounts of energy using up the limited non-renewable resources of the country (Mahgoub, 1997, P.11).

a. Carbon dioxide (Energy consumption)

Domestic buildings are one of the most energy consuming sectors in the UAE. The average energy use per area in domestic buildings, show less sustainable measures in terms of energy features, energy performance, and environmental features. The increased level of the domestic electricity consumption is owed to a large degree to the air-conditioning, which is a major source of electrical energy consumption in the UAE. During the summer months, air-conditioning requires up to 70% of the total energy produced (UAE yearbook, 2006, P.190)

The domestic sector got the priority (32%) in energy consumption in the UAE after the commercial (40%) – Chart 6.1. This means that more than one third of power consumption is used for houses air-conditioning and services especially in the hottest months (July, August and September) where the monthly peak load reached 3000 MW/month (www.dewa.gov.ae – Last accessed 31-03-2007). Those figures show clearly that contemporary houses, constructed with modern building materials, had a negative affect on buildings thermal performance. Consequently, electricity bills take the priority in houses operation costs with its negative effect on environment.

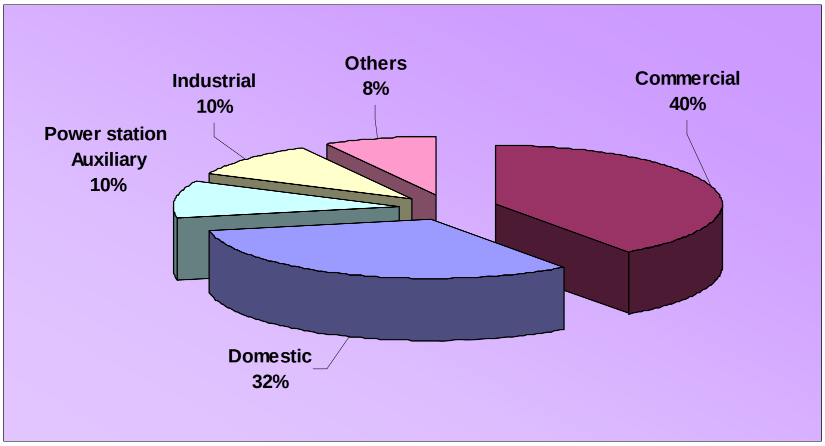


Chart 6.1. - Power Consumption average in the UAE

(Source: the author based on UAE Yearbook, 2006)

b. Renewable energy sources

Total installed electricity generating capacity in the UAE amounted to 12,800 megawatts (MW) at the end of 2004. This will increase to 19,400 MW by 2010 to meet the 6-7 % annual growth rate in demand dictated by the ever-escalating needs of industry and private consumers. Approximately 97% of production is fuelled by natural gas; diesel generation or steam turbines produce the remaining 3 % (primarily in the Northern Emirates). The emirates of Abu Dhabi, Dubai and Sharjah are responsible for 90 % of capacity, with 14 federal plants in the smaller Northern Emirates accounting for the remaining 10 % (UAE yearbook, 2006, P.186). This means that the high-energy consumption in buildings sector, especially domestic, depends completely on non-renewable energy sources with all the environmental disadvantages as resources depletion and air pollution.

Yet, there are some efforts to build renewable resources power generation plants. Some enterprises in the UAE are specialized in alternative power solutions to meet the energy requirements of the region with solar, wind energy, and power backup systems. Therefore, some installations in the UAE were carried out and they are characteristic examples of how RES can help country's daily activities in order to be in total harmony with the surrounding environment. Most of these RES projects concern the design; manufacture, supply, installation and commissioning of solar power systems and solar photovoltaic systems projects (Doukas & Others, 2006, P.766).

c. Building Fabric (envelope)

In the 1950s, new materials became available at the UAE market, imported from abroad. Cement was to make the biggest difference of all for it was much easier and quicker to use; in the 1970s cement factories were built in emirates and production soared. Glass was also to change the style of domestic architecture.

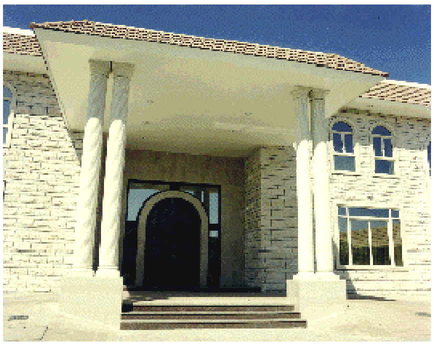


Figure 6.35 – Building materials and construction systems in contemporary houses in the UAE

(Source: The author, 2005)

Building materials: In a contemporary house, the building envelope lost its effectiveness as a thermal barrier and harsh climate modifier. It is not sustainable for it necessitated artificial air conditioning; this means more energy and resources consumption to control the indoor environment. The long-term energy costs of operating a building are heavily dependent on the materials used in its construction.

Use of imported materials, such as concrete, steel, aluminium and glass, is the common practice in contemporary houses in the UAE. Dependency on non-renewable imported materials that are not suitable for the climate of the region requires continuous costly maintenance and artificial air conditioning, which means more energy consumption to control the interior environment (Mahgoub, 1997, P.11). Thus, power (electricity) consumption in the UAE is considered to be one of the highest in the world.

Construction systems: Skeleton structure is the main construction system used in contemporary houses. This system employed the modern building materials as concrete, steel and glass. Most of the houses are built with skeleton structure, reinforced concrete columns and beams, roofs of R.C. concrete slabs, distance between columns filled with walls built of concrete blocks, ceramic brick and lately insulated brick is used to improve walls thermal performance. Internal surfaces are finished with gypsum plaster, roofs usually decorated with plaster ornamentations, and floor finished with marble or ceramic tiles. External elevation plastered with cement screed that is painted with fancy colours or faced with expensive imported finishes as marble or stone- Figure 6.35.

6.3.1.3. Resources

The modern developments in the UAE are linear requiring consumption of more resources for infrastructure and transportation. Moreover, the improved economy in the country has created a consumer society with emphasis on material rather then social and cultural aspects of development (Ghubash, 1993, P.11).

Modern architecture required the use of numerous resources, many of which are not available in the region. Building materials, construction methods, workforce, and building design are all imported from foreign countries. While the revenues of local resources are high at this moment, they are limited and non-renewable. Consumption of local resources is very rapid. Little attention is given to issues of recycling and reuse of waste materials (Mahgoub, 1997, P.16). Demand for power (electricity) is also on a steady rise in the UAE and is expected to reach 14,600 MW in 2010; the current installed generating capacity is around 10,000 MW (www.youthxchange.net – last accessed 31-03-2007)

6.3.1.4. Indoor Environment

Contemporary houses provided comfortable indoor environment for occupants depending artificial methods. These methods are the contrary of the passive methods used in traditional houses utilising natural resources.

a. Natural Ventilation

Fresh air supply and adequate air change within living spaces is essential to obtain healthy indoor environment. Unfortunately, natural ventilation, in contemporary houses, is not one of the design priorities. It does not take the care necessary for social issues such as privacy and social status, decorating, furnishing, and external elevation treatment. Even the large windows that are sometimes provided with shaded and thermal glass are not fully opened due to privacy reasons especially the first floor windows. Thus, these windows do not provide adequate cross ventilation within internal spaces. Other natural ventilation systems as wind stacks or the old barjeel mechanism are not applied in contemporary houses.

b. Indoor air quality

Indoor Air Quality (IAQ) is the aspect by which we define a good environment; that is why associations have come up with standards to define and regulate the quality of air inside a building or a house. No official figures are published about indoor air quality in domestic buildings in the UAE. Yet, total dependency on artificial air-condition, manufactured materials, excessive use of chemical products as air perfumes and cleaning products and insufficient natural ventilation, would suggest that indoor air quality is not within world standards.

c. Thermal comfort

Contemporary houses enjoy comfortable indoor environment due to mechanical air-conditioning. This thermal comfort is artificial consuming a great deal of energy with high cost and negative environmental sequences. Air-conditioning systems utilised separate air-condition units, split units, or central chillers.

Recently, district cooling is widely used throughout the UAE depending on piping chilled water from a centralised plant to a range of residential buildings. This system has several advantages: maintenance-free, economic, environmentally friendly cooling benefits of the technology, ambient noise reduction and better temperature control in indoor environment. The energy savings could be up to 50% the total that consumers spend on traditional air-conditioners (UAE yearbook, 2006, P.111).

6.3.1.5. Water & Waste

a. Water Consumption

Historically, all the UAE's water requirements were met from groundwater obtained from shallow, hand-dug wells and the traditional *falaj* system of aquifers. Nowadays the supply of water comes usually from two sources, wells (ground water) and desalinated water. Moreover, there are constraints on utilisation of both sources. Over the past two decades, rapid economic development, coupled with steep population increases and a push to achieve self-sufficiency in food supplies, have placed ever-increasing pressure on the UAE's precious natural water resources (UAE yearbook, 2006, P.186).

UAE has one of the highest water consumption levels in the world compared to Western countries due to climatic conditions and high per capita income. Statistics of Dubai Electricity and Water Authority, (DEWA), show that the total production of water in 2004 was 61,478 MIG (million imperial gallons) and the total consumption was 53,504 MIG which is higher compared to other cities in the Gulf (www.dewa.gov.ae – Last accessed 31-03-2007). Water consumed for domestic use form 63% of consumed water in the UAE – Chart 6.2. Water demand in the UAE is expected to reach 790 million gallons per day (mg/d) by 2010 from current pick of 465 mg/d. UAE per capita consumption of water is estimated at 133 gallons per day (g/d), compared with 85 g/d in the USA (www.youthxchange.net –Last accessed 31-03-2007)

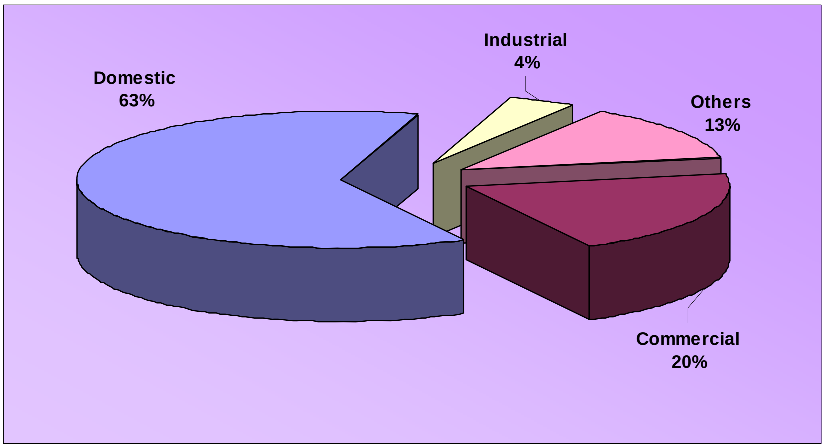


Chart .6.2. -Water Consumption average in the UAE
(Source: the author based on UAE Yearbook, 2006)

Desalinated water comes with a high price tag although it is produced by using associated gas. In 2002, the production of water was 181 billion gallons at a cost of Dh 3,426 million ($ 1 million), according to statistics provided by the UAE Ministry of Water and Electricity (www.drnicolemunk.de – Last accessed 31-03-2007). This is a challenge for a country with no rivers and little rainfall. The UAE is now the world third largest per capita water consumer after the US and Canada (UAE yearbook, 2006, P.186).

Water used for domestic facilities is quite high with the several bathrooms each house has, usually one for each bedroom besides the guest and Majlis bathrooms. These bathrooms are lavishly decorated using the finest materials and latest fittings and equipments. Bath fittings such as tubs, Jacuzzi, and water distributor are designed to provide maximum luxury consuming great quantities of water.
Moreover, modern horticulture has brought a wide range of exotic flowering shrubs and plants to fill the gardens surrounding the house, and modern skills enable palm trees to be transplanted fully-grown to the new gardens (Kay, 1993, P.34). This evergreen landscape consumes a great amount of water.

b. Waste

Due to the high-consumption life style, the UAE has one of the world's highest levels of domestic waste that has reached an average annual 730 kg/capita. Year. In 2002, the UAE total waste was 1.4 million tones; this is expected to rise to 2 million tones in 2008. Dubai was the highest average among other emirates that was 779 kg/capita. Year. The latest statistics issued by Dubai Municipality showed that the average has touched an all-time high of 941kg/capita. Yr. (www.uae.gov.ae/Government/environment. - Last accessed 15-02-2007). Dubai's waste production is considered quite high compared with 550kg reported by the European Union's Organisation of Economic Cooperation and Development (OECD) and a typical western European average of below 400kg, 875kg in the US, 680kg of Australia, 300 kg in UK, and 246kg in Italy (www.globe-net.ca/market_reports/index - Last accessed 15-02-2007).

There is no recycling or separation process takes place in houses. Municipal vehicles gather all the domestic waste where they are disposed in certain landfill sites owned by the local municipalities. Recycling, reuse, and disposal processes are done in these sites.

6.3.2. Social Sustainability Dimensions

According to SSAM area of assessment criteria proposed in chapter five, social sustainability areas that contemporary houses in the UAE will be discussed and analyzed will be privacy, social relations, neighbourhood, family, and identity and social status.

6.3.2.1. Privacy

The potential for privacy of traditional houses has been neglected in the contemporary house; instead, features have been replaced by western methods often inappropriate to local conditions and needs (Cain, Afshar, & Norton, 1975, P.207). Apparently, contemporary houses did not adhere to the traditional levels of privacy. The levels of privacy provided in modern architecture are reflections of the designer’s cultural background, point of view and personal experience. To achieve the desired levels of privacy, the individual employs measures such as fencing and avoidance of use.

Yet, and in spite of the modern lifestyle and extrovert design, the issue of privacy remained essential in contemporary houses design. This is obvious from the first glance. When we look to any contemporary house from outside, the first thing that attracts attention is the high fences all around the plot; they are usually solid, 2-3 m height to keep intruders’ eyes away. Privacy is still ensured in different levels.

a. Urban Planning & Design Philosophy

The main access to the plot is usually through sophisticated double doors in the middle of the high plot walls. Since streets are no less than 12m wide, the location of the main door facing the opposite plot door is common in contemporary houses. The outside wall function exceeds its role to determine property limits; it is the first step to keep occupants’ privacy and family seclusion.

House design values have been reversed in the Arab world, as well as the UAE. The centripetal plan wherein the family life looked into the courtyard has changed to a centrifugal plan with the family life looking upon the street. The serenity and the reverence of the space, violated. (Hinrichs, 1987, PP. 312, 313). Houses are extrovert; built as villas overlooking the outside garden with balconies and large glass windows (Mahgoub, 1997, P.13).

Figure 6.36. -Schematic analysis for space organization in a contemporary house in the UAE

(Source: the author)

However, some aspects of social values and family relationships still influence the design of the house; privacy is one of the most important. Privacy is fulfilled through gender segregation between public (men) and private (family and women) especially in the seating areas. As in the traditional, the house is divided into three zones according to privacy level needed. Public zone is located at the front of the house; it includes male reception (*Majlis*) with its own entrance. Main house entrance leads usually to a central hall where most of the semi-public spaces are located, as women reception, and family living. Service zone as kitchen, laundry, and maids' rooms are usually at the middle or back with its entrance and service yard. Private zone as family bedrooms and bathrooms are located in the back or in the first floor; it is usually provided with private family sitting area and even small kitchenette – Figure 6.36.

b. External Facades

External facades have little relation to the traditional. While efforts are often made to incorporate traditional features, there is less enthusiasm for local traditional designs. Contemporary houses are large, multi-faceted concrete buildings, painted brilliant white or even bright colours, and relieved by half roofs of coloured tiles laid over concrete slabs (Kay, 1993, P.35). In contrary to the traditional introvert design, modern extrovert elevations are transparent with big openings, porches, and balconies; they do not provide an adequate level of privacy. To keep privacy balconies are rarely used and openings are usually of shaded glass covered with heavy curtains to keep privacy.

The entrance tends to be monumental utilizing classical features arranged in a symmetrical pattern giving the expression of stability and monumentality. This impression of formality adds a sense of privacy; it formulates a barrier between the public outside world and the private family realm Figure 6.37.

Figure 6.37- Symmetrical elevations and elaborate entrance to reflect formality and monumentality in contemporary houses in the UAE

(Source: the author, 2007)

c. Acoustical privacy

Acoustical privacy is well reserved in contemporary houses. Building materials, construction systems, big open spaces around the house and the wide streets, provided high quality of quiet. Generally, modern residential districts are quieter than traditional; each house is isolated within its plot as a separated island.

6.3.2.2. Social Relationships

Social relations have changed a lot since the 1970s. Because of the luxurious lifestyle and high consumption trend, social relations between people became weaker and people enjoy spending times in malls and hotels eating and shopping even meeting their friends there instead of their own houses. Yet some social values remained strong as part of the UAE nationals' pride.

a. Hospitality

In spite of modern life style that people enjoy in the UAE, doctrines and traditions remained strong related to the tribal norms and Islamic values. Values as hospitality and guest honouring are essential as part of the nationals' personality and Arab generosity. Thus, house design had to retain a private section or zone for guests. Regardless of the economical status of the owner, hospitality and guest honouring are indispensable.

Guest room (Majlis): The Male guest space or *Majlis* remained essential in each contemporary house in the UAE. As in the traditional houses, *Majlis* is located in the front part of the house with its own entrance to conserve family privacy. *Majlis* should have its own bathroom, sometimes dining room and guest bedroom. Size of Majlis varies, but it is usually the biggest space in the house. Some wealthy people houses have a separated section or building for guests located near the front fence with its own entrance and full service as kitchen and bedroom(s). Women reception is usually located within the house spaces; usually near the main entrance.

b. Guest honouring

As mentioned, some social values are still strong in the UAE society; guest honouring is one of them. The Majlis is usually well decorated and furnished because it is symbol of the owners' hospitality and social status. On important social occasions such as wedding or Ramadan (fasting month), external tents are placed in front of the house to fit the large number of guests.

6.3.2.3. Neighbourhood

Current changes in architecture are not only affecting the appearance of buildings but also the social and cultural life of the inhabitants. The traditional neighbourhood, composed of relatives and clans, is now based on social class and income groups. Relationship between social groups is threatened by the fast pace of life.

a. Strong neighbourhood relations

Automobile dependant planning results, as in other parts of the world, where a monotonous and repetitive pattern of neighbourhood design occurs. Sense of neighbourhood is lost due to repetition of the surrounding environment. Planning for automobile dependant society produces large-scale environments that do not encourage human interaction. Modern developments are linear requiring consumption of more resources for infrastructure and transportation (Mahgoub, 1997, P.13). Neighbourhood relations are not strong, especially in high-class districts, while in rural regions or low-income settlements, neighbourhood relations are still strong somehow especially in social occasions as marriage, funerals, or festivals.

As a tribal community, UAE families prefer to live nearby forming a tribal or family neighbourhood. A young married son or daughter prefers to leave the family house and live in separated houses. However, their departure is geographically limited, and the family prefers that the separation involve setting up an independent house that is only a few metres away. The result is that most of the families belonging to one tribe live in the same neighbourhood or in the same street (Ghubash, 1993, P.14). This trend is encouraged by the government through providing citizens from the same family with nearby plots to revive the tribal neighbourhood with its social values, neighbourhood relations, and security advantages (Dubai Municipality, 2001, P.249).

b. Preservation of neighbours' rights

Concept of neighbourhood, as it was known in the traditional neighbourhood, is lost in the modern residential districts because of the big plots, high fences, wide streets, and busy lifestyle. The sustainable neighbourhood where people enjoy social life with others, working, studying, shopping, and socializing with others is not found in residential districts in the UAE. Yet, neighbours rights are well reserved where each family lives in its private isolated villa surrounded with its own realm.

In other districts, where multi-cultural families live, social interaction is limited due to the differences in background and social values. The neighbourhood as an active social community is not evident in modern residential districts; yet respect for others' privacy and ethnic variety is well preserved.

6.3.2.4. Family

Drastic economical and social development in the UAE since 1971 and the change in pattern of government from the tribal to civil rule has given the individual a feeling of security and protection through state institutions. People corresponded to political life, which attenuate tribal cooperation and solidarity. Individuals have become ambitious; with concerns abut raising their standard of living, even if this results in breaking away from their tribe. Individuals have become less concerned about loyalties to family relations and the tribe (Ghubash, 2003, P.10). However, family relations in the UAE remain stronger than other societies in other countries.

a. Family ties

The new life style and economic prosperity allowed people to live in big houses where each member in the family can enjoy his own private room, internet and TV set. This type of life affected family ties especially when the father is busy in work and most of the mothers spend their time in work and shopping leaving their children with nannies and housemaids.

The new facilities, electricity and air-condition, freed the designer from any environmental constraints, thus houses design could be different and spaces areas were much larger. Family life would no longer be lived outdoors in the central courtyard, but instead in a large air-conditioned entrance hall. Spatial arrangement has changed. The favourite living area is often an open hallway, and landing above, in the centre of the house. Rooms proportion has changed, they tend to be square instead of the limited span that was determined by the length of available rafters to the long narrow oblongs of the traditional spaces (Kay, 1993, P.34).

The houses are designed as final products not allowing its residents to modify or change them (Mahgoub, 1997, P.16). Contemporary houses are designed to fit to certain requirements, thus they are not flexible for expansion and modification. Besides, the lavish lifestyle, nationals live currently and the flourishing economical they still enjoy do not encourage people to think in the future and the possibility of modifying the current houses to more flexible ones.

b. Extended family

Communal living is gradually becoming limited to the phase immediately following the marriage of a son or daughter. Whereas living under the same roof, as parents are generally acceptable and a recognized principle for all unmarried people, it is no longer practised among newly married couples (Ghubash, 1993, P.15). Recently, due to difficult economic conditions, some young married couples returned to live with their extended families and lease their own houses to have use of the rent as an additional income to support the growing young family. Even if the reason to come back to family house is economic, it is a good sign to revive extended family values.

Some wealthy families build a group of independent houses surrounded by one fence. Each satellite house is built for the married male children around the main family house. Children within the extended family have free access to all houses, and spend most of their time together. Even when children live independently, they may visit the family house daily (Ghubash, 1993, P.15). This family housing grouping is usually provided with one big *Majlis* section near the main entrance. Sometimes this Majlis has its own entrance separated from the family's one; it is also provided with full services as kitchen, bedroom, and bathrooms.

6.3.2.5. Identity & Social Status

The successful implementation of western ideas depends on the assumption fostered in people in the Arab world, as well as UAE, that western methods are more appropriate than their own. Perhaps the most insidious affect has been their loss of self-respect & identity (Hinrichs, 1987, P. 138).

a. Humility & Self-advocacy

The values of humility began to weaken and self-advocacy became more popular between society members. The materialistic lifestyle made people tend towards exaggeration in possession and appearance. The humility and adjacent poor and rich people houses that were evident in the traditional city do not exist anymore. The loans given by the government helped the nationals to build big houses that became symbols of modernity and richness.

Figure 6.38 – Elevation treatment using classical features for contemporary house in the UAE

(Source; the author, 2006)

Some architects tried to incorporate traditional and Islamic features in contemporary houses as pointed or semi-circular aches for openings or wooden screens for shading. Few architects tried to be inspired by the spirit of traditional house design through implementing the central courtyard and natural ventilation systems in a new perspective. They tried to grasp the essence of the design more than mere facial masks of traditional elements that are added later as arches, screens, or false *barjeels*.

b. Revealing Social Status

Contemporary houses in the UAE are representing a social status or image. The design and cost of the house signify belonging to a social group. Social and economic mobility is usually associated with the design of the house (Mahgoub, 1997, P.) Unlike traditional house, wealthy people's houses became symptoms of today's imported social culture and values (Al-Rostomani, 1991, P.169). External elevation treatment is an important media to reflect owner's status utilising expensive finishing and bright colours. Most of the contemporary private houses are two stories. Imported features are utilised as symbols of modernity. Although it rarely rains in the UAE and never snows, pitched roofs covered with coloured roof tiles are commonly used on an entrance porch, above openings, or on the house roof – Figure 6.38.

Occasionally, and attractively, the house is faced with coloured stone or painted in some pastel colour picked out with white columns and details. A few complete estates of less grand houses have been built in neo-Tudor or neo-Georgian style, appearing unexpectedly among the scatters of palm trees and brilliant mauve bougainvilleas. The most popular design for the main entrance is the semi-classical one incorporating columns around the front door, or set in a two-storey entrance porch. Columns may also be used around an upper balcony or engaged against a front facade (Kay, 1993, P.35).

Figure 6.39 –Outdoor entrance and fences are symbols for social status in contemporary houses
(Source; the author, 2007)

Since most of the plans are symmetrical, the main house entrance is usually in the middle of the front elevation. It is usually two or three steps height to give the impression of formality and preparation to transfer from the busy outdoor environment to the private internal realm. The fence, marking territoriality and providing privacy, is an important part of the contemporary house. Fences are carefully decorated conveying an image of social class. The entrance plays an important rule in revealing the owner's social and economical status– Figure 6.39.

Conclusions

Domestic buildings in the UAE represent the society product that corresponded to social values and environment. Traditional houses varied according to geographical locations and climatic conditions. Traditional houses represent a matching integration of the social and environmental dimensions of sustainability. Contemporary houses were the normal product of the drastic economical and social changes in the UAE since 1970s. Yet they were less sustainable because they adopted foreign design trends neglecting the environment and depending on artificial air-conditioning. This chapter's conclusions can be listed as follows:

- Natural environment, available resources, and social & cultural values were the major conditioning factors in the formation of traditional architecture in the UAE.
- Architecture in the UAE was influenced by rapid and drastic economic, social & cultural changes that took place in the Gulf region during the second half of the 20th century.
- Traditional architecture was the product of multi-cultural interaction. Nevertheless, contemporary buildings abandoned the rich heritage following imported design ideas and building materials and technology.
- Site was the first step to accommodate to social and environmental requirements in traditional houses, while site in modern architecture lost this importance.
- Traditional houses utilized natural resources to create comfortable indoor environment, while contemporary houses in the UAE, neglected ambient environment and depended on active design systems.
- Indoor environment was healthy depending on natural ventilation and sustainable building materials, while contemporary houses used manufactured materials with no adequate ventilation.
- Consumption of water and production of waste in traditional houses was rational. Contemporary houses are the contrary.
- In spite of modern and luxurious life style in the UAE, social values remained reserved largely in contemporary houses. Most of the traditional cultural values as privacy, gender segregation, and social relations were kept potentially and treated differently in contemporary houses through spaces separations and functional zoning.
- External facades in contemporary houses are sophisticated reflecting the owner's social status, besides the stylish richness of the interior.

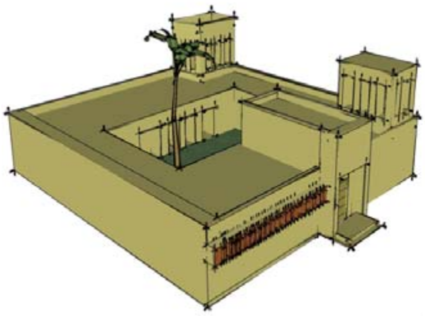
Analysing domestic buildings (traditional and contemporary houses) in the UAE according to sustainability criteria set in chapters four and five, drew a comprehensive view for the region conditions with which this research is concerned. Later chapters, consisting the third part of this research, will go on to investigate this further through research methodology, case study analysis, and testing the proposed SEAM and SSAM by using them in assessing sustainability potential of the chosen case study houses.

Part Three

Testing Sustainability Assessment Method

Chapter 7

Planning the Research Methodology & Case Study Model



Main Headings

Chapter 7: Planning the Research Methodology & Case Study Model

Introduction

The Initiative for Architectural Research (IAR) defines architectural research as follows: "*Architectural research is the search for new knowledge and new ideas about the built environment*" (www.architectureresearch.org –Last accessed 20-05-2007). The guidelines go on to list the characteristics of research. First, the research must have clearly identifiable goals. Secondly, that in pursuit of the "answer" the methodology must be "relevant and accessible to the research domain in which one is operating". The outcome of this methodology must then result in significant results that "reflect a solution or enhances understanding / knowledge within the research domain" (Moloney, 2000).

This chapter explains the objectives of choosing the research methodology that was Comparative Analysis (CA), methods of data collection, and methods of data analysis that will be used in the empirical study (assessment process) of this research. It also determines analysis features that will be the basis for comparison in the CA and defines characteristics of the chosen case studies. This chapter investigates ten houses, five traditional and five contemporary, in the UAE using Comparative Analysis CA. Through qualitative and spatial analysis for these case studies, two of these will be chosen, one each from the traditional and contemporary categories, to be tested in the next chapter.

7.1. Objectives of the Empirical Study

The issues raised in previous chapters represented the theoretical study of this research. These chapters focused on:

- Identification of the sustainability and environment dilemma in the Arab world with special reference to the UAE.
- Recognition of sustainability and environment in Islamic perspective and how it was reflected in traditional architecture, especially houses, in the Arab World,
- Formulation of Sustainability Assessment Method (SAM) for examining sustainability potential in traditional and contemporary architecture in UAE.
- Analysis of traditional and contemporary houses in the UAE to address potential of environmental and social sustainability.

Findings of these theoretical investigations needed to be tested and examined empirically through testing a model of traditional and contemporary houses. The empirical investigation of this research will rely on comparative Analysis CA for traditional and contemporary houses in the UAE. This chapter will focus on planning the CA of the case studies. At the beginning, set objectives for the CA will be set, and then reasons for choosing the CA as a research method for this study will be explained. Criteria to be investigated and methods of data collection will be identified and the methods for analysing the collected data will be determined.

Figure 7.1 shows a structural diagram of the theoretical and field investigation of this research.

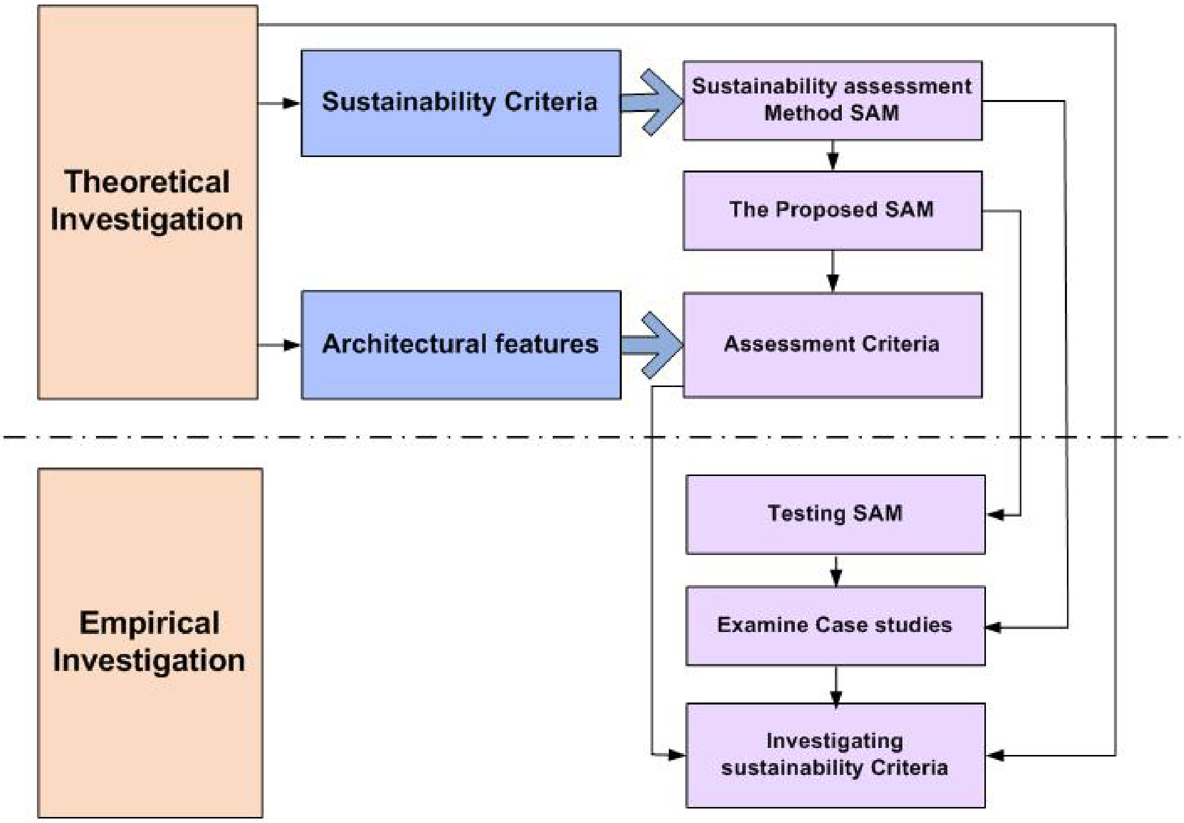


Figure 7.1 Structural diagram of the theoretical and empirical investigation of this research

(Source: the author)

The specific objectives of the empirical study can be identified as follows:

- Examining the sustainability potential in houses.
- Testing the objectivity, reliability, and applicability of the proposed SAM and appropriateness of its criteria to assess (evaluate) sustainability in traditional and contemporary houses (architecture).

According to the identified objectives of the empirical study, a conceptual framework can be constructed that explains this study covering the main themes and presumed relationship. Figure 7.2 shows this framework.

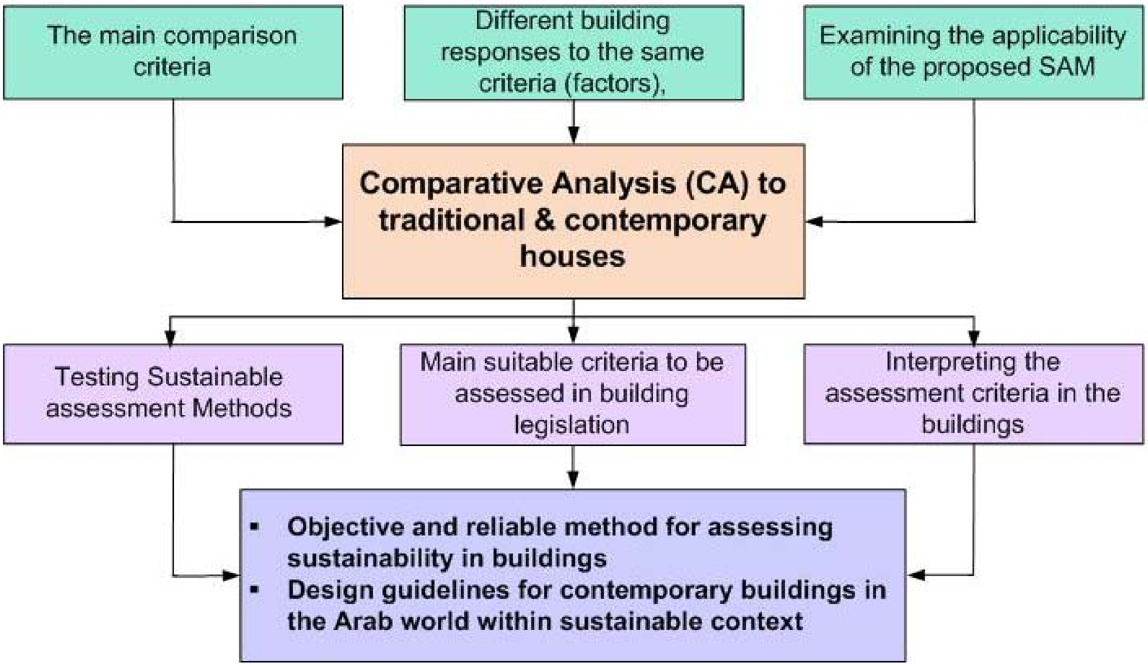


Figure 7.2 – Conceptual framework of the empirical study

(Source: the author)

7.2. Research Methodology: Comparative Analysis

As identified by R. Murray Thomas (2003, P.86), "*the act of comparing things consists of identifying how the chosen things are (similar to) and (different from) each other*". Process to derive comparative analysis consists of five steps: 1) choosing the category of objects to be compared (in this research houses), 2) identifying which two or more types of objects within that category are to be compared (in this research types are traditional and contemporary private houses), 3) selecting the characteristics of the objects on which the comparison will focus (this research will focus on design issues as site planning and internal spaces), 4) collecting and presenting descriptive information about the status of each object (data are obtained from architectural drawings and field survey data), and 5) offering conclusions about how the objects are alike and/or different. In this research, conclusions are concerned with environmental and social sustainability criteria for traditional and contemporary houses in the UAE.

Utilising an analytical method for ten case studies in the UAE, traditional and contemporary houses, two of these case studies will be chosen as the most representative, one from each type. In order to fulfil the empirical study objectives, the research will conduct a deep investigation using Comparative Analysis for the chosen two houses. At this level, two issues are raised:

- The use of CA as the research methodology for empirical study.
- The choice of these houses to be the case studies of this research.

7.2.1. Reasons for Choosing CA as the Research Methodology for this Research

Comparative analysis research methodologies have long been used in social studies especially in cross-cultural studies to identify, analyse and explain similarities and differences across societies (Hantrais, 1995). Comparative analysis methodology has been used for three types of goals: the construction of inferential histories, the development of typologies, and the explication of generalized processes (Peel, 1987).

Three strategies are used in comparative analysis methodology: illustrative comparison, complete or universe comparison, and sampled-based comparisons (Sarana, 1975). The units of comparison distinguish the comparative methodologies and the particular items or features used to compare the units.

Illustrative comparison is the most common form of comparative analysis and has been employed extensively by theorists from diverse camps. Items are used as examples to explain or exemplify phenomena found in different units. They are chosen for their illustrative value and not systematically selected to be statistically representative. Illustrative comparisons are used in historical reconstructions, and to support interpretations or general assertions.

The second strategy is complete or universe comparison, in which all elements of the domain within the study, defined geographically or topically, form the units of comparison. Comprehensive regional ethnographic surveys and analyses of particular topics employ this approach.

Finally, sampled comparison strategically delimits part of the whole, with the goal of selecting data that are statistically representative of the variations within the whole and are intended as the basis for statistical generalizations. This strategy is most appropriate to this research because samples of houses will be chosen that are representative of the variations within the whole. Through comparative analysis, the results can be used for statistical generalization.

The nature of this research empirical study, objectives and level of validity led to choosing CA as the research methodology. However, choosing this methodology is based on specific reasons, as follows:

- This investigation includes testing the application of the proposed SAM in existing buildings from different eras to evaluate its performance from a sustainability standpoint. This comparison is essential to evaluate the performance of each type. Comparison, as Charles Ragin (1989, P.1). recognizes, provides a basis for making statements about empirical regularities and for evaluating and interpreting cases relative to substantive and theoretical criteria.

- Investigating validity of one of the research hypothesis, which is: traditional houses are more sustainable then contemporary. This necessitates a base of comparison to prove or disapprove this hypothesis.
- At the level of buildings sustainability performance, CA is an efficient means to investigate how different buildings (traditional and contemporary houses) perform environmentally and socially within sustainability dimensions.
- At the level of testing the proposed SAM for sustainability assessment, CA is an appropriate methodology for testing sustainability potential in buildings. It means that the results of CA are intended to improve the quality and performance of buildings over building lifespan.

7.2.2. Reasons for Choosing Case Studies

Case study methodology is of the utmost importance in architectural research. Case study methodology is characterized by a purposeful selection of the case to study, which is normally conducted by means of multiple-method data collection. Generalizations are made from a particular case in the interest either of theory or of other cases. In the field of architecture, the case may be an artefact. Understanding of an artefact often requires knowledge, not only of its contemporary setting, but also of the historical context of its design (Johansson, 2003). Generalization is legitimate if they are treated and made explicitly, as Malcolm Williams (2002, P.125) indicates, *moderatum* generalization within the context of a pluralistic approach to research.

A case study is expected to capture the complexity of a single case. Architecture case studies provide consistent standards to document architecture specifications for the planning, management, communication and execution of activities related to system development (Tang; Han; & Pin, 2004, P.3).

To attain the objectives of the empirical study, a CA will be conducted using case studies of traditional and contemporary houses in the UAE. Choosing these case studies for this research is based on the findings in chapter four that house design was a reflection of materials, environment and social values of the region where it was built and the society that produced it. The architectural product (the house) varied between traditional and contemporary. The region (natural environment of the UAE) remained the same, but the society (cultural content) had new values and a modern life style. The range of materials available also changed. Thus, the final product (the house) witnessed radical modifications due to drastic economical and social changes. Accordingly, choosing traditional and contemporary houses was essential to compare each type response to natural environment and social values from sustainability standpoint. These case studies could play an effective role in recognizing sustainability and guiding designers to appropriate sustainable design principles.

The first objective of the empirical study and choosing case study is to examine and analyse potential of sustainability in architecture (houses). According to the findings in chapters four and five and houses analysis in chapter six, principles of sustainability can be recognized in houses through certain criteria used to identify sustainability in buildings. The chosen case studies are the most appropriate to examine and analyse sustainability because they are representative of the most common house design in the region according to the thematic and spatial analysis conducted in chapter six. The second objective of the empirical study is to assess sustainability indicators in buildings that could be attained only through investigating examples of existing buildings (houses).

The third objective of the empirical study is to test the proposed SAM that was driven according to systematic analysis to recognized sustainability assessment methods and modified according to local conditions of the region (UAE). Applying assessment method for buildings requires certain data and statistics to get results that cannot be obtained from sketches or photos. Moreover, some environmental sustainability assessment method criteria (as energy consumption, building envelope thermal performance, and CO_2 emission) require detailed data (input) to get accurate results (output). Thus, it was essential to obtain architectural drawings (plans, sections, elevations). It is crucial to indicate that the chosen case studies are only representatives of houses in the UAE, and the results obtained from CA are used as indicators more than being actual assessment for these buildings.

7.2.3. Reasons for Choosing Case Study Houses

A case study is expected to capture the complexity of a single case. For the purpose of this research investigation, five traditional houses and five contemporary houses were chosen. Choosing these houses as case studies is based on certain objectives that can be summarised as follows:

- Location of these houses: all the traditional and contemporary houses were chosen in Dubai and Sharjah cities because contemporary architecture there is considered one of the most developed urban settlements not only in UAE but also in the Gulf region. Modern architecture in Dubai and Sharjah is of high quality and good examples of contemporary architecture in the UAE. At the same time, traditional houses in these two emirates is rich and well preserved compared to the other emirates. Houses in theses two emirates, traditional and contemporary, are representative of environmental conditions and social values of the UAE society.

- The chosen case studies represent the most common design of houses in the UAE whether traditional or contemporary.
- The traditional houses represent domestic architecture in the UAE until 1950s; the contemporary houses represent domestic buildings trend within the last ten years.
- All traditional houses are built by locals. The chosen contemporary houses are designed by Arab architects.
- Access to data was essential, traditional houses data were obtained from Dubai Municipality and Sharjah Heritage Directory, besides author's survey and field visits. Contemporary houses data were obtained from local designers and architectural bureaus.
- Houses size and design components (spaces, areas, and spatial relations) were chosen to be almost alike to build the CA on an objective basis.

7.3. Methods of Data Collection

In planning the selected CA of the chosen buildings, it is essential to identify the appropriate methods to collect the required data for this investigation. The more ways that they are used to confirm the findings, the more certain that these findings are valid. For this research (empirical study), a multi-method was employed for data collection, including: Documents and archival research, field survey and direct observation for the chosen buildings.

7.3.1. Documents and Archival Research

The non-reactive nature of collecting documentary and archival data represents a distinctive feature of this method. At this point, a possible reactive effect may take place. Using data from archival records and documents in this study aims to;

- Establish a clear and concrete background about the buildings under investigation.
- Helping in setting a group of evaluation criteria (criteria of the SAM) to evaluate the selected buildings.
- Define and describe the architectural design of the chosen buildings.

Types of data required from archival records and documents vary according to the aim of collecting these data. A number of types of data from archival records and documents were identified as required, these being:

- Information about the buildings such as location, plot size, building area, functional requirements, and internal spaces.
- Architectural drawings of the building such as plans, sections, elevations and architectural details.
- Photos and images.

The archival records and documents have been obtained from different resources. The main resources can be listed as follows:

- Dubai Municipality.
- Sharjah Heritage Directory.
- Designers and Architectural Bureaus.
- Field survey.

7.3.2. Field Survey and Direct Observation

Field survey is the process of taking data from buildings on site. Observation is an activity of a sapient or sentient living being, which senses and assimilates the knowledge of a phenomenon in its framework of previous knowledge and ideas. Observation is more than the simple act of observing. To perform an observation, a being must observe and seek to add to its knowledge. For this research, field survey and observation were essential in deciding objectives of choosing the cases studies and aspects of analysis. Field survey enabled the researcher to understand the context of the chosen case studies. Direct observation, images, measurements, and sketches were crucial in conducting the spatial analysis for the chosen case studies.

7.3.3. Evaluation

Evaluation often is used to examine complex systems, yet it does not attempt to reduce complexity, but rather attempts to conceptualize it (Friedman; Zimring & Zube, 1978, P.3). Examining evaluation criteria varies between SEAM and SSAM because of the adopted research method (qualitative or quantitative) and the nature of assessed criteria. For SEAM, each criteria in the “area of environmental assessment” list will be measured according to certified world standards that applied by environmental assessment methods as Eco-Homes, LEED, and Green Globes.

For SSAM, each criteria in the “Area of Social Assessment” list will be measured by giving the researcher’s own judgement according to the building analysis and how it responded to social values. As mentioned, in examining the evaluation criteria, the measurement value differed between Environmental SAM and Social SAM according to the nature of each method and the assessed criteria in each SAM.

For the SEAM, the measuring indicators are more tangible and some of them can be measured according to identified standards such as CO_2 emission, building footprint, electricity and water consumption, and building envelope thermal performance (U-value). Measurement method is different for SSAM because no tangible standard can be used to measure the social criteria. Thus, the researcher measures each criteria in the SSAM by giving her own judgement according to the predefined scale, the main source of the social values, which is Islamic Shari’a’, and the researcher’s experience and background. Each sub-area of assessment will be evaluated and given a score ranging 1-10 depending on degree of relevance the assessed criterion is compared to certain standard. Table 7.1 illustrates the proposed rating score recommended for this research.

Table 7.1- The proposed rating score

(Source: the author)

10	**8 - 9**	**6 - 7**	**5**	**3 - 4**	**1 - 2**	**0**
Total relevance	High relevance	Good relevance	Medium relevance	Average relevance	Low relevance	Not considered

7.4. Methods of Data Analysis

Data analysis is the act of transforming data with the aim of extracting useful information and facilitating conclusions. Depending on the type of data and the question, this might include application of statistical methods, selecting or discarding certain subsets based on specific criteria, or other techniques (www.en.wikipedia.org/wiki/Qualitative_method - Last accessed 02-06-2006).

Architecture analysis provides a set of viewpoints to guide the collection and analysis of information for making architecture choices (Tang; Han; & Pin, 2004, P.2). The collected data for the Comparative Analysis of the chosen case studies will be analysed by different methods. Each group of data collected by a certain method has an appropriate data analysis technique. Architectural analysis and evaluation will be used to analyse the collected data. A qualitative analysis will be used to analyse two types of data that are the data collected through documents and archival research (documentary analysis) for sustainability social assessment. A quantative analysis, which is based on the statistical analysis, will be used to analyse the collected data through results obtained from sustainability environmental assessment.

7.4.1. Qualitative Analysis (content analysis)

Qualitative research is multi-method in focus, involving an interpretive naturalistic approach to its subject matter. It involves the studies use of collection of a variety of empirical materials-case study, personal experience, and introspective (Thomas, 2003, PP.1 & 2). Qualitative research is one of the two major approaches to research methodology especially in social sciences. It involves an in-depth understanding of human behaviour and the reasons that govern human behaviour. Unlike quantitative research, qualitative research relies on reasons behind various aspects of behaviour. Simply put, it investigates the why and how of decision-making, as compared to what, where, and when of quantitative research. Hence, the need is for smaller but focused samples rather than large random samples, which qualitative research categorizes data into patterns as the primary basis for organizing and reporting results (www.en.wikipedia.org/wiki/Qualitative_method Last accessed 02-06-2006)

Qualitative analysis refers to content analysis, which we will employ to analyse documents and archival data on one hand and the researcher analysis on the other hand. The accumulated data and architectural drawings of the houses will be analysed through a documentary analysis to achieve the objectives of collecting these data. The context includes the purpose of the document as well as social and cultural aspects. Qualitative analysis will be used as a supplementary method in the multi-method strategy of this research CA.

7.4.2. Quantative Analysis (statistical analysis)

As defined on Wikipedia Encyclopaedia, "*Quantitative research is the systematic scientific investigation of quantitative properties and phenomena and their relationships. Quantitative research is widely used in both the natural and social sciences*" (www.en.wikipedia.org/wiki/Qualitative_method - Last accessed 02-06-2006). Quantitative research uses numbers and statistical methods. It tends to be based on numerical measurements of specific aspects of phenomena; it abstracts from particular instances to seek general description or to seek casual hypotheses (Thomas, 2003, P. 2). An intelligent way of differentiating Qualitative research from Quantitative research is that largely qualitative research is exploratory, while quantitative research is conclusive. Quantitative data is measurable while Qualitative data cannot be put into a context that can be graphed or displayed as a mathematical term.

The objective of quantitative analysis is to develop and employ mathematical models, theories and hypotheses pertaining to natural phenomena. The process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships. The term quantitative research is most often used in the social sciences in contrast to qualitative research (www.en.wikipedia.org/wiki/Qualitative_method).

Statistics is the most widely used branch of mathematics in quantitative research. Quantitative research using statistical methods typically begins with the collection of data based on a theory or hypothesis, followed by the application of descriptive or inferential statistical methods. Some of the assessment criteria for SEAM will be subjected to a quantitative analysis, which is based on statistical analysis for environmental performance of the chosen case studies. Quantitative research is generally approached using scientific methods that include:

- The generation of models, theories and hypotheses; for our research, it is the research hypotheses: It is possible to develop an AM to examine the sustainability potential in traditional & modern architecture
- The development of instruments and methods for measurement; for this research, the SAM has been set in chapter five.
- Experimental control and manipulation of variables; for this research, it is the assessment criteria that been analyzed and set up in chapter four.
- Collection of empirical data; for this research it is the case studies data that is illustrated in this chapter.
- Modelling and analysis of data; for this research it is the case studies data that has been analysed in this chapter.
- Evaluation of results; for this research it is the assessment process that will be held in chapter eight.

Since the practice of architecture requires knowledge of a vast array of phenomena from physical properties of materials to principles of visual perception, it is hardly surprising that the research sub-disciplines within architecture bring with them a broad range of paradigms. Accordingly, as Linda Groat and David Wong (2002, P.25) identify, distinction between quantitative and qualitative methods are often not clearly to cut. Many research studies adopted a combination of quantitative and qualitative methods. This research will use both, quantitative and qualitative methods, as research methodology for testing the SEAM and SSAM in chapter eight.

7.5. Case Study Analysis

The case study is one of several ways of doing scientific researches (Yin, 2002). Rather than using large samples and following a rigid protocol to examine a limited number of variables, case study methods involve an in-depth, longitudinal examination of a single instance or event: a case. They provide a systematic way of looking at events, collecting data, analyzing information, and reporting the results. As a result, the researcher may gain a sharpened understanding of why the instance happened as it did, and what might become important to look at more extensively in future research. Case studies lend themselves to both generating and testing hypotheses (Flyvbjerg, 2006, P. 219).

Robert Yin (2002) suggests that, "*case study should be defined as a research strategy, an empirical inquiry that investigates a phenomenon within its real-life context*". Case study method means single and multiple case studies, can include quantitative evidence, relies on multiple sources of evidence and benefits from the prior development of theoretical propositions. He notes that case studies should not be confused with qualitative research and points out that they can be based on any mix of quantitative and qualitative evidence.

When selecting a case for a case study, researchers often use information-oriented sampling, as opposed to random sampling. It is more appropriate to select some few cases chosen for their validity. Bent Flyvbjerg (2006) distinguished three types of information-oriented cases: (1) Extreme or deviant cases, (2) Critical cases, and (3) Paradigmatic cases. The extreme case can be well suited for getting a point across in an especially dramatic way, which often occurs for well-known case studies. A critical case can be defined as having strategic importance in relation to the general problem. A paradigmatic case may be defined as an exemplar or prototype. Paradigmatic cases, that is, cases that highlight more general characteristics of the societies or issues in question. Careful case selection may help generalization from case studies. The case study is effective for generalizing using by selecting cases strategically in this manner; one may arrive at case studies that allow generalization, which is one of this research aims. Accordingly, objective selection of case studies, in this research, and data comparative analysis for the chosen cases studies will lead to choose paradigmatic cases that provide the possibility to formulate a generalization of characteristic of traditional and contemporary houses in the UAE.

In architectural research, Linda Groat and David Wong (2002, P.347), classify five primary characteristics for case study method: 1) a focus on either single or multiple cases, studies in their real life context; 2) the capacity to explain casual links; 3) the importance of theory development in the research design phase; 4) a reliance on multiple sources of evidence, with data needing to converge in a triangulating fashion; and 5) the power to generalize to theory. In this research, choice of case studies aimed to find similarities and differences between the chosen case studies of the same type, traditional or contemporary.

There is no quick or easy formula for making the choice between single and multiple case studies of their number. Two principles are paramount: 1) the nature of the study or research questions; and 2) the role of replication in testing or confirming the study's outcomes. The number of case studies depends on the power of generalizability that comes from the concept of replication, rather than the concept of sampling (Groat & Wong, 2002, P.356). Choice of case studies, in this research, aimed to be suitable for the study aims and they can be analysed according to criteria discussed in this research. Accordingly, objectives for choosing case studies (houses) depended on:

- Resemblance in houses features (location, functional requirements, social status, and date of construction).
- House design is representative of typical house design in the UAE whether traditional or contemporary.

To support this objectivity, a quantitative analysis will be conducted for the chosen case studies such as plot area, built-up area, plot coverage, open/ built-up ration, and internal spaces zones. Then a spatial analysis will be conducted to each house to identify functional diagram and spaces relationships, inside-outside relation, and inward-outward relation.

Data analysing will be conducted to find similarities and differences in each. Through discussion and analysis, the most representative paradigmatic case of each type will be chosen to be tested and assessed using SAM in chapter eight aiming to conclude generalization for sustainability potential in traditional and contemporary houses.

7.5.1. Setting Case Study Data

In order to assess the chosen case studies with SAM, certain data are required. A descriptive analysis is held to obtain the required data useful for the assessment process. The data analysis is divides into the following categories:

1. **General Information:** includes location, house type, and construction date. This is to confirm that the houses are of similar features and era.
2. **Site Planning:** includes plot area, built-up area, plot coverage, built-up to open ration, and total built-up area.
3. **Internal spaces:** includes internal spaces zoning and areas, spatial relations, zoning percentage, and structure and circulation percentage. The zones were divided into three categories according to their level of privacy:

- Public zone: indicates the spaces that are used for public occasions were men are hosted without intruding into family privacy. It includes the main entrance, male *Majlis*, and services such as the bathroom.
- Semi-public zone: indicates the spaces that are used freely by all family members and others as women guests and servants, except strange men. It includes the women *Majlis*, circulation areas including the central hall, and services such as kitchen, laundry, bathrooms, and maid's room.
- Private zone: indicates the spaces that are only used by family members such as bedrooms. Private zones, in contemporary houses, may include private family sitting area, pantry, and an office.

4. **Spatial Analysis:** includes zoning analysis, design concept, built-up to open, and inside-outside relation (introvert or extrovert) to identify that the case study is designed within the common style of house design in the UAE whether for the traditional or the contemporary.

Ten cases studies were chosen, five traditional and five contemporary. Traditional houses were constructed within the first quarter of the 20^{th} century; they were built by local builders. The contemporary houses were constructed within the last five years; Arab architects in local consultant bureaus designed them. Design concept, for each type, was comparable representing the most common houses design in the time of construction. The case studies were numbered according to its type (Traditional: Tra.1, Tra.2 …; and contemporary: Con.1, Con.2…etc). The ten cases studies statistics were organized in tables according to the previous mentioned categories.

7.5.2. Descriptive Analysis of Case Study Model

As discussed earlier in this chapter, the chosen case studies (traditional and contemporary) were located in Dubai and Sharjah cities because architecture there is a representative of houses in the UAE environmentally and socially. A descriptive analysis will be illustrated for the case studies and a quantitative and spatial analysis, for each case study, was set in tables below.

7.5.2.1. Traditional case study 1 (Tra.1)

It is located in Bastakia district in Dubai, and was built in 1910. The plot is almost square (13.5 m* 14 m) with an area of 189 m^2. The house is one story, the total built up area is 156 m^2 and the total plot coverage is 82.5%. The courtyard is about 33 m^2 and the open to built-up ratio is about 1:4.7. The main entrance is in the northwest elevation. The house is small, thus it contained the main required spaces such as *Majlis*, rooms, kitchen, store, and bathrooms. The house is designed on introvert concept were all spaces open to a central courtyard. Construction system is load-bearing walls using coral stones for walls and wooden joists and palm and Chandal mats for roofing. Table 7.2 illustrates quantitative and spatial analysis for case study Tra.1.

7.5.2.2. Traditional case study 2 (Tra.2)

It is located in Bastakia district in Dubai, and was built in 1925-1927. The plot is almost square (21.22 m* 21.63 m) with an area of 460 m^2. The house is two stories, the ground floor area is 403 m^2, the total built up area is 515.4 m^2 and the total plot coverage is 87.6%. The courtyard is relatively small compared to plot area; it is about 57 m^2 where the open to built-up ratio is about 1:7. The main entrance is in the northeast elevation. The house contained two reception spaces (Majlis); one for the cold season and one for the hot season with a *barjeel*, in addition to a small pantry and bathroom. The house contained a women reception besides the services spaces. For family uses, the house contains a family sitting, two rooms in the ground floor and five rooms in the first floor. The house is designed on introvert concept were all spaces open to a central courtyard. Construction system is load-bearing walls (0.60 m) and partitions (0.30 m) using coral stones for walls and wood joists and palm for roofing. Table 7.3 illustrates quantitative and spatial analysis for case study Tra.2.

7.5.2.3. Traditional case study 3 (Tra.3)

It is located in Bastakia district in Dubai, and was built in 1929. The plot is almost square (23.6 m* 26.2 m) with an area of 630 m^2. The house is two stories, the ground floor area is 475 m^2, the total built up area is 571 m^2 and the total plot coverage is 75.4%. The courtyard is relatively big compared to the previous two case studies; it is about 155 m^2 where the open to built-up ratio is about 1:3. The main entrance is in the northeast elevation. The house design is a typical model for merchant’s traditional houses in the UAE and the region. It contained the *Majlis* with internal guest room. The house contained a women reception besides the services spaces and a *Liwan*. For family uses, the house contains six rooms in the ground floor and two rooms in the first floor. The house is designed on introvert concept were all spaces open to a central courtyard. Construction system is load-bearing walls (0.60 m) and partitions (0.30 m) using coral stones for walls and wood and palm for roofing. Table 7.4 illustrates quantitative and spatial analysis for case study Tra.3.

7.5.2.4. Traditional case study 4 (Tra.4)

It is located in Bastakia district in Dubai, and was built in 1930-1931. The plot tends to be rectangular (28.9 m* 23.3 m) with an area of 667.4 m^2. The house is two stories, the ground floor area is 504.4 m^2, the total built up area is 625.2 m^2 and the total plot coverage is 75.6%. The courtyard is almost square (13.3 m* 12.2 m); it is about 163 m^2 where the open to built-up ratio is about 1:3. Main entrance is located in the north elevation facing the creek and it is reached through a ramp. It is considered one of the biggest houses at its time; it contained a big *Majlis* and separate guest room that are reached via main lobby (*Dehrez*). The house has another entrance for the family located on the south elevation, which leads directly to the courtyard and family quarter. The family quarter contains services spaces, two long *Liwans* and seven rooms in the ground floor. Rooms in the ground floor are reached through few steps that lead to the *Liwan*. In the first floor, there are seven rooms with a long balcony in the front of the north rooms facing the creek. The house is designed on introvert concept. Construction system is load-bearing walls (0.60 m) and partitions (0.30 m) using coral stones for walls and wood and palm for roofing. Table 7.5 illustrates quantitative and spatial analysis for case study Tra.4.

7.5.2.5. Traditional case study 5 (Tra.5)

It is located in Shandaga district in Dubai, and was built in 1930. The plot is irregular (31.65m* 32.24m * 32.06m* 20.85m, 19.22m) with an area of 1235 m^2. The house is two stories, the ground floor area is 797.5 m^2, the total built up area is 961.05 m^2 and the total plot coverage is 64.6%. The courtyard is irregular following the plot axis; it is about 437.5 m^2 where the open to built-up ratio is about 1:1.8. The house main entrance is in the north elevation facing the creek. It is one of the biggest houses in the Shandaga district; it contained a big *Majlis* that is reached via big lobby (*Dehrez*). The house has two other entrances for the family and services located on the east and south sides; they lead directly to the courtyard and family quarter. The house has two long *Liwans* in front of the family rooms. The family quarter contains services spaces, nine rooms in the ground floor, and four rooms in the first floor. The house is designed on introvert concept. The courtyard is big compared to the other houses because of the house size. Construction system is load bearing walls (0.60 m) using coral stones for walls and wood and palm for roofing. Table 7.6 illustrates quantitative and spatial analysis for case study Tra.5.

7.5.2.6. Contemporary case study 1 (Con.1)

It is located in Sharjah, and was built in 2003. The plot is rectangular (23 m* 30.5 m) with an area of 701.5 m^2. The main elevation of the plot is northwest. The house is two stories, the ground floor area is 235 m^2, the total built up area is 470 m^2 and the total plot coverage is 33.5%. The building block is sited in the centre of the plot with a setting back from the four sides leaving an open space around the building. The open spaces are 466.5 m^2 and open to built-up ratio is about 2:1. The house main entrance is in the northeast leading directly to the male Majlis that is oriented northwest. There is another entrance for women in the northwest elevation leading to the female reception. The house has a third entrance for services located at the back. Usually in contemporary houses, there is a central hall where most of the semi public and some private spaces are open. It is also the main circulation area. The ground floor contains the kitchen and one bed room and bathroom that can be used for guests. The family quarter is in the first floor that contains four bedrooms, three bathrooms, and family hall. The house is designed on extrovert concept where all windows are opened to the outside. Construction system is skeleton using R.C. columns and slabs, walls are (0.20 m) and partitions (0.30 m) using concrete blocks. This house represents the average houses, and considered small compared to most of the UAE nationals' houses. Table 7.7 illustrates quantitative and spatial analysis for case study Con.1.

7.5.2.7. Contemporary case study 2 (Con.2)

It is located in Sharjah, and was built in 2004. The plot is almost square (29 m* 30.5 m) with an area of 885 m^2. The main elevation of the plot is northeast. The house is two stories, the ground floor area is 435 m^2, the total built up area is 828 m^2 and the total plot coverage is 49%. The building block is sited in the centre of the plot with a setting back from the four sides leaving an open space around the building. The open spaces are 450 m^2 and open to built-up ratio is about 1.1:1. The house main entrance is in the middle of the front elevation leading to the entrance lobby. The lobby leads to the male Majlis at the left, female reception to the right, and the main hall in the middle. Both Male Majlis and female reception are provided with bathroom. The house has another entrance for services located in the southeast side near the kitchen. There are three bedrooms with their bathrooms in the ground floor. The staircase can be reached through the central hall. The family quarter is in the first floor that contains five bedrooms, five bathrooms, and family pantry. The house is designed on extrovert concept where all windows are opened to the outside. Construction system is skeleton using R.C. columns and slabs, walls are (0.20 m) using concrete blocks. Table 7.8 illustrates quantitative and spatial analysis for case study Con.2.

7.5.2.8. Contemporary case study 3 (Con.3)

It is located in Dubai, and was built in 2003. The plot is polygon (32.5 m* 45.5 m * 31m *45.5m) with an area of 1450 m^2. The main elevation of the plot is west. The house is one story, the ground floor area is 400 m^2 and the total plot coverage is 27%. The building block is sited in the centre of the plot with a setting back from the four sides leaving an open space around the building. The open spaces are 1050 m^2 and open to built-up ratio is about 2.7:1. The house main entrance, which is reached via few steps, is in the middle of the front elevation leading to the main hall. The Majlis is in the front of the house and reached through a separate entrance from the entrance porch. The house has another entrance for services located in the backside leading to the kitchen. There are four bedrooms with their bathrooms and dressing spaces in the ground floor. The bedrooms quarter is well designed to keep family privacy. The central hall is used as the family sitting area. The house is designed on extrovert concept where all windows are opened to the outside. Construction system is skeleton using R.C. columns and slabs, walls are (0.20 m) using concrete blocks. Table 7.9 illustrates quantitative and spatial analysis for case study Con.3.

7.5.2.9. Contemporary case study 4 (Con.4)

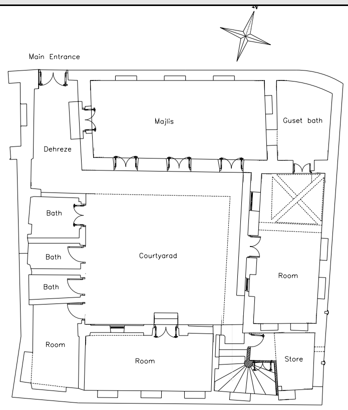
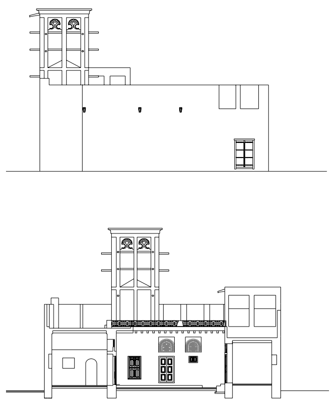
It is located in Dubai, and was built in 2004. The plot is rectangular (37 m* 46 m) with an area of 1702 m². The main elevation of the plot is northwest. The house is two stories, the ground floor area is 360 m², the total built up area is 720 m² and the total plot coverage is 21%. The building block is sited in the centre of the plot with a setting back from the four sides leaving an open space around the building. The open spaces are 1342 m² and open to built-up ratio is about 3.7:1. The house main entrance, which is reached via elaborate steps that leads to the main porch, is in the middle of the front elevation leading to the main hall. The Majlis is in the front of the house and reached through a separate entrance from the entrance porch. The house has another entrance for services located in the backside leading near the kitchen. There are three bedrooms with their bathrooms and dressing spaces in the ground floor. The bedrooms quarter is well designed to keep family privacy. The family quarter is in the first floor that contains three bedrooms, three bathrooms, an office, a pantry, and a family hall. The house is designed on extrovert concept where all windows are opened to the outside. Construction system is skeleton using R.C. columns and slabs, walls are (0.20 m) using concrete blocks. Table 7.10 illustrates quantitative and spatial analysis for case study Con.4.

7.5.2.10. Contemporary case study 5 (Con.5)

It is located in Sharjah, and was built in 2004. The plot is rectangular (30 m* 60 m) with an area of 1800 m². The main elevation of the plot is southwest. The house is two stories, the ground floor area is 679 m², the total built up area is 1079 m² and the total plot coverage is 37.7%. The building block is sited in the centre of the plot with a setting back from the four sides leaving an open space around the building. The open spaces are 1121 m² and open to built-up ratio is about 1.7:1. The house main entrance, which is reached via colonnade steps that leads to the main porch, is in the middle of the front elevation. The main entrance leads to the Majlis is in the right and the dining in the left. The entrance leads also to the main hall, which is the central part of the house. The house has another entrance for services located in the northwest near the kitchen. There are three bedrooms with their bathrooms and dressing spaces in the ground floor. The family quarter is in the first floor that contains six bedrooms, six bathrooms, and family sitting area. The staircase is well designed as an important feature of the central hall. The house is designed on extrovert concept. Construction system is skeleton using R.C. columns and slabs, walls are (0.20 m) using concrete blocks. Table 7.11 illustrates quantitative and spatial analysis for case study Con.5.

Table 7.2- Traditional case study 1 (Tra.1) quantative and spatial analysis
(Source: The author)

	House No.	**Type**	**Location**	**Date of construction**
	Tra.1	Traditional	Dubai-Bastakia	1910

Architectural Drawings	**Plan**	**Sections & Elevations**	**Images**
			

Site Planning	**Plot area**	**Perimeter**	**Built-up area (Gr.)**	**Plot coverage**	**Open space area**	**Open/built up ratio**	**Total Built-up area**
	m²	**m**	**m²**	**%**	**m²**		**m²**
	189 (13.5*14)	56.75	156	82.5%	33 (6*5.5)	1:4.7	156

Internal Spaces	**Zone**	**Spaces**	**Area**	**Zone**	**Spaces**	**Area**	**Zone**	**Spaces**	**Area**
	Public	Majlis	24.5	**Semi-Public**	Kitchen	7	**Private**	Rooms (3)-G. floor	37
		Dehrez	9		Store	5			
					Baths(3)	8.5			
	Total		**33.5m²** 36.8%	**Total**		**20.5m²** 22.5%	**Total**		**37 m²** 40.7%
	Spaces area= 91 m², 59% total built-up area				Structure & circulation= 65 m², 41 % built-up area				

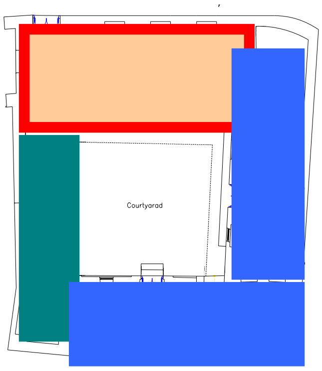
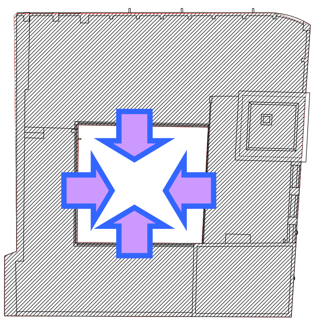
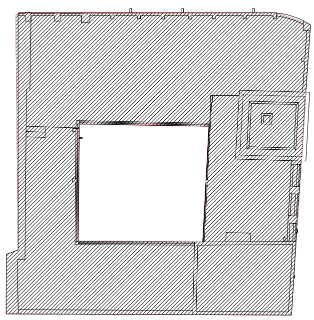
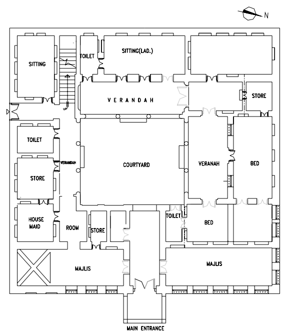
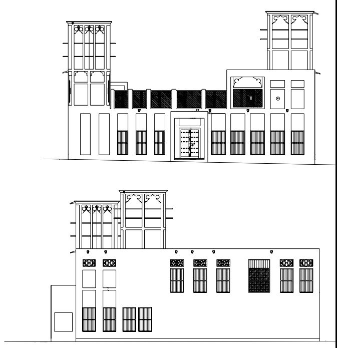
Spatial Analysis	**Zoning analysis**	**Inside-outside relation**	**Built up/ open**
			

Table 7.3- Traditional case study 2 (Tra.2) quantative and spatial analysis
(Source: The author)

	House No.	Type	Location	Date of construction
	Tra.2	Traditional	Dubai -Bastakia	1925-1927

Architectural Drawings	Plan	Sections & Elevations	Images
			 

Site Planning	Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
	m²	m	m²	%	m²		m²
	460 (21.22*21.63)	85.88	403	87.6%	57 (8.53*6.86)	1:7	515.4

Internal Spaces	Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
	Public	Majlis (2)	51.6	Semi-Public	Women Rec.	20.2	Private	Bed rooms (2)-G. floor	38.7
		Dehrez	13		Kitchen	14.2		Family sitting	20.3
		Pantry	3		Services	17.7		Bed rooms (5)-1st floor	101.4
		Guest bath	3		Stores(2)-G. floor	13.3			
					Liwans	52.8			
	Total		70.6m² 19.6 %	Total		129.2m² 35.9 %	Total		160.4m² 44.5 %
	Spaces area= 360.2 m², 70% total built-up area				Structure & circulation= 155.2 m², 30 % built-up area				

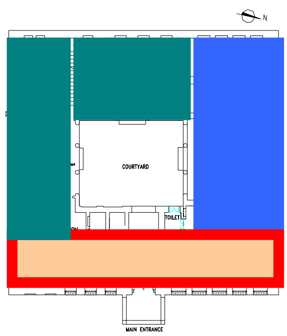
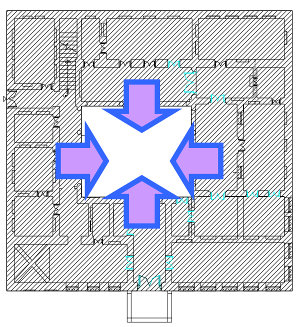
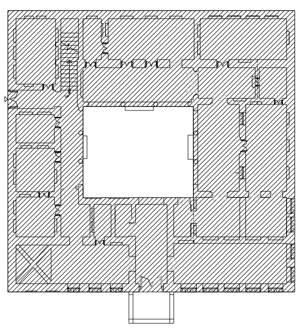
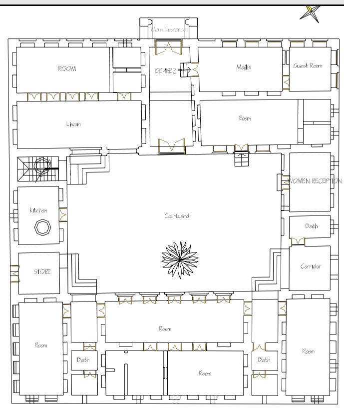
Spatial Analysis	Zoning analysis	Inside-outside relation	Built up/ open
			

Table 7.4- Traditional case study 3 (Tra.3) quantative and spatial analysis
(Source: The author)

	House No.	Type	Location	Date of construction
	Tra.3	Traditional	Dubai-Bastakia	1929

Architectural Drawings

Plan	Sections & Elevations	Images
		 

Site Planning

Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
m²	m	m²	%	m²		m²
630 (23.6*26.2)	100.48	475	75.4%	155 (15.7*9.9)	1:3	571

Internal Spaces

Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
Public	Majlis	19.6	Semi-Public	Women Rec.	12.8	Private	Bed rooms (6)-G. floor	168
	Dehrez	21.8		Kitchen	12.4		Bed rooms (2)-1st floor	62.5
	Guest room	9.6		Services	25.8			
				Liwan	31			
Total		51m² 14%	Total		82m² 22.5%	Total		230.5m² 63.5%

Spaces area= 363.5 m², 64% total built-up area	Structure & circulation= 207.5 m², 36 % built-up area

Spatial Analysis

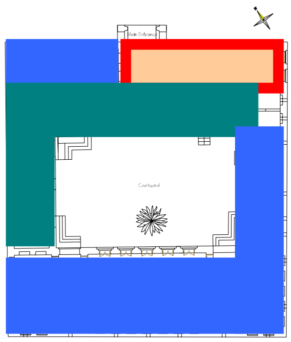
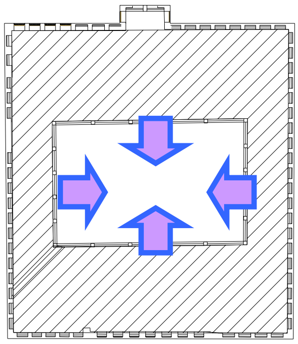
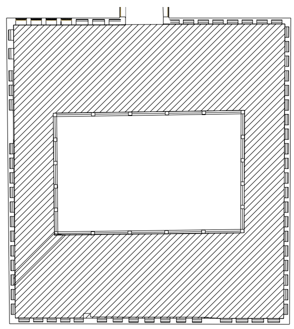
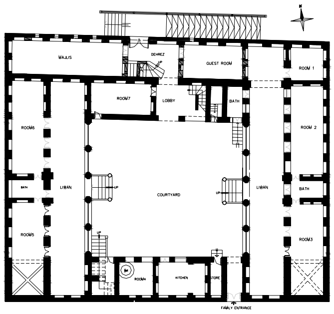
Zoning analysis	Inside-outside relation	Built up/ open
		

Table 7.5- Traditional case study 4 (Tra.4) quantative and spatial analysis
(Source: The author)

House No.	Type	Location	Date of construction
Tra.4	Traditional	Dubai	1930-1931

Architectural Drawings

Plan	Sections & Elevations	Images
		 

Site Planning

Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
m²	m	m²	%	m²		m²
667.4 (28.9*23.3)	104	504.4	75.6%	163 (13.3*12.2)	1:3	625.2

Internal Spaces

Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
Public	Majlis	28.5	Semi-Public	Family Ent.	5.3	Private	Rooms (7)-G. floor	123
	Dehrez	13		Kitchen	11.2		Rooms (7)-1st floor	106.2
	Guest room	15.5		Services	33.6			
				Liwans	112.7			
Total		57m² 12.7%	Total		162.8m² 28.3%	Total		229.2m² 51%

Spaces area= 449 m², 71.8% total built-up area	Structure & circulation= 176.2 m², 28.2 % built-up area

Spatial Analysis

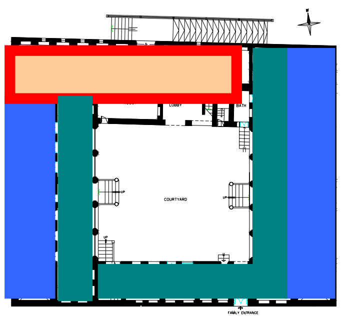
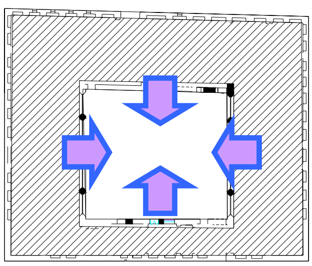
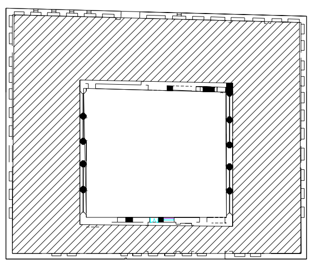
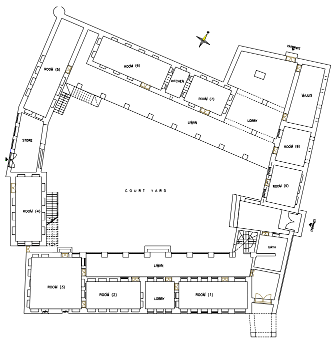
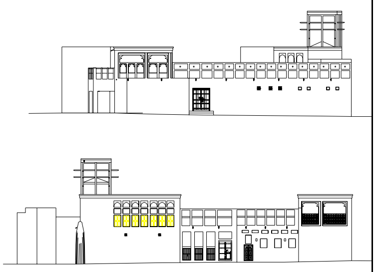
Zoning analysis	Inside-outside relation	Built up/ open
		

Table 7.6- Traditional case study 5 (Tra.5) quantative and spatial analysis
(Source: The author)

	House No.	Type	Location	Date of construction
	Tra.5	Traditional	**Dubai**-Shandagh	

Architectural Drawings

Plan	Sections & Elevations	Images
		 

Site Planning

Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
m²	m	m²	%	m²		m²
1235 (31.65* 32.24 * 32.06* 20.85, 19.22)	147.35	797.5	64.6%	437.5	1:1.8	961.05

Internal Spaces

Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
Public	Majlis	24.8	Semi-Public	Family entrance	11.2	Private	Rooms (9)- G. floor	250.3
	Dehrez	40.6		Kitchen	7		Rooms (4)- 1st floor	153.8
	Lobby & services	31.3		Services	50.5		Store-1st floor	9.75
				Liwans	153.5			
Total		**96.7m²** 13%	Total		**222.2m²** 30.3%	Total		**413.85m²** 56.7%
Spaces area= 732.75m², 76.2% total built-up area				Structure & circulation=228.3 m², 23.6% built-up area				

Spatial Analysis

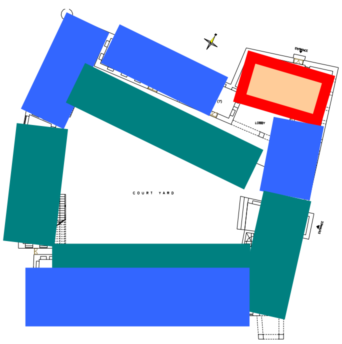
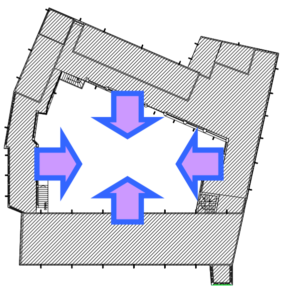
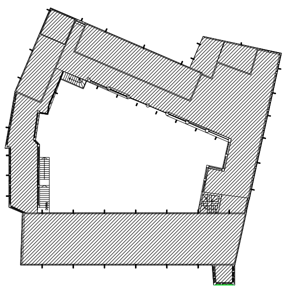
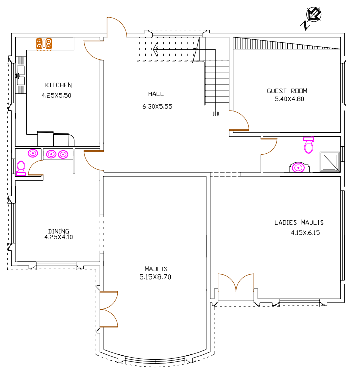
Zoning analysis	Inside-outside relation	Built up/ open
		

Table 7.7- Contemporary case study 1 (Con.1) quantative and spatial analysis
(Source: The author)

House No.	Type	Location	Date of construction
Con.1	Contemporary	Sharjah	2003

Architectural Drawings

Plan	Sections & Elevations
	

Site Planning

Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
m²	m	m²	%	m²		m²
701.5 (23*30.5)	107	235	33.5%	466.5	2:1	470

Internal Spaces

Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
Public	M. Majlis	47	Semi-Public	F. Majlis	40.5	Private	Bed rooms (4)-1st floor	133.5
	Dining	17.5		Kitchen	23		Baths (3)-1st floor	23
	services	4		Guest Bed room	25.4		Family hall 1st floor	33.5
				services	6.6			
				Hall	28.5			
Total		68.5m² 18%	Total		124m² 32%	Total		190m² 50%

Spaces area= 382.5 m²,81% total built-up area	Structure & circulation= 87.5 m², 19 % built-up area

Spatial Analysis

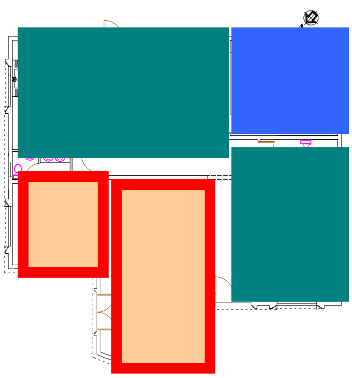
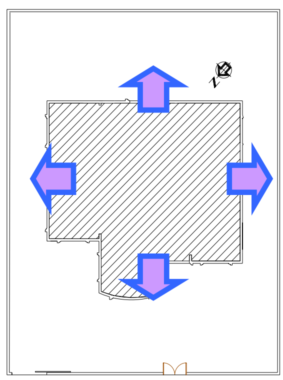
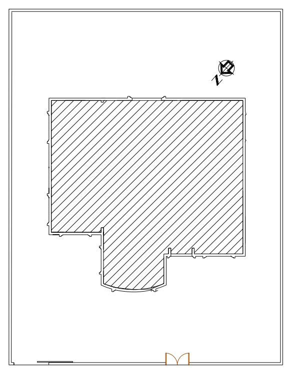
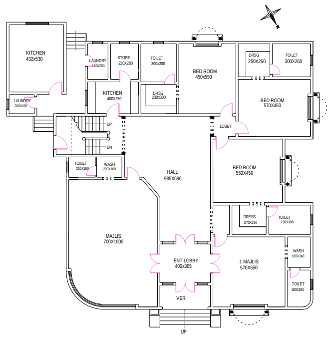
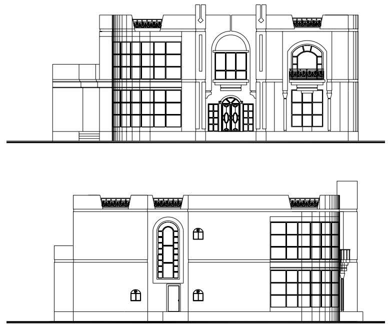
Zoning analysis	Inside-outside relation	Built up/ open
		

Table 7.8- Contemporary case study 2 (Con.2) quantative and spatial analysis
(Source: The author)

	House No.	Type	Location	Date of construction
	Con.2	Contemporary	Sharjah	2004

Architectural Drawings	**Plan**	**Sections & Elevations**
		

Site Planning	**Plot area**	**Perimeter**	**Built-up area (Gr.)**	**Plot coverage**	**Open space area**	**Open/built up ratio**	**Total Built-up area**
	m²	**m**	**m²**	**%**	**m²**		**m²**
	885 (29*30.5)	119	435	49%	450	1.1:1	828

Internal Spaces	**Zone**	**Spaces**	**Area**	**Zone**	**Spaces**	**Area**	**Zone**	**Spaces**	**Area**
	Public	Main Ent.	12	**Semi-Public**	F. Majlis	31.5	**Private**	Bed rooms (3)-G. floor	78
		M. Majlis	70		Kitchen	23		Baths (3)-G. floor	44.5
		services	8.5		services	48		Pantry1st floor	22
								B. room (5)-1st. floor	177.5
								Baths (5)-1st floor	75
	Total		**90.5m²** 15.5%	**Total**		**102.5m²** 17.5%	**Total**		**397m²** 67%
	Spaces area= 590 m²,71% total built-up area				Structure & circulation= 238 m², 29 % built-up area				

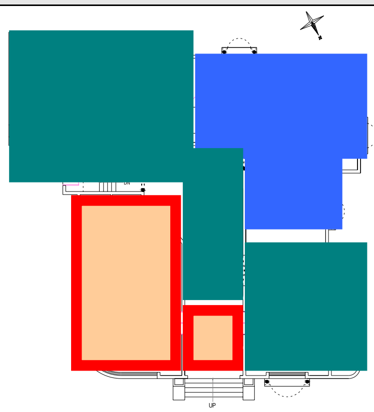
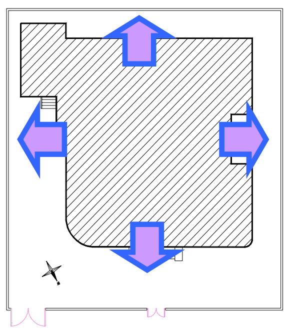
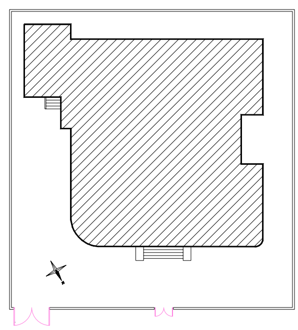
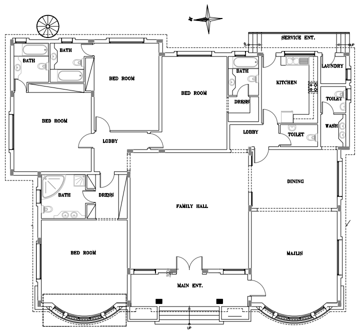
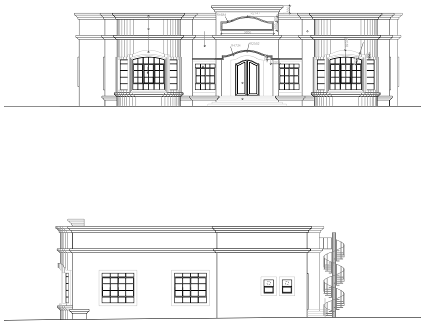
Spatial Analysis	**Zoning analysis**	**Inside-outside relation**	**Built up/ open**
			

Table 7.9- Contemporary case study 3 (Con.3) quantative and spatial analysis
(Source: The author)

	House No.	Type	Location	Date of construction
	Con.3	Contemporary	Dubai	2005

Architectural Drawings	Plan	Sections & Elevations
		

Site Planning	Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
	m²	m	m²	%	m²		m²
	1450 (32.5*45.5*31*45.5)	155	400	27 %	1050	2.7:1	400

Internal Spaces	Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
	Public	Main Ent.	18	Semi-Public	Family Hall	64	Private	Bed rooms (4)	130
		Majlis	43		Kitchen	18		Baths & dressing	40
		Dining	24		service	15			
	Total		85 m² 24%	Total		97 m² 28%	Total		170m² 48%
	Spaces area=352 m², 88% total built-up area				Structure & circulation= 48 m², 12 % built-up area				

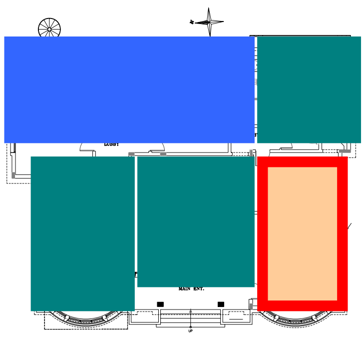
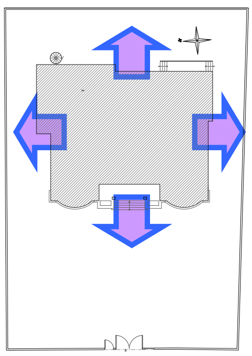
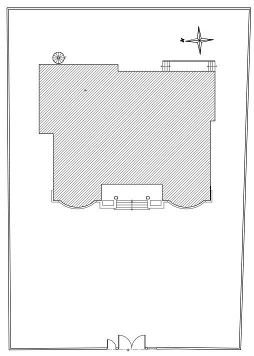
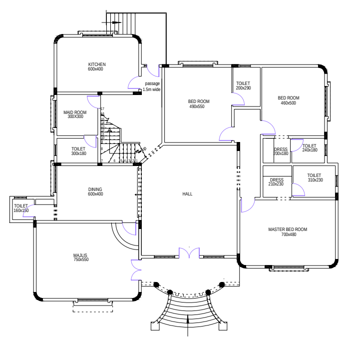
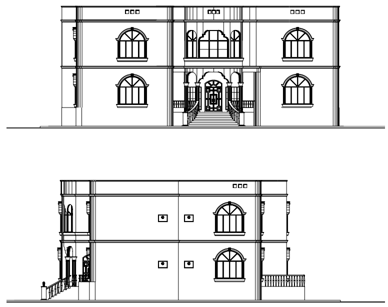
Spatial Analysis	Zoning analysis	Inside-outside relation	Built up/ open
			

Table 7.10- Contemporary case study 4 (Con.4) quantative and spatial analysis
(Source: The author)

House No.	Type	Location	Date of construction
Con.4	Contemporary	Dubai	2004

Architectural Drawings

Plan	Sections & Elevations
	

Site Planning

Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
m²	m	m²	%	m²		m²
1702 (37*46)	340	360	21%	1342	3.7:1	720

Internal Spaces

Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
Public	M. Majlis	41.5	Semi-Public	Hall	55	Private	Bed rooms (3)-G. floor	84
	Dining	24		Kitchen	24		Baths (3)-G. floor	25
	services	4.5		services	15		Family hall1st floor	80
							B. room (3)-1st. floor	126
							Baths (3)-1st floor	57
							Office	27
							Pantry	13
Total		70m² 12%	Total		94m² 16.5%	Total		412m² 71.5%

Spaces area= 576 m²,80% total built-up area | Structure & circulation=145 m², 20 % built-up area

Spatial Analysis

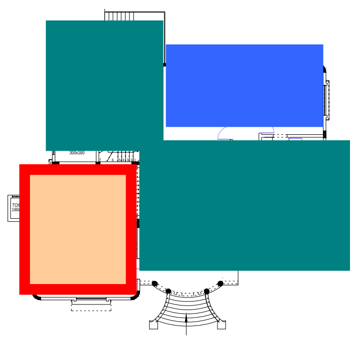
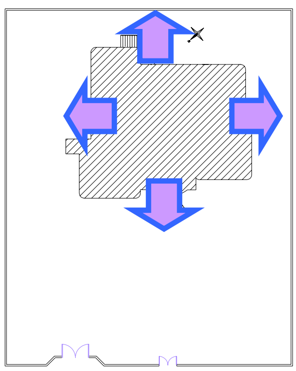
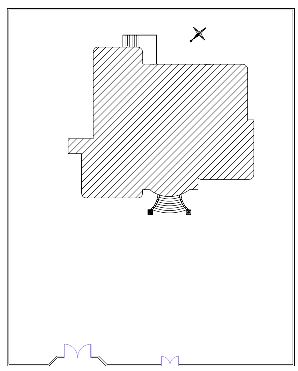
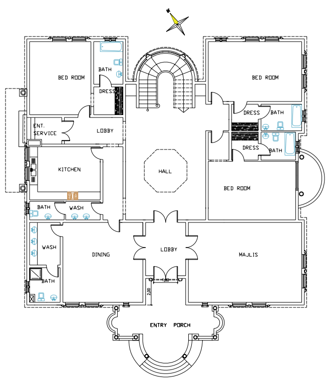
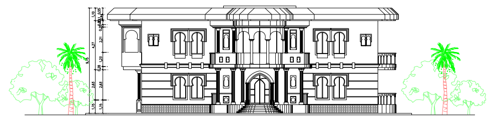
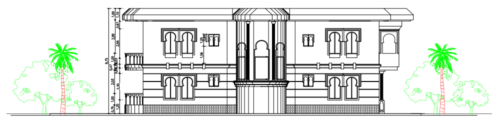
Zoning analysis	Inside-outside relation	Built up/ open
		

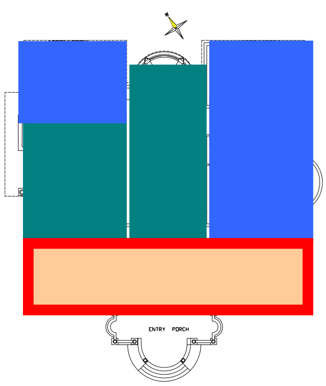
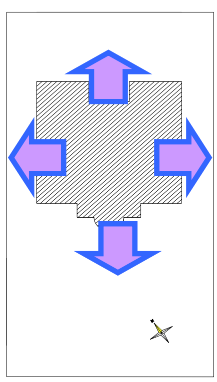
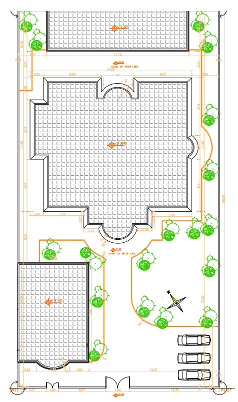
Table 7.11- Contemporary case study 5 (Con.5) quantative and spatial analysis
(Source: The author)

	House No.	Type	Location	Date of construction
	Con.5	Contemporary	Sharjah	2004

Architectural Drawings	**Plan**	**Sections & Elevations**
		 

Site Planning	**Plot area**	**Perimeter**	**Built-up area (Gr.)**	**Plot coverage**	**Open space area**	**Open/built up ratio**	**Total Built-up area**
	m²	**m**	**m²**	**%**	**m²**		**m²**
	1800 (30*60)	180	679	37.7%	1121	1.7:1	1079

Internal Spaces	**Zone**	**Spaces**	**Area**	**Zone**	**Spaces**	**Area**	**Zone**	**Spaces**	**Area**
	Public	Main Ent.	12	**Semi-Public**	Kitchen	21.5	**Private**	Bed rooms (3)-G. floor	86
		Majlis 1	80		Outdoor services	122.5		Baths (3)- G. floor	33
		Dining 1	48					Sitting1st floor	20.5
		Majlis 2	51					B. room (6)-1st. floor	191.5
		Dining 2	36					Baths (6)- 1st floor	71
		services	29						
	Total		**256m²** 32%	**Total**		**144m²** 18%	**Total**		**402m²** 50%
	Spaces area= 802 m²,74.5% total built-up area				Structure & circulation= 277 m², 25.5 % built-up area				

Spatial Analysis	**Zoning analysis**	**Inside-outside relation**	**Built up/ open**
			

7.5.3. Findings of Case Study Analysis

Based on the descriptive, quantitative, and spatial analysis which were held for the case studies, a set of findings will be applied to chose the most appropriate paradigmatic case study of each type, traditional and contemporary, to be tested using SAM. The main findings may be listed as follows:

7.5.3.1. General overview

All the case studies, according to its type and date of construction, held features of similarity more than differences. The overall design concept, site treatment, zoning, and spatial relationships are almost the same in each type. Minor differences appeared according to plot size, form, and family requirements.

7.5.3.2. Site Planning

Generally, plot areas in traditional houses were smaller than the contemporary. Most of the traditional plots tend to be square while contemporary plots tend to be rectangular. Traditional plot areas were (189 m², 460 m², 630 m², 667.4 m², and 1235 m²); the average of plot size is 636.3 m². While contemporary plot areas were (701.5 m², 665 m², 1450 m², 1702 m², and 1800 m²); the average of plot size is 1307 m². This indicates the major difference in land use between the past and the present, which was reflected in site planning and plot coverage that was high in the traditional houses (64.6%, 75.4, 75.6%, 82.5%, and 87.6%); the average of plot coverage is 77%. While plot coverage in the contemporary houses is less than the traditional (21%, 27%, 33.5%, 37.7%, and 49%) the average of plot coverage is 33.7% . Built-up to open ratio and total built-up area varied between the traditional and contemporary houses. Open spaces in the traditional houses (the courtyard) were less than open spaces in the contemporary houses (the outdoor spaces). In average, built-up areas are double or triple the open spaces in the traditional houses; open/built up are (1:1.8, 1:3, 1:4.7, and 1:7); the average of open/built up is1:3.9. In contemporary houses, the contrary occurs; the open spaces are double or triple the built-up area. Open/built up in contemporary houses are (1.1:1, 1.7:1, 2:1, 2.7:1, and 3.7:1); the average of open/built up is 2.25:1.

7.5.3.3. Internal spaces

The spaces zoning and internal spatial relation are similar in both traditional and contemporary houses in many ways. Social values such as keeping the family privacy, segregation between genders, guest hospitality are effective factors in houses spaces zoning design and internal spatial relation. Main categories of spaces zones (public, semi-public, and private) can be clearly identified in traditional and contemporary houses, yet they were slightly different between each type in size, design, and number of spaces. Major findings for internal spaces analysis are listed as follows:

- **Public zone:** In traditional and contemporary houses, the public zone that includes the main entrance, men *Majlis* with its services, and sometimes dining space, is located at the front part of the house with direct access from the main entrance: *dehrez* in traditional houses or entrance porch in contemporary houses. In average, public zone took about (19-20%) of spaces area. In traditional houses the public spaces percentage is (12.7%, 13%, 14%, 19.6%, and 36. 8%) with an average of 19.2%. In contemporary houses, the public spaces percentage is (12%, 15.5%, 18%, 24%, and 32%) with an average of 20.3%. The high percentage of public spaces (36.8%) in traditional houses appears in case study (Tra.1), which is a small house. Although the *Majlis* area is within the average, the percentage is high because of the small built up area compared to other case studies. The high percentage of public spaces (32%) in contemporary houses appears in case study (Con.5), which is a large house and has two *Majlises,* one within the house block and the other in a separate block, with their services. Thus, the public spaces percentage was high compared to other case studies. This is common in wealthy people's contemporary houses, where another *Majlis* is located in a separate block.
- **Semi-public zone:** indicates spaces that are used freely by all family members and others as women guests and servants. It includes women *Majlis*, circulation areas, family sitting area, and services. Generally, the semi-public zones are located near the main entrance such as the women reception, or integrated within the house spaces such as the central hall that might be used as family sitting area besides being a circulation area in contemporary houses. Services such as kitchen, laundry, bathrooms, and maid's room are located in a certain quarter, usually at the backside. Sometimes, in large contemporary houses, services are built as a separate block, as in case study (Con.5). In average, semi-public zones took about (26-28%) of spaces area. In traditional houses the semi-public spaces percentage is (22.5%, 28.5%, 30.3%, and 35. 9%) with an average of 27.9%. In contemporary houses, the semi-public spaces percentage is (16.5%, 17.5%, 18%, 28%, and 32%) with an average of 26.8%.The high percentage of semi-public spaces (35.9%) in traditional houses appears in case study (Tra.2) that has two *Liwans* and women *Majlis*. The high percentage of semi-public spaces (32%) in contemporary houses appears in case study (Con.5), that has a separate services block at the backside of the plot.

- **Private zone:** indicates to spaces that are only used by family members such as bedrooms. Generally, the private zone took most of the houses built-up area, whether in traditional (51.3%) or contemporary houses (57.3%). In traditional houses, the bedroom is not specified as a bedroom; it was used for multi-functions especially in extended family houses. Thus, it is indicated as “room” not “bedroom”. Private zone in traditional houses are (40.7%, 44.5%, 51%, 56.7%, and 63.5%). The high private percentage (63.5%) appears in case study (Tra.3) because it was built for a large family with several rooms in the ground and first floor. In contemporary houses, family bedrooms are so private and almost each member in the family has his own bedroom with its own dressing and bathroom. Private zone, in contemporary houses, is usually located in the first floor and may include private family sitting area such as in case study (Con.1) and (Con.5), pantry in case study (Con.2), and an office in case study (Con.4). Private zone in contemporary houses are (48%, 50%, 67%, and 71.5%). The high private percentage (71.5%) appears in case study (Con.4) because it contained an office, pantry, and family sitting in addition to the bedrooms in the first floor. The private zone took more space in contemporary houses than the traditional because of the exaggeration in spaces, privacy, and luxurious life style.
- **Circulation and structure:** the percentage is higher in traditional houses (31.7%) than in contemporary (21.1%). This is referred to massive structural system (load bearing) in the traditional houses compared to skeleton system (column and beam) in the contemporary houses. Most of the contemporary case study houses are designed around a central hall, which is the main circulation area besides its use as a sitting space. This eliminated area needed for transitional spaces and corridors that appear in traditional houses.

7.5.3.4. Spatial Analysis

The house design concept reflects society culture and identity at the era it was erected. All traditional case study houses are designed as introvert where all spaces oriented towards an open central courtyard. Contemporary houses reflected modern life style of society in the UAE. All contemporary case study houses are designed as extrovert where all spaces are opened to the outside. The idea of an open central courtyard in the traditional houses is replaced with a covered central hall through which most of the spaces are reached and it may be used as a family sitting space. Orientation was an important issue in siting traditional houses. According to the traditional case study houses, it was found that most of the front elevations, where the main entrance located, are oriented towards the angle between northeast to northwest facing the creek and prevailing wind. Orientation varied in contemporary case study houses following the urban planning of the sector; it varied between northeast, northwest, west, and southwest.

Case study major findings and quantitative and spatial analysis are illustrated in table 7.12 and table 7.13 and the average of the quantitative analysis is illustrated in table 7.14.

7.5.4. Choosing Case Study Models

According to the findings obtained of the quantitative and spatial analysis and the average figures, the traditional case study house (Tra.3) and contemporary case study house (Con.2) were chosen as the most appropriate paradigmatic case studies to be assessed using SSAM and SEAM in chapter eight. Each case study, within its type, is most close to the average in most of the analyzed statistics, contains most of the spaces that other cases studies contain, and spaces zones are well organized.

Frequencies, percentages, and cross tabulation give concrete data regarding buildings' sustainability performance. Theses data will be treated to support the related hypotheses to the objectives of the building sustainability potential. The researcher will get results, make interpretations, finds patterns or typologies in order to formulate conclusions based on what have been investigated, tested and discovered. At this point, it is important to indicate that data in itself is not of great use unless it observed within the case study context, objectives, and hypotheses.

Table 7.12- Case studies quantitative and spatial analysis-Traditional houses
(Source: the author)

Site Planning

	Tra.1		**Tra.2**		**Tra.3**		**Tra.4**		**Tra.5**	
Site Planning	Plot area (m²)	189	Plot area (m²)	460	Plot area (m²)	630	Plot are (m²)	667.4	Plot area (m²)	1235
	Built-up area - Gr. (m²)	156	Built-up area - Gr. (m²)	403	Built-up area - Gr. (m²)	475	Built-up area - Gr. (m²)	504.4	Built-up area - Gr. (m²)	797.5
	Plot coverage	82.5%	Plot coverage	87.6%	Plot coverage	75.4%	Plot coverage	75.6%	Plot coverage	64.6%
	Open space area (m²)	33	Open space area (m²)	57	Open space area (m²)	155	Open space area (m²)	163	Open space area (m²)	437.5
	Open/built up ratio	1:4.7	Open/built up ratio	1:7	Open/built up ratio	1:3	Open/built up ratio	1:3	Open/built up ratio	1:1.8
	Total Built-up area (m²)	156	Total Built-up area (m²)	515.4	Total Built-up area (m²)	571	Total Built-up area (m²)	625.2	Total Built-up area (m²)	961.05

Internal Spaces

	Tra.1			**Tra.2**			**Tra.3**			**Tra.4**			**Tra.5**		
Internal Spaces	Public	33.5	36.8%	Public	70.6	19.6%	Public	51	14%	Public	57	12.7%	Public	96.7	13%
	Semi-public	20.5	22.5%	Semi-public	128.2	35.9%	Semi-public	82	22.5%	Semi-public	162.8	28.3%	Semi-public	222.2	30.3%
	Private	37	40.7%	Private	160.4	44.5%	Private	230.5	63.5%	Private	229.2	51%	Private	413.85	56.7%
	Spaces area	91	59%	Spaces area	360.2	70%	Spaces area	363.5	64%	Spaces area	449	71.8%	Spaces area	732.75	76.2%
	Cir. & structure	65	45%	Cir. & structure	155.2	30%	Cir. & structure	207.5	36%	Cir. & structure	176.2	28.2%	Cir. & structure	228.3	23.6%

Spatial analysis

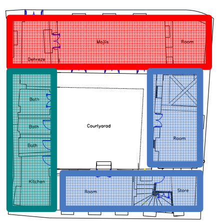
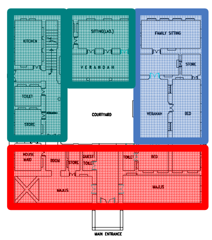
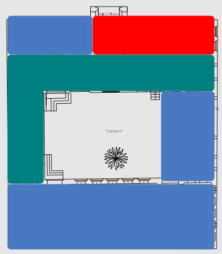
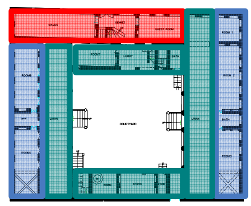
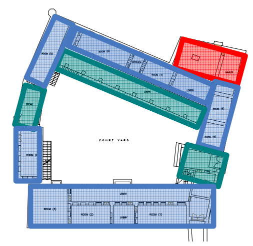
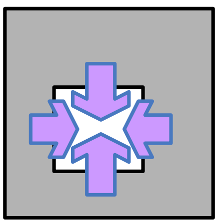
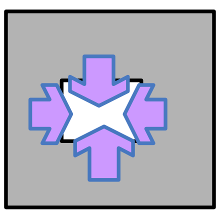
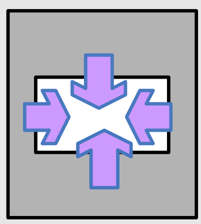
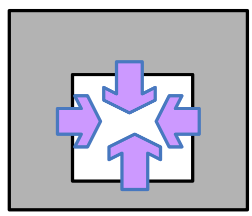
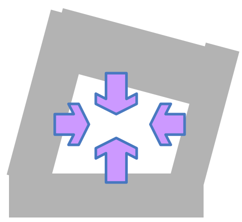
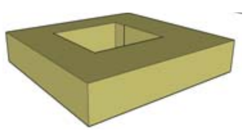
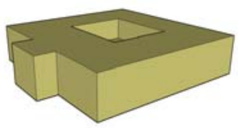
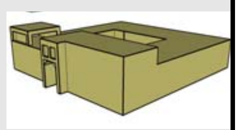
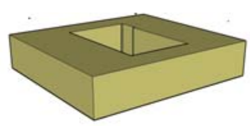
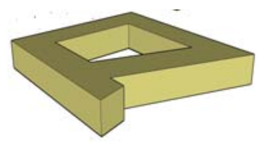
	Tra.1	**Tra.2**	**Tra.3**	**Tra.4**	**Tra.5**
Spatial analysis	Zoning analysis	Zoning analysis	Zoning analysis	Zoning analysis	Zoning analysis
					
	Inside-outside relation	Inside-outside relation	Inside-outside relation	Inside-outside relation	Inside-outside relation
					
	Built-up/ open	Built-up/ open	Built-up/ open	Built-up/ open	Built-up/ open
					

Table 7.13- Case studies quantitative and spatial analysis-Contemporary houses
(Source: the author)

	Con.1		Con.2		Con.3		Con.4		Con.5	
Site Planning	Plot area(m²)	701.5	Plot area (m²)	885	Plot area(m²)	1450	Plot area(m²)	1702	Plot area(m²)	1800
	Built-up area- Gr. (m²)	235	Built-up area - Gr.(m²)	435	Built-up area -Gr.- (m²)	400	Built-up area - Gr. (m²)	360	Built-up area - Gr. (m²)	679
	Plot coverage	33.5%	Plot coverage	49%	Plot coverage	27%	Plot coverage	21%	Plot coverage	37.7%
	Open space area (m²)	466.5	Open space area (m²)	450	Open space area (m²)	1050	Open space area (m²)	1342	Open space area (m²)	1121
	Open/built up ratio	2:1	Open/built up ratio	1.1:1	Open/built up ratio	2.7:1	Open/built up ratio	3.7:1	Open/built up ratio	1.7:1
	Total Built-up area (m²)	470	Total Built-up area (m²)	828	Total Built-up area (m²)	400	Total Built-up area (m²)	720	Total Built-up area (m²)	1079

	Con.1			Con.2			Con.3			Con.4			Con.5		
Internal Spaces	Public	68.5	18%	Public	90.5	15.5%	Public	85	48%	Public	70	71.5%	Public	256	32%
	Semi-public	124	32%	Semi-public	102.5	17.5%	Semi-public	97	28%	Semi-public	94	16.5 %	Semi-public	144	18%
	Private	190	50%	Private	397	67%	Private	170	24%	Private	412	12%	Private	402	50%
	Spaces area	382.5	81%	Spaces area	590	71%	Spaces area	352	88%	Spaces area	576	80%	Spaces area	802	74.5 %
	Cir. & structure	87.5	19%	Cir. & structure	238	29%	Cir. & structure	48	12%	Cir. & structure	145	20%	Cir. & structure	277	25.5%

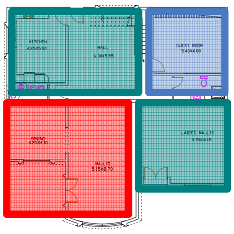
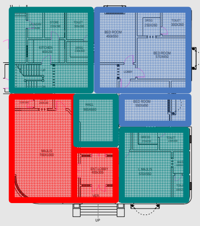
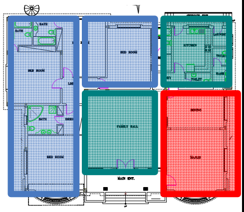
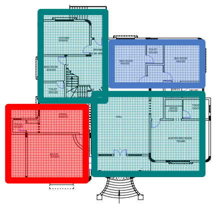
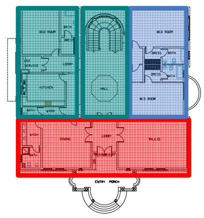
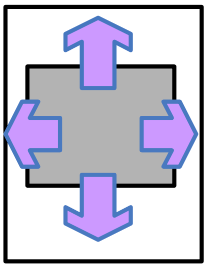
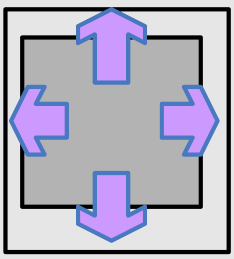
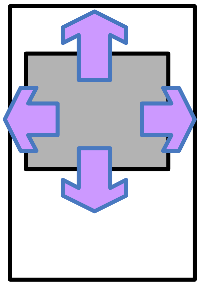
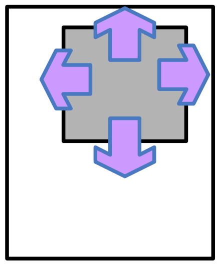
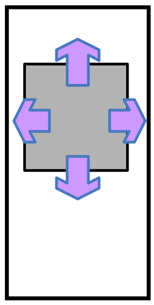
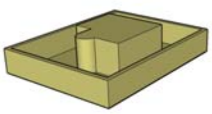
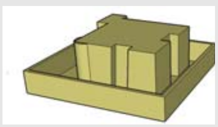
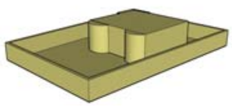
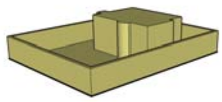
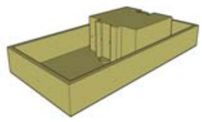
	Con.1	Con.2	Con.3	Con.4	Con.5
Spatial analysis	Zoning analysis	Zoning analysis	Zoning analysis	Zoning analysis	Zoning analysis
					
	Inside-outside relation	Inside-outside relation	Inside-outside relation	Inside-outside relation	Inside-outside relation
					
	Built-up/ open	Built-up/ open	Built-up/ open	Built-up/ open	Built-up/ open
					

Table 7.14- Average Case studies quantitative analysis
(Source: the author)

	Traditional Houses		Contemporary Houses	
Site Planning	Plot area (m²)	636.3	Plot area (m²)	1307
	Built-up area - Gr. (m²)	467	Built-up area - Gr. (m²)	421
	Plot coverage	77%	Plot coverage	33.7%
	Open space area (m²)	169	Open space area (m²)	886
	Open/built up ratio	1:3.9	Open/built up ratio	2.25:1
	Total Built-up area (m²)	565.7	Total Built-up area (m²)	699.4
Internal Spaces	Public	19.2%	Public	20.3%
	Semi-public	27.9%	Semi-public	26.8%
	Private	51.3%	Private	57.3%
	Spaces area	68.3%	Spaces area	79%
	Cir. & structure	31.7%	Cir. & structure	21%

Conclusions

This chapter has investigated a research methodology, which is the Comparative Analysis (CA) that will be used for assessing sustainability potential for the chosen case studies through clarifying the (CA) objectives, methods of data collection, and methods of data analysis. The main conclusions of this chapter can be summarised as follows:

- The CA is the most appropriate methodology for this research for investigating the comparison assessment criteria and testing the reliability and applicability of the proposed SAM.
- The two chosen case studies for traditional and contemporary houses in the UAE represent the most appropriate case studies to achieve the empirical investigation objectives.

The two chosen case studies will be assessed using the proposed SEAM and SSAM in chapter eight to investigate environmental and social performance of traditional and contemporary houses and to test appropriateness of the proposed SEAM and SSAM.

Part Three

Testing Sustainability Assessment Method

Chapter 8

Testing the Proposed Sustainability Assessment Method

Main Headings

Chapter 8: Testing the Proposed Sustainability Assessment Method (SAM)

Introduction

Theoretical investigations that have been conducted in the previous chapters gave a basis to develop the preliminary Sustainability Assessment Method (SAM) for examining the potential of sustainability in architecture (houses) in the Arab World (the UAE). This method is an attempt to assess sustainability in the region. As discussed in chapters four and five, features of environmental and social sustainability and standards of existing SAM are the main sources of assessment criteria of the proposed SEAM and SSAM. This chapter focuses on testing and crystallising the proposed Sustainability Environmental and Social Assessment Methods. It includes evaluation method according to indicators of the SEAM and SSAM. The testing process includes also application of the proposed SEAM and SSAM on the model case study houses that have been selected in chapter seven. This chapter introduces the revised version of the proposed SEAM and SSAM.

The testing process will be carried out at two levels. At the first level, reliability and objectivity of the SAM will be tested through examining appropriateness of the proposed SAM criteria to respond to world sustainability indicators standards in the Arab World. At the second level, the applicability of the proposed SAM will be tested explaining ways of assessing sustainability criteria in the case study houses.

8.1. Aims of Testing the SAM

Testing the proposed SAM is a complex process. It includes different variables and standards; some are integral, others may appear in more than one assessment criteria such as building materials or energy. However, it is essential to define objectivity and reliability of the SAM. Investigating appropriateness of the SAM is one aim of the testing process in order get use of standards set by existing environmental and social sustainability assessment methods. Examining applicability of this method on buildings (houses) in the Arab World is another aim.

8.1.1. Appropriateness of the SAM to Assess Sustainability in Buildings

Investigating appropriateness of the proposed SAM, whether SEAM or SSAM, to assess environmental and social sustainability in buildings, is the first stage in testing the method. Even though, as Cole (2000, P.949) asserts, "*The increase in the development and application of assessment methods has provided considerable theoretical and practical experience concerning their potential contribution in furthering environmentally responsible* *building design, construction and operational practices. Their most significant contribution to date clearly has been to acknowledge and institutionalize the importance of assessing building across a broad range of considerations beyond established single performance criteria such as energy*".

8.1.2. Examining Applicability of the SEAM and SSAM

As discussed in previous chapters, the proposed SEAM was refined according to analyzing three chosen EAMs: EcoHomes, Green Globes, and LEED comparing their area of assessment priorities, sub-areas of assessment, and rating systems. The research has modified the SEAM according to the previous analysis and the UAE and the Arab World circumstances and environmental conditions, such as raising the rating weight for "Water" because it is a valuable resource in the UAE and Arab World. The proposed SSAM was formulated according to the main source of social and cultural values in the region; Islamic *Shari'a.* Area of assessment criteria was derived from Islamic principles and social values priorities in the UAE and Arab World.

Considerations of validity and reliability typically are viewed as essential elements for determining the quality of any assessment. However, professional and practitioner associations frequently have placed these concerns within broader contexts when developing standards and making overall judgments about the quality of any assessment as a whole within a given context (www.en.wikipedia.org/wiki/Qualitative_method - Last accessed 20-05-2007). A valid assessment is one that measures what it is intended to measure. A reliable assessment is one that consistently achieves the same results with the same (or similar) assessment methods. Various factors affect reliability – including chosen case study, region, building type, assessment priorities, and assessor's skills. Yet, validity and reliability of the proposed SEAM and SSAM need to be affirmed by its applicability. Thus, defining the appropriate application methods is essential for the approach usefulness.

8.1.3. Evaluation Standards

Evaluation is the systematic determination of merit, worth, and significance of something or someone. Evaluation is methodologically diverse using both qualitative methods and quantitative methods, including case studies, survey research, statistical analysis, and model building among others (www.en.wikipedia.org/wiki/Qualitative_method - Last accessed 20-05-2007). As discussed earlier, assessment method, is an evaluation process; it is used to measure one or more criteria for a specific building(s) during design stage or already existing buildings. One of this research aims is to estimate the sustainability potential of traditional architecture compared to contemporary in the Arab world, with particular reference to UAE housing. To achieve this aim, comparative analysis was adapted utilising the proposed SEAM and SSAM.

The proposed SEAM and SSAM were conducted to compare environmental and social sustainability for chosen traditional and contemporary houses as case studies. Each area of assessment criteria will be analysed in the two case studies according to an objective method, then the score will be determined and multiplied by the weight of this criteria to get its credit. It is important to give weight to each of the assessment criterion. This weight is based on the nature of the assessment, its aim, purpose of the evaluation, and the building context and type. As mentioned in chapter seven, each sub-area of assessment will be evaluated and given a score ranging (0-10) depending on degree of relevance the assessed criterion to the acceptable standards. This score will be multiplied by the sub-area of assessment credit to obtain the final credit of this part. Then all sub-area of assessment credits will be summed to get the total credits of the assessed criteria. Table 8.1 shows the rating score and degree of relevancy for the proposed SEAM and SSAM.

Table 8.1- The proposed rating score

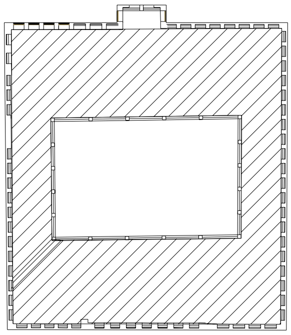
(Source: the author)

10	**8 - 9**	**6 - 7**	**5**	**3 - 4**	**1 - 2**	**0**
Total relevancy	High relevancy	Good relevancy	Medium relevancy	Average relevancy	Low relevancy	Not considered

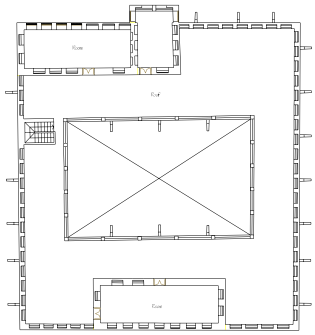
Sub-area of assessment credit = *Score (range 0-10) X criteria credit / 10*

Total area of assessment credit = $\textit{Sub-area}_1$ *credit+* $\textit{Sub-area}_2$ *credit+…+* $\textit{Sub-area}_n$ *credit*

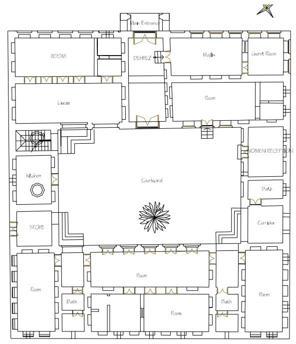
As discussed in chapter seven, two case study houses were chosen, Tra.3 for the traditional and Con.2 for the contemporary, as the most appropriate paradigmatic models for traditional and contemporary houses in the UAE. A descriptive analysis and quantitative and spatial analysis has been illustrated in chapter seven for each case study. For the assessment process, more detailed illustrations are shown below. Figures 8.1 and 8.2 show the architectural drawings for the chosen case studies that will be assessed using SAM.



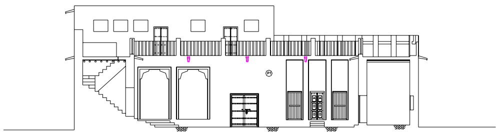
Roof Plan



1st Floor Plan



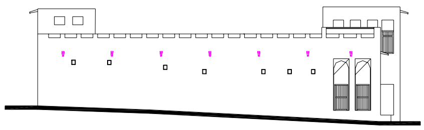
Ground Floor Plan



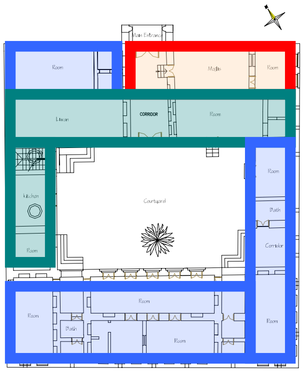
Longitudinal Section

Northeast Elevation

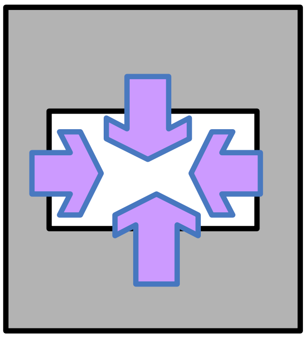
Cross Section



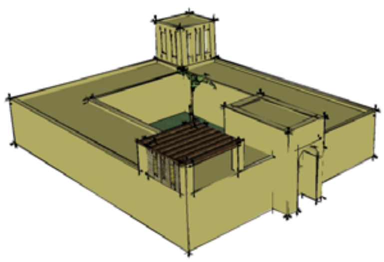
Southeast Elevation



Zoning Analysis

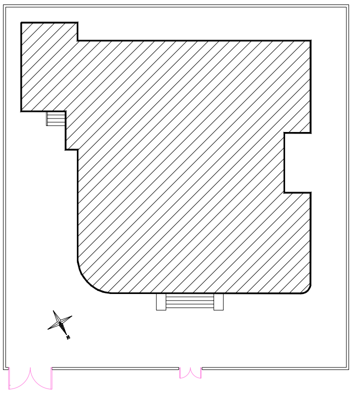


Inward Design

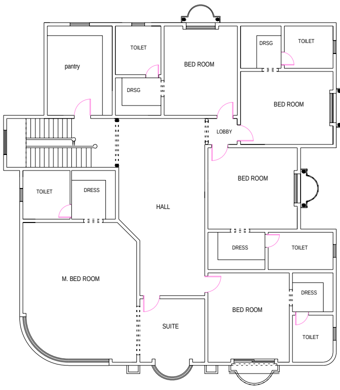


Mass form

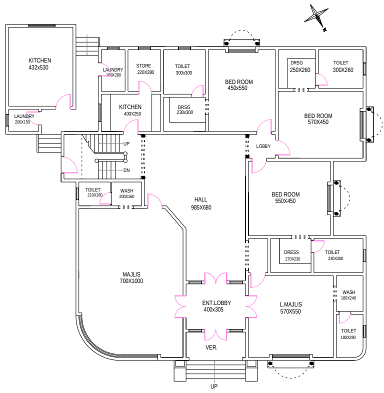
Figures 8.1- Architectural drawings for the chosen case study – The traditional house
(Source: the author)



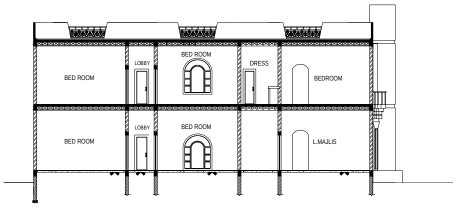
Roof Plan



1st Floor Plan

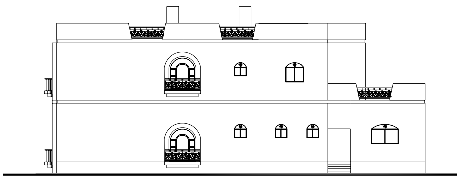


Ground Floor Plan

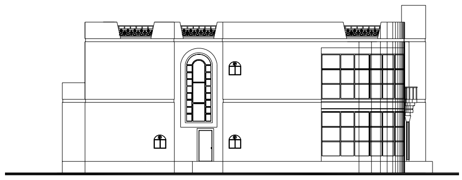


Longitudinal Section

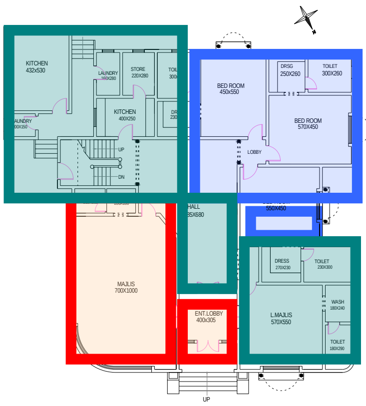
Northeast Elevation



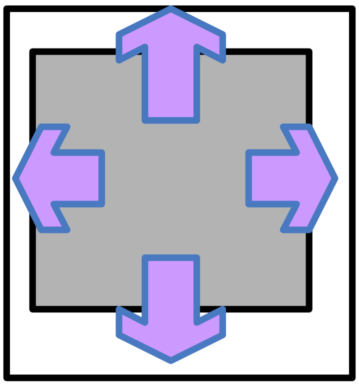
Southwest Elevation



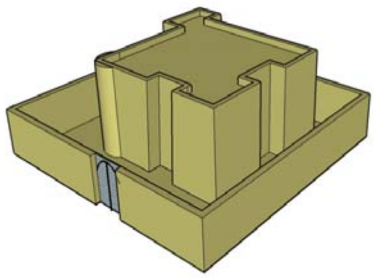
Southeast Elevation



Zoning Analysis



Outward Design



Mass form

Figures 8.1- Architectural drawings for the chosen case study – The contemporary house
(Source: the author)

8.2. Testing the Proposed SEAM

Testing the proposed SEAM process will be held through comparative analysis for the two case studies that have been chosen in chapter seven. In the application stage, the proposed SEAM will be applied to assess environmental sustainability in the chosen houses. Findings of this assessment are important to feedback the proposed SEAM developing and refining. Figure 8.3 shows the criteria that will be assessed using sustainability environmental assessment method.

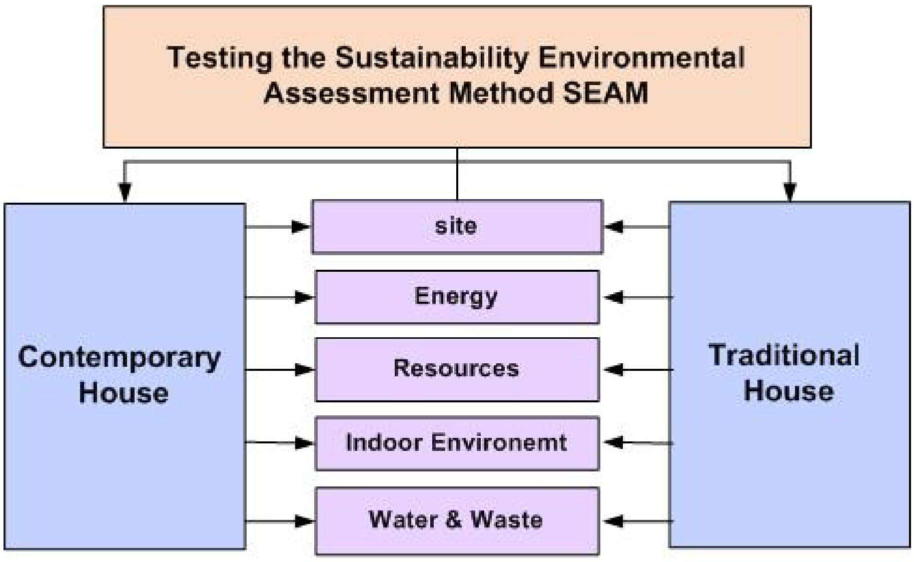


Figure 8.3- The criteria of sustainability environmental assessment method

(Source: the author)

Testing the SEAM by using it to assess buildings (houses) is of great use for examining its appropriateness. In this research, investigating environmental sustainability in architecture is based on five assessment areas: site, energy, resources, indoor environment, and water and waste. As discussed in chapter four, each area of assessment consisted of sub-area of assessment that is used in assessing sustainability performance of the house. Testing the SEAM appropriateness is essential for objectivity and reliability of the proposed method.

8.2.1 Site

According to the proposed SEAM rating system, “Site” was given 15 credits; these credits are divided as follows: site selection (6 credits), site planning (6 credits), and building footprint (3 credits).

a. Site selection

In the UAE, there are no Greenfields or sites with noticeable ecological value, as in UK for instance. Most of the sites are considered “zeroculture” sites with minimal organic mass.

Thus, standards for accreditation ecological value and site enhancement and protection set by EcoHomes or LEED cannot be applied to evaluate sites in the UAE.

Site selection for residential buildings had to fulfil the occupants' requirements environmentally and socially. Selecting sites for traditional houses was based on geographical location, topography and availability of resources, especially water. The traditional case study is located within the Bastakia district in Dubai within the urban fabric of residential buildings. The contemporary case study is located within the modern residential district in Sharjah within the urban fabric of the modern city gridiron planning system. Selecting sites for contemporary houses is based on modern urban planning where urban settlements expanded over available lands. All these residential sites were new and were not used before; it means that all modern sites were virgin lands. Yet, the accelerating need for urban expansions to cope with architectural boom in the UAE since 1971 may justify this trend.

According to the previous discussion, the research concluded that site selecting in both case studies are acceptable, nevertheless the traditional house scored better level in site selection than the contemporary did. Final rate for the two case studies is 8/10 for traditional house, and 6/10 for the contemporary.

b. Site planning

Front elevation orientation for the traditional house is northeast, where the angle between northeast to northwest is the common orientation for most of the traditional houses to receive the prevailing wind. For the contemporary house, main elevation is oriented towards northeast also, but this is a coincident because attached plot from the back is oriented towards southwest. Moreover, the open spaces around the building allow elevations to have different orientations according to its siting. In traditional house, the inward design allowed all the internal elevations and openings to open into the central courtyard. This solution provided natural lighting and ventilation, yet shaded elevations according to the sun path along the day. The traditional house was built on a plot area 630 m^2 where the plot coverage is 75.4% while the contemporary plot area is 885 m^2 where the plot coverage is 49%. This gives an advantage to the traditional house in plot size, plot coverage, and orientation compared to the contemporary.

According to EcoHomes accreditation, private space is important to improve the occupants' quality of life by providing a private outdoor space. Full credit is given for the provision of outside space that is at least partially private (BRE, 2005, P.111). Internal courtyard, in the traditional house, was an adequate private space for the family, especially women. While in the contemporary house, open space surrounded the building mass, thus it did not provide an adequate private space for the family, in spite of high boundary walls.

According to the previous discussion, the research concluded that site planning in the traditional house scored better level than the contemporary. Final rate for the two case studies is 10/10 for traditional house, and 6/10 for the contemporary.

c. Building footprint

To evaluate building footprint (ecological impact), EcoHomes used what called "Footprint ratio"; it equals Floor Area / Footprint Area. Definition of Floor Area is the area contained within inner leaf of the external walls, including that taken up by halls, stairwells, cupboards and partitions, but for semi-detached or terraced**.** Definition of Footprint Area is the area that dwelling imprints on the ground surface, including any other outbuildings with permanent foundations that are part of the home (Total built-up/ground floor area). In EcoHomes accreditation, building footprint aims to promote the most efficient use of a building's footprint by ensuring that land and material use is optimised across the development (BRE, 2005, P.97). EcoHomes gives credits when Footprint ratio is greater than 2.5:1. For the traditional house, Footprint ratio is 1.2:1, and for the contemporary house is 1.9:1. Both of the case study ratios did not match with the standards set by EcoHomes, yet the contemporary footprint ratio was higher than the traditional.

According to the previous discussion, the research concluded that building footprint in the contemporary house scored better level than the traditional did. Final rate for the two case studies is 7/10 for traditional house and 8/10 for the contemporary. Final assessment for "site" criteria is illustrated in table 8.2.

Table - 8.2 - Final assessment for environmental sustainability-Site
(Source: the author)

Area of Assessment	Sub-areas of Assessment						Total Credits
Site	**6**	**Site Selection**	**6**	**Site Planning**	**3**	**Building Footprint**	**15**
Traditional House	1 2 3 4 5 / 6 7 8 9 10		1 2 3 4 5 / 6 7 8 9 10		1 2 3 4 5 / 6 7 8 9 10		
	Credit= 8 × 6/10 =4.8		Credit=10×6/10 = 6		Credit= 7 ×3 /10 = 2.1		**12.9**
Contemporary House	1 2 3 4 5 / 6 7 8 9 10		1 2 3 4 5 / 6 7 8 9 10		1 2 3 4 5 / 6 7 8 9 10		
	Credit= 6 ×6 /10 = 3.6		Credit= 6 ×6 /10 = 3.6		Credit= 8 ×3 /10 = 2.4		**9.6**

8.2.2. Energy

According to the proposed SEAM rating system, “Energy” was given 30 credits; these credits are divided as follows: carbon dioxide (10 credits), renewable energy resources (10 credits), and building envelope (10 credits).

a. Carbon dioxide

The aim of this assessment is to minimise emission of carbon dioxide (CO_2) to the atmosphere arising from the operation of a home and its services. CO_2 is selected as the measured quantity as it has a direct environmental impact and allows the type of primary fuel to be taken into consideration. According to EcoHomes rating systems, certain credits are given according to CO_2 emissions per year depending on type and quantity of energy the house consume annually. To assess CO_2 emissions using EcoHomes standards, information on energy used for heating and hot water is taken from the SAP worksheets and added to a calculation to estimate the energy consumption from lights and appliances (BRE, 2005, P.4). For the purpose of assessment process in this research, the EcoHomes method in calculating emission will not be used because calculations for heating and hot water are required, which is not appropriate to the UAE climate.

Different primary fuel sources release varying amounts of CO_2 as a proportion of the energy that they release on combustion. The term used to state a primary fuel sources energy content is ‘Calorific Value’. Calorific Value is the amount of heat generated by a given mass of fuel when it is completely burned and is measured in joules per kilogram. Using this knowledge the Carbon Trust decided that to quantify the CO_2 emission burden of an energy source; it is needed to use a set of nationally agreed carbon emission factors values. Based on this understanding the Carbon Trust has published the following set of nationally agreed emission factors presented for a range of widely used primary fuel sources. In the case of electricity consumption, it is in most cases impossible to identify with any certainty the source of generation. For this reason, the Climate Change Levy Negotiated Agreements and the ETS are using an average carbon intensity factor for the estimation of carbon dioxide emissions from the consumption of electricity; this has been fixed at 0.43 $kgCO_2/kWh$. For renewable energy sources, the CO_2 emission factor is 0.00 (www.thecarbontrust.co.uk/foundation/0302GWP.html - Last accessed 15-07-2006)

Using the Carbon Trusts nationally agreed emission factors and the formula presented below, the calculation of an energy sources CO_2 emission responsibility can be seen to be a fair and reliable process:

CO_2 emissions= Energy Consumption (kWh) x Energy Source Emission Factor ($kgCO_2/kWh$) x 0.001

To assess CO_2 emission for traditional and contemporary houses, the above equation has been adopted.

CO_2 emissions for case study Tra.3= 0.00 (the CO_2 emission factor for renewable energy sources is 0.00.)

CO_2 emissions for case study Con.2 = (Total energy consumed in domestic buildings/No. of residential buildings in the UAE) x 0.43 $kgCO_2$/kWh x 0.001

($4{,}313 \times 10^6$ KWh / 863,860) x 0.43 $kgCO_2$/kWh x 0.001=2.14656 kg CO_2

According to the results of the equation above and based on EcoHomes accredits 10/10 for houses with zero CO_2 emission and 9/10 for houses that release less than 10 kg/m²/year (BRE, 2005, P.3), the final rate for the two case studies is 10/10 for traditional house and 9/10 for the contemporary.

b. Renewable energy sources

As recommended by EcoHomes (2005, P.53) assessing renewable energy resource aims to reduce atmospheric pollution by encouraging locally generated renewable energy to supply a significant proportion of the development's energy demand. A full credit is given if at least 10% of either the heat (space and hot water) demand or the non-heating electrical demand within the development is supplied from local renewable energy sources (BRE, 2005, P.67). Energy resources in the traditional house are renewable depending on sun and natural ventilation (wind). The contemporary house depends totally on non-renewable energy resources. Accordingly, final rate for the two case studies is 10/10 for traditional house and 1/10 for the contemporary.

c. Building envelope

Green Globes environmental assessment method accredits buildings envelope because it is the media to minimize the energy that is gained or lost through the envelope (Green Building Initiative, 2005, P.19). The resistance of heat transfer through building envelope depends on its thermal properties, construction system and design concept. The heat transference through building envelope can be minimized if the surface area is limited and the R-value (thermal resistance) is high (Moore, 1993, P.13). R-value is the effectiveness of a building envelope assembly in resisting the flow of heat under static conditions and it is the reciprocal of thermal conductance(C-value) where: R = 1/ C (Evans, 1980, P.78). The resistance of the wall assembly equals the sum of the resistances of its components, the greater the R-value, the greater the resistance to thermal conductance through the wall (Moore, 1993, P.13). The insulative properties of materials and building envelope are expressed as the U-value (thermal transmittance); it is the reciprocal of the total R-value. Materials or building envelope with low U-value has high insulative properties or resistance (Koch-Nielsen, 2002, P.105).

Table 8.3 - Thermal properties of building materials in traditional and contemporary houses
(Source: the author based on Moore, 1993)

Material	**Thickness** Inch	**Thermal Conductivity (K)** Btu.inch/ft.hr.F°	**Thermal Conductance(C)** Btu/ft^2.hr.F°	**Thermal Resistance (R)** Ft2.hr.F°/Btu
Coral stone	24	0.5	0.021	47.6
Concrete	8	12	1.5	0.67
Gypsum	2	1.2	0.6	1.7

Traditional wall R- value	=	47.6 Ft^2.hr.F°/Btu +1.7 Ft^2.hr.F°/Btu	=	49.3 Ft^2.hr.F°/Btu
Traditional wall U-value	=	1/ 49.3	=	0.02 Btu /Ft^2.hr.F°
Contemporary wall R- value	=	0.67 Ft^2.hr.F°/Btu + 1.7 Ft^2.hr.F°/Btu	=	2.37 Ft^2.hr.F°/Btu
Contemporary wall U-value	=	1/ 2.37	=	0.4 Btu /Ft^2.hr.F°

As illustrated in table 8.3, R-value of the wall in the traditional house is about 49.3 ft^2.hr.F°/Btu and the U-value is 0.02 Btu/ft^2.hr.F°, while R-value of the wall in the contemporary house is about 2.37 ft^2.hr.F°/Btu and the U-value is 0.42 Btu/ft^2.hr.F°. This shows that building envelope in the traditional house is more insulative than the contemporary is, thus it has a better thermal performance.

Poor thermal performance of the contemporary house compared to traditional, is referred to use of non-sustainable building materials that are not suitable for local climate. Contrarily, traditional building envelope and materials are sustainable taken from available resources and ambient environment. According to the previous discussion, the research concluded that building envelope in the traditional house has better thermal performance than the contemporary did. Final rate for the two case studies is 9/10 for traditional house and 7/10 for the contemporary. Final assessment for “Energy” criteria is illustrated in table 8.4.

Table 8.4 - Final assessment for environmental sustainability-Energy
(Source: the author)

Area of Assessment	**Sub-areas of Assessment**						**Total Credits**
Energy	**10**	**Carbon Dioxide**	**10**	**Renewable energy resources**	**10**	**Building envelope**	**30**
Traditional House	1 2 3 4 5 6 7 8 9 10 Credit=10 ×10 /10= 10		1 2 3 4 5 6 7 8 9 10 Credit=10×10/10= 10		1 2 3 4 5 6 7 8 9 10 Credit= 9 ×10/10= 9		29
Contemporary House	1 2 3 4 5 6 7 8 9 10 Credit= 9 ×10 /10 = 9		1 2 3 4 5 6 7 8 9 10 Credit=1×10/10 =1		1 2 3 4 5 6 7 8 9 10 Credit= 7 ×10 /10 = 7		17

8.2.3. Resources

According to the proposed SEAM rating system, “Resources” was given 21 credits; these credits are divided as follows: Building materials (9 credits), recycle and reuse (7 credits), and materials lifecycle (5 credits).

The scale of resource use and ecological impacts associated with buildings is widely acknowledged. Much of the discussion relates to the amount of energy used during building operation and the associated greenhouse gas emissions and the use of ozone-depleting substances in mechanical cooling (Cole, 2000, P.949).

a. Building materials

Building materials constitute the major elements in the buildings costs, ranging between 64% and 67% of the basic cost of any building. Thus, the increase in its cost consequently leads to the increase in the cost of buildings (CAMRE, 2005, P.3).The considerable increase in the housing costs in the UAE has created difficulties for low-income UAE nationals to build their own houses especially that most of them depend on one income such as the monthly income. Beside that, the cost of construction seems to vary from one emirate to the other. For example, double-story villa size of 630 m² (7,000 feet²), with four bed rooms along with their bath-rooms and dressing rooms, two majlises (visitors’ sitting room), dinning room, a family setting area, kitchen, pantry, guest room and one maid room), would cost in Abu Dhabi between Dhs1,600,000 – Dhs1,900,000 (US$ 432,432- 513,513). The same villa, in Dubai, will cost between Dhs1, 300,000 – Dhs1, 500,000 (US$ 351,351-405,405), in Sharjah Dhs800, 000 – Dhs1, 200,000 (US$ 216,216- 324,324) (Balkir; Hassan & Al-Segini, 2006, P.31).

In addition to materials’ high cost, houses consume great quantities of materials in the UAE where average built up area is higher than world standards. LEED recommends certificate for houses smaller than the US national average as efficiency in materials and resources. This certificate is between (-10 and 10); the highest assessment (10) is given to houses that their size is less than the areas set by LEED. For a 4-bed room house, the US national average is 238.32 m² (2648 ft²), the highest certificate (10) for houses size no more than 373.32 m² (4148 ft²), and the lowest certificate (-10) for houses size no more than 103.5 m² (1150 ft²) (GBC, 2004). Consequently, world standards cannot be used to assess the chosen case studies for this research because they already exceed these standards. This difference is justified because of the different life style, type and size of families, nature of social relations, and cultural values in the UAE and the Arab World.

Nevertheless, using locally sustainable building materials, such as coral stone, limestone, and palm trees, in the traditional house promoted conservation of dwindling non-renewable resources. In the contemporary house, using non-renewable imported materials such as concrete, steel, aluminium and glass, is not suitable for the climate of the region and involve continuous costly maintenance. Imported materials necessitate air conditioning and more energy consumption to control the interior environment. Thus, power (electricity) consumption in UAE is considered one of the highest in the world. On the contrary, sustainable building materials used in traditional houses accommodated to ambient environment depending on natural resources and needed no artificial power to provide comfortable internal environment for occupants.

Moreover, spaces areas in the traditional house are more rational than the contemporary. Total built-up area in the traditional house was 571 m^2 while in the contemporary was 828 m^2. In the traditional house, the average bedroom area is (25-28) m^2 , men *Majlis* is 19.6 m^2, and women *Majlis* is 12.8 m^2,while in the contemporary house, the average bedroom area is (30-35) m^2, men *Majlis* is 70 m^2 and women *Majlis* is 31.5 m^2,.

According to the previous discussion, the research concluded that building materials consumption in the traditional house is more rational than the contemporary does, thus it was more sustainable. Final rate for the two case studies is 9/10 for traditional house and 6/10 for the contemporary.

b. Recycling and Reuse

Reusability is a function of the age and durability of a material. Durable materials may have many useful years of service left when the building in which they are installed is decommissioned, and may be easily extracted and reinstalled in a new site (Kim & Rigdon, 1998B, P.15). In many cases, the quality of materials and quality displayed by traditional buildings could not be reproduced today.

Recyclability measures a material's capacity to be used as a resource in the creation of new products. Recycling differs from reuse in as much as the element can be reduced to raw materials and used in new products (Spiegel, & Meadows,1999, P.29). Main building material used in the traditional house, coral stone, is of recycled content and can be reused. Concrete blocks, used in the contemporary house, can be recycled if crushed for new aggregate.

Analysing sustainability criteria in local traditional building materials and modern imported ones, declares sustainability potential in local materials. Careful investigation and selection of the materials used and the way they are combined can yield significant improvements in the comfort and energy efficiency of the house. Kim and Rigdon (1998B) identify characteristics of sustainable building materials such as low embodied energy, natural materials, locally available, energy efficiency, non-toxic, log life, reusable, recyclable, and Biodegradable. According to table 8.5 that illustrates sustainability characteristics of building materials used in the traditional and contemporary case study houses, it is concluded that building materials used in the traditional house have more sustainability characteristics than building materials used in the contemporary.

Table 8.5 - Sustainability characteristics of building materials used in the traditional and contemporary case study houses

(Source: the author based on Kim & Rigdon, 1998B)

Type of Houses	Building Materials	Manufacturing Process MP					Building operations BO					Waste Management WM			
		P2	RC	EER	NM	WR	EE	WTC	RES	NT	LL	RU	R	B	O
Traditional House	Coral stone		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
	Gypsum			✓	✓		✓			✓			✓		
	Wood	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Contemporary House	Concrete block		✓			✓	✓			✓	✓	✓	✓		✓
	Steel		✓		✓					✓	✓	✓	✓	✓	
	Glass		✓									✓	✓		
	Aluminium		✓								✓	✓	✓		

Symbol	Material Characteristic	Symbol	Material Characteristic
P2	Pollution Prevention	**RES**	Renewable Energy Systems
RC	Recycled Content	**NT**	Non-Toxic or Less-Toxic Material
EER	Embodied Energy Reduction	**LL**	Longer Life
NM	Natural Materials	**RU**	Reusability
WR	Waste Reduction	**R**	Recyclability
EE	Energy Efficiency	**B**	Biodegradability
WTC	Water Treatment/Conservation	**O**	others

According to the previous discussion, the research concluded that recycling and reuse of building materials is more evident in the traditional house than in the contemporary, thus it was more sustainable. Final rate for the two case studies is 10/10 for traditional house and 6/10 for the contemporary.

c. Materials lifecycle

The Impact of a given material can occur at all stages of the material's lifecycle. It is not just the energy consumed during the life of a building that has to be considered. Energy is involved in the extraction, manufacture and transportation of building materials and this is known as "embodied energy" and directly relates to the gross carbon intensity of a material (Smith, 2002, P.73).

A “cradle-to-grave” analysis of building products, from the gathering of raw materials to their ultimate disposal, provides a better understanding of the long-term costs of materials. These costs are paid not only by the client, but also by the owner, the occupants, and the environment. The principles of "Life Cycle Design" provide important guidelines for the selection of building materials. A material’s life cycle can be organized, as identified by Kim and Rigdon (1998B, P.3), into three phases relate to the flow of materials through the life of the building - Figure 8.4.:

1. Pre-Building Phase

The Pre-Building phase describes the production and delivery process of a material up to, but not including, the point of installation. This includes discovering raw materials in nature as well as extracting, manufacturing, packaging, and transportation to a building site.

2. Building Phase

The Building Phase refers to a building material’s useful life. This phase begins at the point of the material’s installation and assembly into a structure, includes the maintenance and repair of the material, and extends throughout the life of the material within or as part of the building. This phase is most notable phase in house operating cost especially in energy consumption during house lifetime habitation.

3. Post-Building Phase

The Post-Building Phase refers to the building materials when their usefulness in a building has expired. At this point, a material may be reused in its entirety, have its components recycled back into other products, or be discarded.

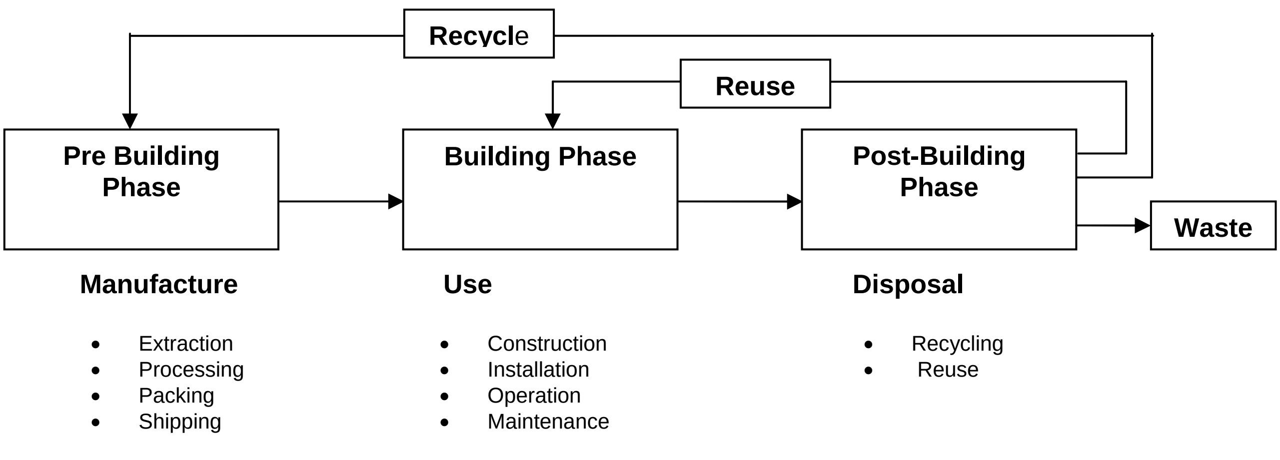


Figure 8.4- The three phases of materials lifecycle
(Source: Kim & Rigdon, 1998B)

Materials with a longer life relative to other materials designed for the same purpose need to be replaced less often. This reduces the natural resources required for manufacturing and the amount of money spent on installation and the associated labour. Durable materials, as brick, stone and steel that require less frequent replacement will require fewer raw materials and will produce less landfill waste. Maintenance consumes a significant portion of a building's operating budget; so using low maintenance materials will reduce the house cost over the building's lifetime.

According to the previous discussion, the research concluded that materials lifecycle is more sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 10/10 for traditional house and 6/10 for the contemporary. Final assessment for "Resources" criteria is illustrated in table 8.6.

Table 8.6 - Final assessment for environmental sustainability-Resources
(Source: the author)

Area of Assessment	Sub-areas of Assessment															Total Credits
Resources	**9**	**Building materials**				**7**	**Recycle & reuse**				**5**	**Materials lifecycle**				**21**
Traditional House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	**20.1**
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	
	Credit= 9 × 9 /10 = 8.1					Credit= 10 ×7 /10 = 7					Credit= 10 ×5 / 10 = 5					
Contemporary House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	**13.2**
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	
	Credit= 6 × 9 /10 = 5.4					Credit= 6 ×7 /10 =4.2					Credit= 6 ×6 /10 = 3.6					

8.2.4. Indoor environment

According to the proposed SEAM rating system, "Indoor Environment" was given 15 credits; these credits are divided as follows: natural ventilation (5 credit), indoor air quality (5 credits), and thermal comfort (5 credit).

a. Natural Ventilation

The aim of ventilation systems is to provide effective ventilation thereby helping to ensure occupant well-being and comfort (Green Building Initiative, 2005, P.30). Natural ventilation and natural building materials were of great effect in providing comfortable indoor environment. Ventilative cooling strategy was the best method to provide comfortable indoor environment in hot humid region as UAE coastal regions.

The traditional case study house had two barjeels, one opens to the Majlis in the ground floor, the other opens to one of the rooms in the upper floor. With an area 155 m², courtyard along with the barjeels created natural ventilation across the house. In spite of large windows from the four sides in the contemporary case study house, they are not fully opened. Thus, these windows do not provide adequate cross ventilation within internal spaces without any additional natural ventilation systems as wind stacks.

According to the previous discussion, the research concluded that natural ventilation is more considered in the traditional house than in the contemporary. Final rate for the two case studies is 9/10 for traditional house and 5/10 for the contemporary.

b. Indoor air quality

Building materials, as an essential part of construction processes, have a significant role on occupants' health and quality of indoor environmental. This often extends far beyond the specific context of their end-use. Some building materials, especially manufactured, such as adhesives, emit dangerous fumes for only a short time during and after installation; others can contribute to air quality problems throughout a building's life. Generally, natural building materials are less toxic than modern. They require less processing and are less damaging to the environment (Kim & Rigdon, 1998B, PP.16, 18).Thus, we may presume that the traditional house has better in indoor air quality.

Building materials used in the traditional house such as coral stone, wood, and clay mortar are all natural, thus they are not toxic and do not emit pollution or gases that may affect negatively on air. They are environment-friendly and sustainable. Accordingly, indoor air quality was free of toxicity or polluted gases. Yet, in winter coal and wood is used for warming spaces in cold nights where the whole family gathered in one room. Thus, air quality is affected especially that rooms used in winter are sometimes windowless, otherwise windows are closed firmly.

The contemporary house is characterised with total dependency on artificial air-conditioning, manufactured materials, excessive use of chemical products as air perfumes and cleaning products and insufficient natural ventilation. Since no official figures are published about indoor air quality in domestic buildings in the UAE, and measuring that is beyond the limits of this research, it is concluded that indoor air quality is not within world standards.

According to the previous discussion, the research concluded that indoor air quality is more sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 6/10 for traditional house and 5/10 for the contemporary.

c. Thermal comfort

Traditional houses in the UAE provided maximum comfort in a hot climate of the region. Using available local materials such as coral stones, limestone, and mud brick provided good insulation, preserving a cool interior environment, utilizing natural ventilation and catching any passing breeze through walls and lattice wooden and gypsum screens.

Sustainable building materials used in the traditional house accommodated to ambient environment depending on natural resources and needed no artificial power to provide comfortable internal environment for occupants. The resistance to thermal conductance through the wall is an indicator for the good resistance to thermal conductance through the wall to minimize the internal temperature fluctuation, which is one of the strategies used in the traditional house to protect the indoor spaces from heat gain and external extreme temperatures. This protection provided comfort indoor environment without depending on artificial air conditioning equipments.

Comfortable indoor environment in Contemporary houses obtained depending on mechanical air-conditioning. This thermal comfort is artificial consuming a great deal of energy with high cost and negative environmental sequences.

According to the previous discussion, the research concluded that thermal comfort is more natural and sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 7 /10 for traditional house and 4/10 for the contemporary. Final assessment for "Indoor Environment" criteria is illustrated in table 8.7

Table 8.7- Final assessment for environmental sustainability – indoor Environment
(Source: the author)

<table>
<tr><th>Area of Assessment</th><th colspan="15">Sub-areas of Assessment</th><th>Total Credits</th></tr>
<tr><th>Indoor environment</th><th>5</th><th colspan="4">Natural ventilation</th><th>5</th><th colspan="4">Indoor air quality</th><th>5</th><th colspan="4">Thermal comfort</th><th>15</th></tr>
<tr><td rowspan="3">Traditional House</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td rowspan="3">11</td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Credit= 9 ×5 /10 = 4.5</td><td colspan="5">Credit= 6 ×5 /10 = 3</td><td colspan="5">Credit= 7 ×5 /10 = 3.5</td></tr>
<tr><td rowspan="3">Contemporary House</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td rowspan="3">7</td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Credit= 5 × 5/10= 2.5</td><td colspan="5">Credit= 5 ×5 /10 = 2.5</td><td colspan="5">Credit= 4 ×5 /10 = 2</td></tr>
</table>

8.2.5. Water & waste

According to the proposed SEAM rating system, “Water and Waste” was given 19 credits; these credits are divided as follows: Water consumption and recycling (11 credits), and waste output and recycling (8 credits).

a. Water consumption and recycling

According to EcoHomes, assessing water consumption aims to reduce consumption of water in the home (BRE, 2005, P.71). In the traditional house, wells were the main source for getting fresh water by digging a vertical shaft to reach the water below the ground (groundwater). Although Islam calls for cleaning, the traditional house had only three bathrooms. Water was used rationally and rarely discarded immediately; it was recycled and reused more than once because of water scarcity and difficulty to obtain.

As discussed in chapter six, the UAE has one of the highest water consumption levels in the world compared to Western countries due to climatic conditions and high per capita income. Water consumed for domestic use form 63% of consumed water in the UAE. Statistics of Dubai Electricity and Water Authority (DEWA), show that the total consumption in domestic buildings was 53,504 MIG (million imperial gallons) with an average 0.142 MIG per house (www.dewa.gov.ae – Last accessed 31-03-2007). UAE per capita consumption of water is estimated at 133 gallons per day (g/d), compared with 85 g/d in the USA (www.youthxchange.net –Last accessed 31-03-2007).

Water used for domestic facilities is quite high with the several bathrooms in each house. The contemporary house contains eight bathrooms, one for each bedroom, besides bathrooms for the Majlis, living room, and for the maid. Moreover, there is no water recycling process taken place in houses. Yet, municipalities treated domestic water for irrigating public parks.

According to the previous discussion, the research concluded that water consumption and recycling is more rational and sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 8 /10 for traditional house and 3/10 for the contemporary.

b. Waste output

Domestic waste produced by the traditional house negligible amount of waste as compared with the contemporary. Furthermore, most waste was bio-gradable and natural scavengers picked up the remains.

The UAE has one of the world's highest levels of domestic waste. Per capita household waste has reached an average annual 730 kg/capita. Year. There is no recycling or separation process takes place in contemporary house. Municipal vehicles gather all the domestic waste where it is disposed in certain landfill sites, recycled, reused, and disposed by the local municipalities.

According to the previous discussion, the research concluded that waste output is more sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 7 /10 for traditional house and 4/10 for the contemporary. Final assessment for “Water & Waste” criteria is illustrated in table 8.8.

Table 8.8 - Final assessment for environmental sustainability-Water & Waste
(Source: the author)

<table>
<tr><th>Area of Assessment</th><th colspan="12">Sub-areas of Assessment</th><th>Total Credits</th></tr>
<tr><td>Water & Waste</td><td>11</td><td colspan="5">Water consumption & recycling</td><td>8</td><td colspan="5">Waste output & recycling</td><td>19</td></tr>
<tr><td rowspan="3">Traditional House</td><td>1</td><td>2</td><td>3</td><td>4</td><td colspan="2">5</td><td>1</td><td>2</td><td>3</td><td>4</td><td colspan="2">5</td><td rowspan="3">14.4</td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td colspan="2">10</td><td>6</td><td>7</td><td>8</td><td>9</td><td colspan="2">10</td></tr>
<tr><td colspan="6">Credit= 8 ×11/10 = 8.8</td><td colspan="6">Credit= 7 × 8/10 = 5.6</td></tr>
<tr><td rowspan="3">Contemporary House</td><td>1</td><td>2</td><td>3</td><td>4</td><td colspan="2">5</td><td>1</td><td>2</td><td>3</td><td>4</td><td colspan="2">5</td><td rowspan="3">6.5</td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td colspan="2">10</td><td>6</td><td>7</td><td>8</td><td>9</td><td colspan="2">10</td></tr>
<tr><td colspan="6">Credit= 3 ×11 /10 = 3.3</td><td colspan="6">Credit= 4 ×8 /10 = 3.2</td></tr>
</table>

According to discussed issues and assessment process for environmental sustainability criteria for the chosen case study, it is concluded that traditional house is more environmentally sustainable. Final assessment results for environmental sustainability performance are illustrated in table 8.9.

Table 8.9 - Final assessment for environmental sustainability of traditional and contemporary houses
(Source: the author)

<table>
<tr><th>SEAM</th><th colspan="6">Areas of Assessment Credits</th></tr>
<tr><td rowspan="2">Areas of assessment</td><td>Site</td><td>Energy</td><td>Resources</td><td>Indoor Environment</td><td>Water & Waste</td><td>Total Credits</td></tr>
<tr><td>15</td><td>30</td><td>21</td><td>13</td><td>21</td><td>100</td></tr>
<tr><td>Traditional House</td><td>12.9</td><td>29</td><td>20.1</td><td>11</td><td>14.4</td><td>87.4</td></tr>
<tr><td>Contemporary House</td><td>9.6</td><td>17</td><td>13.2</td><td>7</td><td>6.5</td><td>53.3</td></tr>
</table>

8.3. Testing the Proposed SSAM

Testing the SSAM process will be held through comparative analysis for the two case studies that have been chosen in chapter seven. In the application stage, the proposed SSAM will be applied to assess social sustainability in the chosen houses. Findings of this assessment are important for feedback for developing and refining the proposed SSAM. In this research, investigating social sustainability in architecture is based on five assessment areas: privacy, social relations, neighbourhood, family, and Identity and social status. As discussed in chapter five, each area of assessment consisted of sub-areas of assessment criteria that are used in assessing sustainability performance of the house. Testing the SSAM appropriateness is essential for objectivity and reliability of the proposed method. Figure 8.5 shows the criteria of sustainability social assessment method.

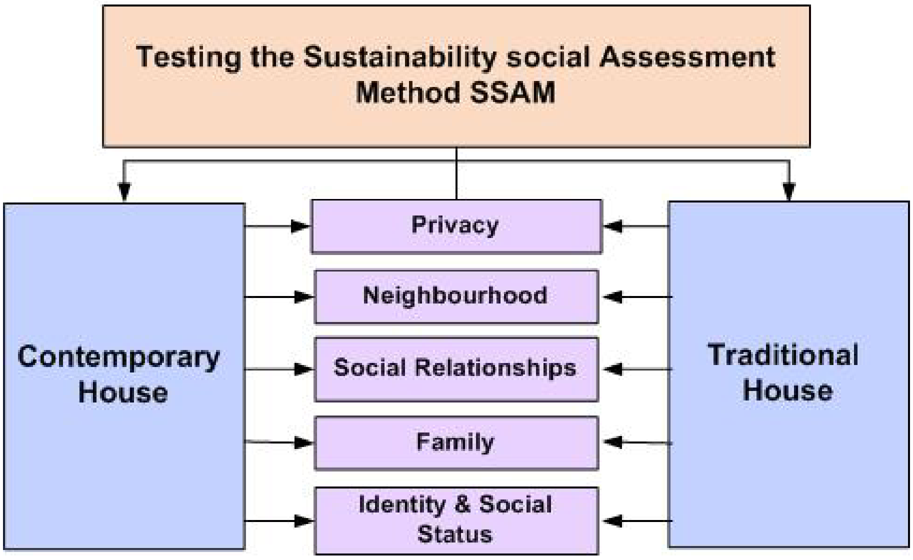


Figure 8.5- The criteria of sustainability social assessment method

(Source: the author)

8.3.1. Privacy

According to the proposed SSAM rating system, “Privacy” was given 25 credits; these credits are divided as follows: urban planning and design concept (13 credits), external facades (7 credits), and acoustical privacy (5 credit).

a. Urban planning and design concept

Privacy is one of the most important social values that influence the design of the house. It is fulfilled through gender segregation between public (men) and private (family and women) especially in the seating areas. Both in the traditional and contemporary, spaces are divided into three zones according to privacy level needed. Public zone is located at the front of the house; it includes male reception (*Majlis*) with its own entrance. Main house entrance leads to the *dehrez* in the traditional houses while it leads to a central hall where most of the semi-public spaces are located, as women reception, and family living. Service zone such as kitchen, laundry, and maids' rooms are usually at the middle (traditional house) or back (in the contemporary) with its entrance and service yard. Private zone such as family bedrooms and bathrooms are located in the back or in the first floor. For the contemporary house, the first floor rooms are provided with private family sitting area and pantry.

The courtyard, in traditional house, is a private inward space where family meets and other spaces oriented. This private outdoor space (courtyard) is substituted with outer spaces surrounded with high walls in contemporary house.

According to the previous discussion, the research concluded that both traditional and contemporary houses design is based on keeping family privacy and segregation between genders through spaces zoning and spatial arrangement. Yet, the traditional houses achieved privacy through introvert design and reflected family way of living. Final rate for the two case studies is 9 /10 for traditional house and 8/10 for the contemporary.

b. External facades

The traditional house reflected privacy by semi-solid external facades with no openings in the ground floor, except the *Majlis*, and treating the first floor opening with wooden screens. Spaces were opened to the internal courtyard directly or indirectly through Liwan. External facades in the contemporary house have little relation to the traditional. They are transparent with big openings and porches that do not provide an adequate level of privacy. To keep privacy openings are covered with heavy curtains.

According to the previous discussion, the research concluded that the traditional house achieved privacy through external facades treatment more than the contemporary did. Final rate for the two case studies is 9 /10 for traditional house and 4/10 for the contemporary.

c. Acoustical privacy

Acoustical privacy is well reserved in the traditional and contemporary houses, either by thick walls and introvert design (in the traditional) or by big open spaces around the house and the wide streets (in the contemporary).

According to the previous discussion, the research concluded that both the traditional and contemporary houses achieved acoustical privacy in design. Final rate for the two case studies is 8 /10 for traditional house and 8/10 for the contemporary. Final assessment for "Privacy" criteria is illustrated in table 8.10.

Table 8.10 - Final assessment for social sustainability-Privacy

(Source: the author)

Area of Assessment	Sub-areas of Assessment															Total Credits
Privacy	**13**	**Urban planning and design concept**				**7**	**External facades**				**5**	**Acoustical privacy**				**25**
Traditional House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	22
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	
	Credit= 9 ×13 /10 = 11.7					Credit= 9 ×7 /10 = 6.3					Credit= 8 ×5 /10 = 4					
Contemporary House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	17.2
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	
	Credit= 8 ×13 /10 = 10.4					Credit= 4 ×7 /10 = 2.8					Credit= 8 ×5 /10 = 4					

8.3.2. Social Relations

According to the proposed SSAM rating system, "Social Relations" was given 20 credits; these credits are divided as follows: hospitality (10 credits), and guest honouring (10 credits).

For most of the country's inhabitants, a traditional lifestyle is but a distant memory. Nevertheless, despite the social transformation, that has take place in the UAE, with all its positive and negative implications, the very essence of traditional society, religion, language, family and tribal affiliations, remain constants (UAE Year Book, 2006, P.55).

a. Hospitality

Social relations have changed a lot since the 1970s. Yet, doctrines and traditions remained strong related to the tribal norms and Islamic values. Values as hospitality and guest honouring are essential as part of the nationals' personality and Arab generosity. Therefore, it is found that both the traditional and contemporary houses design had to retain a private section or zone for guests; men *Majlis* and women *Majlis* with the required services.

According to the previous discussion, the research concluded that both traditional and contemporary houses took hospitality as an essential factor in house design to sustain social values. Yet, the traditional *Majlis* was open even for strangers, while the contemporary *Majlis* is for family guests and relatives. Final rate for the two case studies is 9 /10 for traditional house and 8/10 for the contemporary.

b. Guest honouring

Guest honouring is well preserved in the traditional and contemporary houses. The *Majlis*, in both houses, is big in size (19.6 m² in the traditional and 70 m² in the contemporary), well decorated, and furnished because it is symbol of the owners' hospitality.

According to the previous discussion, the research concluded that both traditional and contemporary houses kept guest honouring in design and decorations. Yet, the contemporary house was more elaborate because of the modern life style and high economic standard. Final rate for the two case studies is 8 /10 for traditional house and 9/10 for the contemporary. Final assessment for "Social Relations" criteria is illustrated in table 8.11.

Table - 8.11 Final assessments for social sustainability-Social relation
(Source: the author)

<table>
<tr><th>Area of Assessment</th><th colspan="10">Sub-areas of Assessment</th><th>Total Credits</th></tr>
<tr><td>Social relations</td><td>10</td><td colspan="4">Hospitality</td><td>10</td><td colspan="4">Guest honouring</td><td>20</td></tr>
<tr><td rowspan="3">Traditional House</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td rowspan="3">17</td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Credit= 9 ×10 /10 = 9</td><td colspan="5">Credit= 8 ×10 /10 = 8</td></tr>
<tr><td rowspan="3">Contemporary House</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td rowspan="3">17</td></tr>
<tr><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td colspan="5">Credit= 8 ×10 /10 = 8</td><td colspan="5">Credit= 9 ×10 /10 = 9</td></tr>
</table>

8.3.3. Neighbourhood

According to the proposed SSAM rating system, "Neighbourhood" was given 20 credits; these credits are divided as follows: strong neighbourhood relations (8 credits), and preservation of neighbourhood rights (12 credits).

a. Strong neighbourhood relations

Neighbourhood was the backbone of Islamic *ummah* embodying Islamic values and rules regardless of any radical, social, geographic, or other differences. The traditional house was located within organic urban fabric in Bastakia district that kept strong neighbourhood relations. At the contrary, the contemporary house as located in modern residential district surrounded with wide gridiron streets where each family lived within her own property isolated with high walls.

According to the previous discussion, the research concluded that the traditional was more successful to keep neighbourhood relations. Final rate for the two case studies is 8 /10 for traditional house and 4/10 for the contemporary.

b. Preservation of neighbourhood rights

As a Muslim society, preserving neighbours' rights was evident in the traditional house through thick walls, semi-solid elevations, and main entrance door. In spite of modern life style and changes in some social values, neighbours rights are well preserved in the contemporary house where family lives in its private isolated villa surrounded with its own realm in of the big plot high fences, wide streets, and busy lifestyle

According to the previous discussion, the research concluded that both traditional and contemporary houses design has preserved neighbours rights. Final rate for the two case studies is 9 /10 for traditional house and 9/10 for the contemporary. Final assessment for "Neighbourhood" criteria is illustrated in table 8.12.

Table 8.12 - Final assessment for social sustainability-Neighbourhood
(Source: the author)

Area of Assessment	Sub-areas of Assessment										Total Credits
Neighbourhood	**8**	**Strong neighbourhood relations**				**12**	**Preservation of neighbourhood rights**				**20**
Traditional House	1	2	3	4	5	1	2	3	4	5	17.2
	6	7	8	9	10	6	7	8	9	10	
	Credit= 8 ×8 /10 = 6.4					Credit= 9 ×12 /10 = 10.8					
Contemporary House	1	2	3	4	5	1	2	3	4	5	14
	6	7	8	9	10	6	7	8	9	10	
	Credit= 4×8 /10 = 3.2					Credit= 9 ×12 /10 = 10.8					

8.3.4. Family

According to the proposed SSAM rating system, "Family" was given 25 credits; these credits are divided as follows: strong family ties (15 credits), and extended family (10 credits).

a. Strong family ties

Relationship between family members is permanent and enduring in Islamic perspective where family is the nuclear seed of society. This factor was evident in the traditional house. The house included several rooms that fit for the grandfather and the grandmother and married sons and daughters. All spaces were opened to the central courtyard creating a common space for the family members to share their everyday life activities. This enhanced family relation ties. The contemporary house reflected the new life style and economic prosperity that allowed each member in the family to have his private room. The contemporary house had three bedrooms in the ground floor and five bedrooms in the first floor; each room is provided with separate bathroom. This type of design affected family ties where each member had his life and interest.

According to the previous discussion, the research concluded that the traditional house sustained family ties better than the contemporary did. Final rate for the two case studies is 10 /10 for traditional house and 6/10 for the contemporary.

b. Extended family

The traditional house was designed to fit to the extended family members where several families (married sons, their wives, and children) shared the same house. The house had six rooms in the ground floor and two rooms in the first floor. These rooms were flexible; they were deigned to be a suite for one nuclear family comprising a living room, bedroom, children room, bathroom & store. Thus, most of the rooms tended to be rectangular to fit to multi-functional design. The contemporary house is designed as a final product not allowing for modifying or changing.

According to the previous discussion, the research concluded that the traditional house is more flexible for modification, expansions, and change. Thus, it is more sustainable than the contemporary is, because flexibility is one of sustainable architecture principles. Final rate for the two case studies is 9 /10 for traditional house and 5/10 for the contemporary. Final assessment for "Family" criteria is illustrated in table 8.13.

Table 8.13 - Final assessment for social sustainability-Family
(Source: the author)

Area of Assessment	Sub-areas of Assessment										Total Credits
Family	**15**	**Strong family ties**				**10**	**Extended family**				**25**
Traditional House	1	2	3	4	5	1	2	3	4	5	24
	6	7	8	9	10	6	7	8	9	10	
	Credit= 10 ×15 /10 = 15					Credit= 9 ×10 / 10 = 9					
Contemporary House	1	2	3	4	5	1	2	3	4	5	14
	6	7	8	9	10	6	7	8	9	10	
	Credit= 6 ×15 /10 = 9					Credit= 5 ×10 /10 = 5					

8.3.5. Identity & social status

According to the proposed SSAM rating system, “Identity & Social Status” was given 10 credits; these credits are divided as follows: humility and self-advocacy (5 credits), and revealing social status (5 credits).

a. Humility & self-advocacy

Humility and avoiding self-advocacy are principles of Islam that calls for equity and social justice between people. The traditional house was simple, using local materials with plain simple elevations. In the contemporary house, the values of humility began to weaken and self-advocacy became more popular. Elevations were sophisticated with big windows, high porch, classic columns, and curved corners.

According to the previous discussion, the research concluded that the traditional reflected humility and simplicity, thus it was more sustainable than the contemporary was. Final rate for the two case studies is 9 /10 for traditional house and 3/10 for the contemporary.

b. Revealing social status

For the traditional house, richness of inner spaces via the external ones was the main trend in dealing with spaces in term of decorative issues. External elevations were simple, reflecting equity between the rich and poor. The contemporary house represented the social status reflecting the owner’s economical level and social status. The house facade was painted in pastel colour picked out with white columns and details. According to the previous discussion, the research concluded that contemporary house reflected the owner’s identity and social status, while the traditional house reflected society identity and social values. Final rate for the two case studies is 6/10 for traditional house and 9/10 for the contemporary. Final assessment for “Identity & Social Status” criteria is illustrated in table 8.14.

Table 8.14 - Final assessment for social sustainability- Identity & Social Status
(Source: the author)

Area of Assessment	Sub-areas of Assessment										Total Credits
Identity & Social Status	**5**	**Humility & self-advocacy**				**5**	**Revealing social status**				**10**
Traditional House	1	2	3	4	5	1	2	3	4	5	7.5
	6	7	8	9	10	6	7	8	9	10	
	Credit= 9 ×5 /10 = 4.5					Credit= 6 ×5 /10 = 3					
Contemporary House	1	2	3	4	5	1	2	3	4	5	6
	6	7	8	9	10	6	7	8	9	10	
	Credit= 3 ×5 /10 = 1.5					Credit= 9 × 5 /10 =4.5					

According to discussed issues and assessment process for social sustainability criteria for the chosen case studies, it is concluded that traditional house is more socially sustainable. Final assessment results for social sustainability performance are illustrated in table 8.15.

Table 8.15 - Final assessment for social sustainability of traditional and contemporary houses
(Source: the author)

SSAM	**Areas of Assessment Credits**					
Areas of assessment	**Privacy**	**Neighbourhood**	**Social Relations**	**Family**	**Identity & Social status**	**Total Credit**
	25	**20**	**20**	**25**	**10**	**100**
Traditional House	22	17	17.2	24	7.5	**87.7**
Contemporary House	17.2	17	14	14	6	**68.2**

8.4. Modification of the Final SEAM and SSAM

Through the theoretical investigation of this research, a proposed Sustainability Assessment Method (SAM) was developed for examining the potentiality of sustainability in traditional and contemporary architecture in the Arab World. As discussed in chapters four and five, assessment criteria were identified according to investigating existing sustainability assessment methods to formulate environmental and social sustainability assessment methods. In this chapter, the proposed SEAM and SSAM were tested in assessing sustainability performance of the chosen cases studies; traditional and contemporary houses. The second stage of developing the SAM is modifying the final SEAM and SSAM. The testing process will investigate reliability and objectivity of the SAM through examining the appropriateness of the proposed SAM criteria to identify and assess sustainability potentiality. Testing the applicability of the SAM depended on its application in the two chosen case studies through comparative analysis evaluation.

8.4.1. Appropriateness of the SEAM & SSAM

Testing the SEAM, as a process to identify environmental sustainability criteria in traditional and contemporary architecture, helped in providing systematic approach for assessing environmental performance within sustainability standpoint. However, testing appropriateness pointed the importance of modifying environmental issues to accommodate to the ambient environment of the investigated region (The Arab World with reference to the UAE).

Testing the SSAM to explore appropriateness of this method in addressing social values of the society needed to be assessed. This step helped to examine objectivity and reliability of the SSAM. However, testing the appropriateness of SSAM pointed the significance of investigating social values, cultural context, and people's life style before developing and social assessment method for any region or society (the Muslim society in this research).

Testing applicability of the SAM is one aims of the process to investigate applicably in the real world by different people in several fields. Being objective and reliable does not necessitate that the proposed SAM is applicable. This depends on the proposed methodology, experience of assessors, and availability of resources. Testing the SAM is a two-way feedback process. It helps in identifying points of weakness in the SAM and appropriateness of application of the SAM for buildings.

Evaluation, as Voordt & Wegen identify (2005, P.142), allows lessons to be learnt which could lead to an improvement in the project under investigation and more generally improve the quality of programming, designing, building and management of the built environment.

8.4.2. Assessment Results and Analysis

The assessment conducted, using SEAM to evaluate environmental sustainability performance for the chosen case studies shows that the traditional house was more sustainable than the contemporary was. Chart 8.1 illustrates the assessment results. Traditional house scores were higher than the contemporary was in all areas of assessment criteria. The final accreditation was 87.4/100 for the traditional house and 53.3/100 for the contemporary. The maximum difference was in "Energy" where the traditional house scored 29/30 while the contemporary scored 17/30; the difference was obvious in "Site", "Resources" and "Water & Waste" criteria, while scores were close in "Indoor Environment". These results confirmed the success of traditional houses in accommodation to ambient environment, while the contemporary houses neglected environmental issues depending on artificial condition and manufactured building materials.

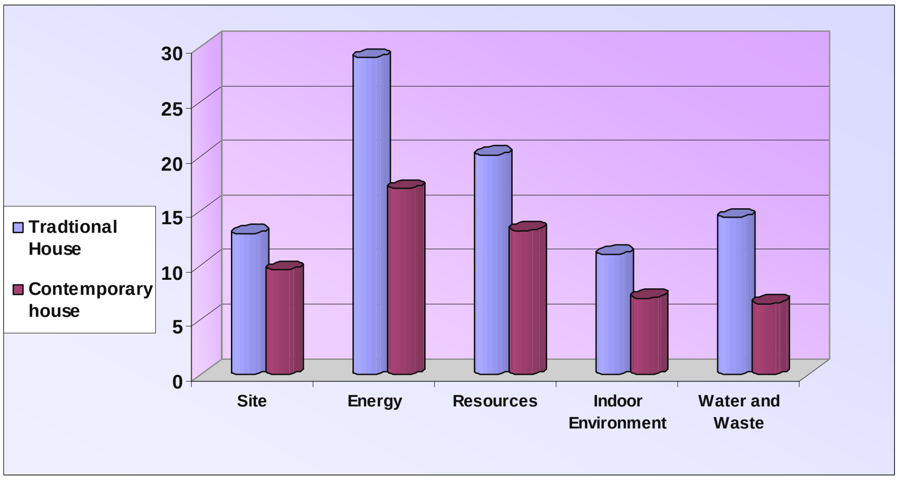


Chart 8.1 - Final assessment for environmental sustainability of traditional and contemporary houses
(Source: the author)

The assessment conducted, using SSAM, to evaluate social sustainability performance for the chosen case studies shows that the traditional house was more sustainable than the contemporary was. Chart 8.2 illustrates the assessment results. Traditional house scores were higher than the contemporary was in most areas of assessment criteria except “Social Relations”. The final accreditation was 87.7/100 for the traditional house and 68.2/100 for the contemporary. The maximum difference was in “Family” where the traditional house scored 24/25 while the contemporary scored 14/25; the difference was obvious in “Privacy” and “Neighbourhood” criteria, while scores were almost the same in “Social relations” and “Identity & Social Status”.

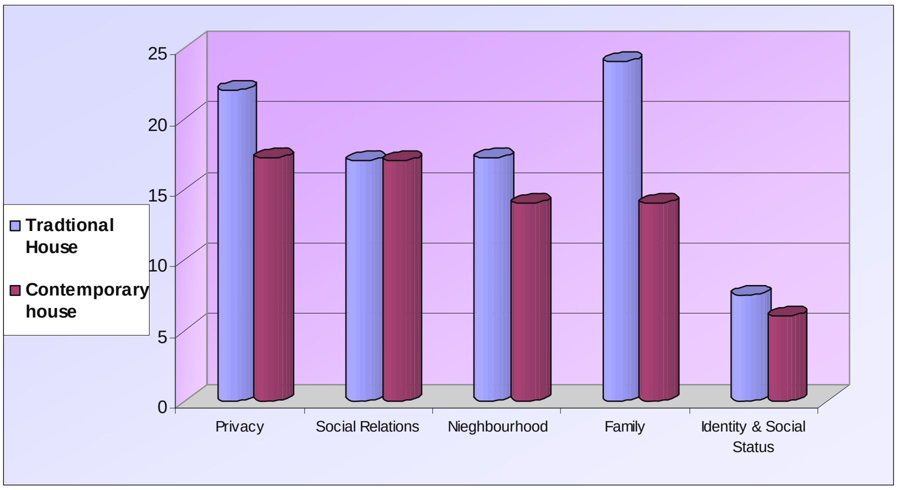


Chart 8.2 - Final assessment for social sustainability of traditional and contemporary houses
(Source: the author)

Results obtained from the assessment process, proved validity of one of this research hypotheses, which is “Traditional houses in the United Arab Emirates are more sustainable and are more appropriate for the ambient environment than their modern counterparts are”.

8.4.3. Setting the Final SAM

The assessment and testing process that has been conducted in this chapter, affirmed that it is an objective and sufficiently demanding measure. It is mostly needed to design the new sustainability assessment methods in the UAE and to develop relevant performance indicators and benchmarks for charting environmental and sustainability progress.

During the assessment process using SEAM; it was found that evaluation standards varied according to the type of the assessed criteria and the investigated architectural features that relate to this criterion. Some score could be identified directly such as investigating availability of renewable energy resources; it just needed (yes) or (No). While assessing building envelope thermal performance required some calculations to obtain envelope thermal properties such as R-value and U-value. Some criteria required accurate readings using special equipments that were not available for the researcher. Thus, the assessment depended on qualitative analysis for the available data such as indoor air quality, thermal comfort, and site selection.

Generally, the proposed SEAM provided a good tool to assess environmental sustainability performance for building (houses) within a comprehensive perspective. It takes in account the most important environmental issues that influence the building environmental performance with special consideration to sustainability principles.

Conducting the assessment process using SSAM proved that social values are still well preserved in the UAE in spite of western lifestyle and outward looking design. Segregation between genders, women privacy, social relations, and hospitality are important standards in contemporary houses design. The final product (the house) could seem different between traditional and contemporary, yet the internal zoning and spatial relationships remained almost the same (within the traditional vision or realm).

According to the previous discussion, the research concluded that both traditional and contemporary houses design is based on keeping family privacy and segregation between genders. Yet, the traditional house achieved privacy in spaces zoning and spatial relationships and facades treatments, while the contemporary house achieved privacy in spaces zoning and spatial relationships but facades treatment did not reflect privacy. Evaluation process depended on qualitative method based on objective analysis and the researcher experience and background.

During the assessment process, it was found that the SSAM was comprehensive; it took several social issues in account. The proposed SSAM provided a good tool to assess social sustainability performance for building (houses) within a comprehensive perspective. It considered the most important social issues that influence the building design with special reference to the UAE society cultural values and local identity.

From testing the SAM, it was concluded that it is an objective, reliable, ad applicable method to assess sustainability potential in buildings in the Arab World. Yet, the testing process indicated that there are some assessment criteria that need to be revised and reworded in order to set the final SAM. These criteria are:

- Amount of consumed materials or resources were not assessed.
- Putting “Water and Waste” in one area of assessment criteria needed to be revised because each criterion need to be assessed separately.
- Choosing “Humility & self-advocacy” and “Revealing social status” to assess “Identity & Social Status”, created a kind of contradiction because tendency towards humility and avoiding self-advocacy did not match with desire for revealing social status. Thus, assessment results of this criterion were so close between the traditional and the contemporary house because the humility that characterised the traditional house was compromised with desire for revealing social status of the contemporary house. Thus, results were illusive somehow.
- The issue of cultural identity was not assessed within area of assessment of the SSAM.

Based on the previous discussion, the SEAM and SSAM will be revised and modified according to the mentioned comments. Modifying the SEAM and SSAM will include:

- For “Resources” criteria, it is recommended to add sub-area assessment criteria about “consumption of resources”.
- It is preferable to put “Water” as a separate assessment criteria because of the importance of water as a sacred resource in the Arab World.
- It is recommended to put “Waste” as a separate assessment criteria to assure that the issue of waste takes the required attention and evaluation.
- For “Identity & Social Status” criteria, it recommended to substitute the sub-area of assessment “Revealing Social Status” with “Cultural Identity” to encourage innovative ideas to interpret architectural heritage of the region and reveal the society identity.

Accordingly, the final SAM was crystallised to suit the recommended modifications. The final SEAM and SSAM are shown in tables 8.16 and 8.17 respectively. For applicability the SEAM and SSAM on the real world, it is recommended doing further modification with the participation of experts in different majors.

At this point validity of another hypothesis of this research has been proved, which is “It is possible to develop a sustainability assessment method to examine the sustainability potential in traditional & contemporary architecture”.

Conclusions

This chapter focused on testing and modification of the proposed Sustainability Assessment Method (SAM). It includes evaluation method according to the indicators of the SAM. The testing process included also application of the proposed Sustainability Environmental Assessment Method SEAM and Sustainability Social Assessment Method SSAM on the model case study houses. The main conclusions of this part can be listed as follows:

- Using CA methodology, by applying the proposed SEAM and SSAM, was an appropriate methodology to identify sustainability potential in traditional and contemporary houses.
- Assessing environmental sustainability performance for the chosen case studies shows that the traditional house was more sustainable than the contemporary was.
- The maximum difference in environmental sustainability performance of traditional and contemporary houses was in “Energy” criteria.
- Assessing social sustainability performance for the chosen case studies shows that the traditional house was more sustainable than the contemporary was, yet final credits were closer than in assessing environmental sustainability.
- The maximum difference in social sustainability performance of traditional and contemporary houses was in “Family” criteria.
- Social values are still well preserved in the UAE in spite of western lifestyle.
- The proposed SAM was an objective, reliable, ad applicable method to assess sustainability potential in buildings in the Arab World.
- In modification of the final SEAM and SSAM, all the revised and reworded criteria were taken in account in crystallising the final SAM.

This chapter approved appropriateness of the proposed SEAM and SSAM and their applicability in the UAE and Arab World.

Table 8.16- The final environmental assessment method criteria and rating system

(Source: the author)

Areas of Assessment	Credits (100)	%	Sub-area of Assessment	Credits	%	Architectural features
Site	15	15%	Site selection	6	40%	Architectural planning Orientation Access to plot Plot size
			Site planning	6	40%	Site organization Outside-inside relationship Building mass Building form
			Building footprint	3	20%	Brown field
Energy	30	30%	Carbon Dioxide	10	33.3%	Energy consumption
			Renewable energy resources	10	33.3%	Energy source
			Building envelope	10	33.3%	Building materials Construction system
Resources	21	21%	Building materials	9	43%	Sustainability features of materials
			Recycling and Reuse	4	19%	Building lifecycle Building flexibility
			Materials lifecycle	4	19%	Materials durability
			Resources consumption	4	19%	Materials consumption Environment-friendly materials
Indoor Environment	15	15%	Natural Ventilation	5	33.3%	Ventilation system
			Indoor air quality	5	33.3%	Building materials properties
			Thermal comfort	5	33.3%	Building envelope Spaces flexibility
Water	11	11%	Water consumption	7	64%	Water consumption rate Water recycling facilities
			Water recycling	4	36%	
Waste	8	8%	Waste output	4	50%	Waste production Waste recycling facilities
			Waste treatment	4	50%	

Table 8.17- The final social assessment method criteria and rating system

(Source: the author)

Areas of Assessment	Credits (100)	%	Sub-area of Assessment	Credits	%	Architectural Criteria
Privacy	25	25%	Urban planning and design concept	13	52%	Site organization Design philosophy Building form Outside-inside relation Spaces organization
			External facades	7	28%	Elevation treatment House entrance Openings
			Acoustical privacy	5	20%	Building envelope Spatial zones
Social relations	20	20%	Hospitality	10	50%	Spatial organization Guest room (Majlis) Entry levels
			Guest honouring	10	50%	Guest room (Majlis) size Interior design
Neighbourhood	20	20%	Strong neighbourhood relationships	8	40%	Organic compact planning Attached dwellings Public spaces within neighbourhood
			Preservation of neighbours' rights	12	60%	Main entrance Roof parapet Walls height
Family	25	25%	Strong family ties	15	60%	Spatial organization Flexibility in space use
			Extended family	10	40%	House area No. and size of rooms Interior spaces design
Identity & Social Status	10	10%	Humility and self-advocacy	5	50%	Building materials Architectural details
			Cultural Identity	5	50%	Design concept Elevation treatments

Part Three

Testing Sustainability Assessment Method

Chapter 9

Conclusions and Recommendations

Main Headings

Chapter 9: Conclusions and Recommendations

Introduction

Studying sustainability potential in traditional architecture, which is the main subject of this research, is an attempt to find solutions for present problems by investigating the validity of the traditional solutions that have proved success for centuries. Traditional architecture, as identified by Brian Edwards (2005, P.162), represents a resource that has considerable potential for helping us to understand the principles of sustainable design and construction. Principles, on which traditional architecture is built, are of sustainable content. These principles are still valid in the present time.

This chapter summarises conclusions of the research and discusses the major findings. It also discusses limitations of the research and points about its recommendations. This research investigates the issue of sustainability of traditional architecture in the Arab World with special reference to domestic buildings in the UAE. The main objectives of this research were:

- To explore and understand the meaning of the term” sustainability” and the issues surrounding it by examining sustainability criteria
- To analyze traditional and contemporary housing in terms of plan, form, building materials, construction, environmental performance, and in particular, social sustainability
- To assess the sustainability potential of traditional and contemporary housing
- To formulate guidelines found in the above exploration and analysis for use in sustainable contemporary housing design for the region

To achieve theses objectives, the following hypothesis were tested:

- Traditional houses in the United Arab Emirates are more sustainable and are more appropriate for the ambient environment than their contemporary counterparts are.
- It is possible to develop a sustainability assessment method to examine the sustainability potential in traditional & contemporary architecture

In order to test these hypotheses, the following issues were raised and related aspects were investigated.

9.1. Issues raised and aspects investigated in the this thesis

As Charles Ragin (1989, P.54) states' “*Behind every research effort are general goals that extend beyond the specific goals of the study at hand*”. Accordingly, several issues were raised and many aspects were investigated to examine this research's hypotheses and fulfill its goals. The raised issues can be summarised as follows:

1. The sustainability potential in traditional architecture through investigating the concept of environment and sustainability in Islamic philosophy and how this was implemented in traditional architecture, especially houses.
2. Architecture development in the UAE during the 20th century. Analytical method for secondary data was used to investigate socio-economic and cultural changes that took place since declaration of federation in 1971 and their impact on architecture development in the UAE.
3. To what degree traditional and contemporary houses are sustainable in the UAE through using sustainability assessment method. Several sustainability assessment methods were illustrated and analysed to find the major assessment areas, assessed criteria, and evaluation system.
4. Sustainability Assessment Methods and their appropriateness to address sustainability potential in architecture in the UAE as well as the Arab World. At this aspect, several Sustainability Assessment Methods (SAM) were investigated at two levels, theoretical and empirical. The SAM was investigated within two of sustainability dimensions; environmental and social to develop Sustainability Environmental Assessment Method (SEAM) and Sustainability Social Assessment Method (SSAM).
5. At the theoretical level (first level), SEAM investigation was based on analytical approach for three environmental assessment methods: EcoHomes, LEED and Green Globes. This investigation included assessment areas, sub-area of assessment, and rating systems. Then a proposed SEAM was set to be examined. At the empirical level (second level), the proposed areas of assessment were used to evaluate SEAM appropriateness by assessing the environmental performance of two chosen case studies. Examining the SEAM appropriateness was carried out through comprising environmental performance between traditional and contemporary houses from environmental sustainability standpoint.
6. At the theoretical level (first level), SSAM investigation was based on analytical approach for three social assessment methods: Social Impact Assessment (SIA), Social Compatibility Analysis (SCA), and Beneficiary Assessment (BA) including assessment areas, sub-area of assessment, and rating systems. At the empirical level (second level), the proposed SSAM was examined and the areas of assessment were used to evaluate SSAM appropriateness by assessing the social performance of two chosen case studies and their respond to social values from social sustainability standpoint.

7. The appropriateness of the proposed assessment to be generalized and used to examine sustainability potential in architecture in the Arab World. Investigating this aspect was based on documentary analysis of architectural data (architectural drawings, images, and photos) concerning the chosen houses criteria. The environmental assessment process using SEAM was based on quantitative analysis for assessing standards approved by the investigated environmental assessment methods. The social assessment process using SSAM was based on qualitative analysis based on Islamic *Shari'a* and its main sources: the Holy Quran and the Prophet *Sunnah*.
8. How to examine sustainability in architecture using a systematic, reliable, and objective way. This aspect was investigated at both theoretical and empirical levels. At the theoretical level, the investigation was based on literature review and documentary analysis of secondary data concerning the issues of sustainability and sustainable architecture in general and the sustainability environmental and social assessment methods for houses in the UAE in particular.
9. This analysis included examining criteria of sustainability assessment method and how to be modified according to the Arab World conditions environmentally and socially. Primary data collected by the author through field investigation and criteria analysis to ten case studies (houses), five traditional and five contemporary. According to spatial and context analysis, two case studies were chosen, one of each type. At the empirical level, the investigations included comparison approach for the two chosen case studies, one traditional one contemporary, that were chosen to be models for testing sustainability potential in architecture. Each model was tested to examine environmental and social sustainability dimensions.
10. How to evolve a set of design principles, guidelines, and sustainability assessment methods that enable designers and planners to deal with issues of sustainability in contemporary architecture in the UAE and the Arab World.

Figure 9.1 shows the raised issues and investigated aspects of this research.

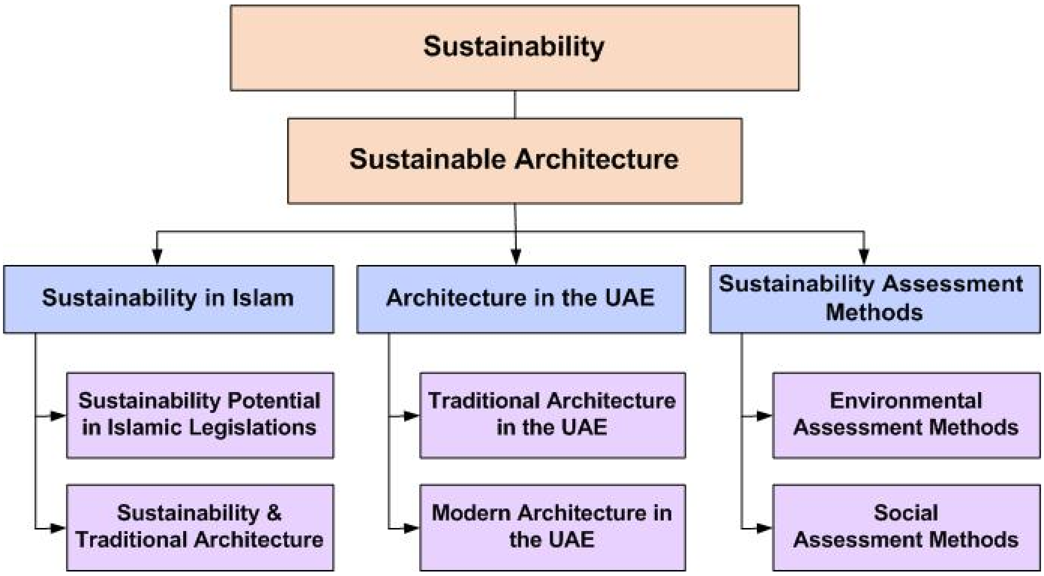


Figure 9.1-The raised issues and investigated aspects in this research
(Source: the author)

9.2. Major findings

Findings of this research were drawn at three levels.

9.2.1. Evolution of Sustainability as a Concept in Islamic Philosophy

Through discussing definition of sustainability, its dimensions and principles, and its effect on architecture, the literature review demonstrated the importance of sustainability and sustainable architecture to face environmental crises all over the world, such as climate changes, resources and fossil fuel depletion, pollution, and earth population growth. According to investigating sustainability and environment dilemma in the Arab World, the research concluded that sustainability issues face many predicaments in the Arab World and that sustainability indicators in the Arab World are critical compared to the rest of the world.

Through discussing sustainability perspective in Islamic philosophy, the research asserted that the concept and essence of sustainability and environment was evident in Islam proved by verses from Quran and the Prophet Sayings and deeds. The research related principles of sustainability with Islam doctrines about environment conservation, rational consumption of resources, preserving resources such as air and water, call for greenery and plantation, and keeping environment balance and human wellbeing. Figure 9.2 shows the philosophy of sustainability & environment in Islamic perspective.

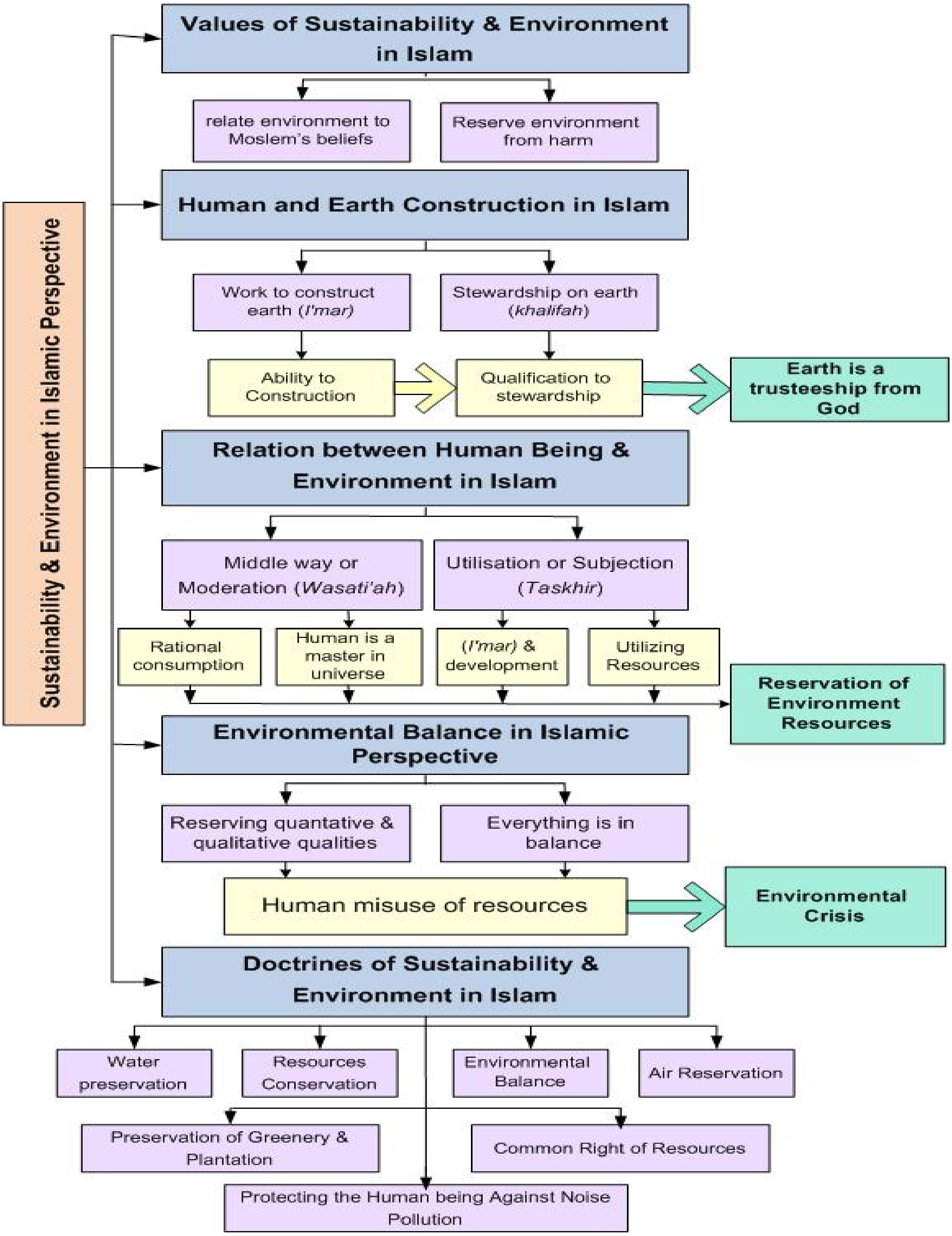


Figure 9.2- Sustainability & environment in Islamic perspective

(Source: the author)

Sustainability principles & environment preservation in Islamic perspective were demonstrated in traditional architecture in the Arab world that responded to Islamic *Shari'a* and integrated with Islamic legislations and social values, thus it has great potential of sustainability environmentally and socially– Figure 9.3.

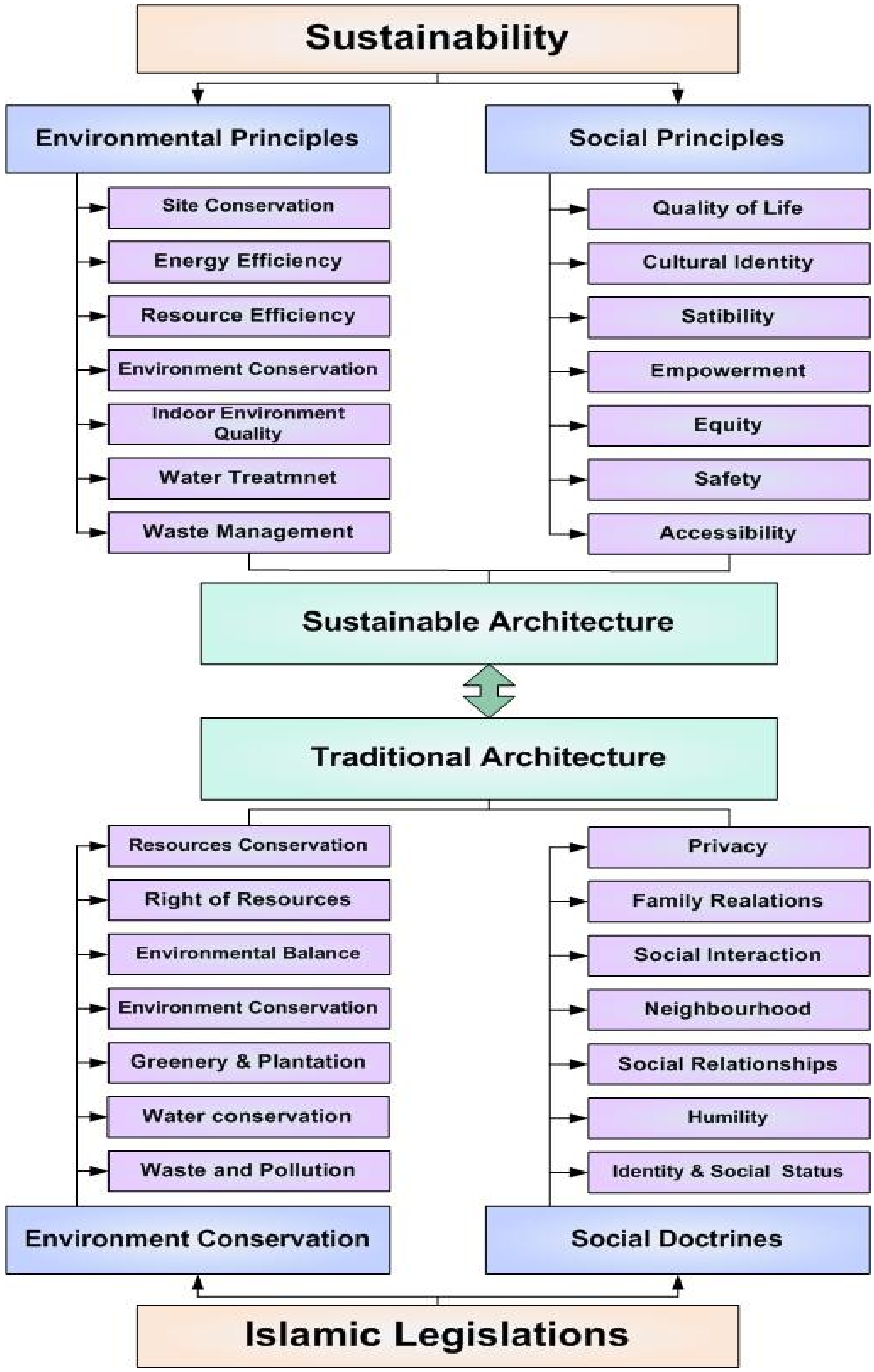


Figure 9.3- Environmental & social principles in sustainable and traditional architecture

(Source: the author)

Traditional architecture achieved environmental and social sustainability, on urban planning level and design level. Sustainability was achieved on urban planning level by responding and modifying climatic conditions, preservation society privacy of inhabitants within the city and the neighbourhood community and respecting neighbours' rights. On design level, traditional architecture achieved sustainability, through utilising suitable design solution;

especially courtyard that was the most appropriate design solution to provide privacy and comfortable internal environment. Figure 9.4 shows environmental and social sustainability principles in traditional architecture.

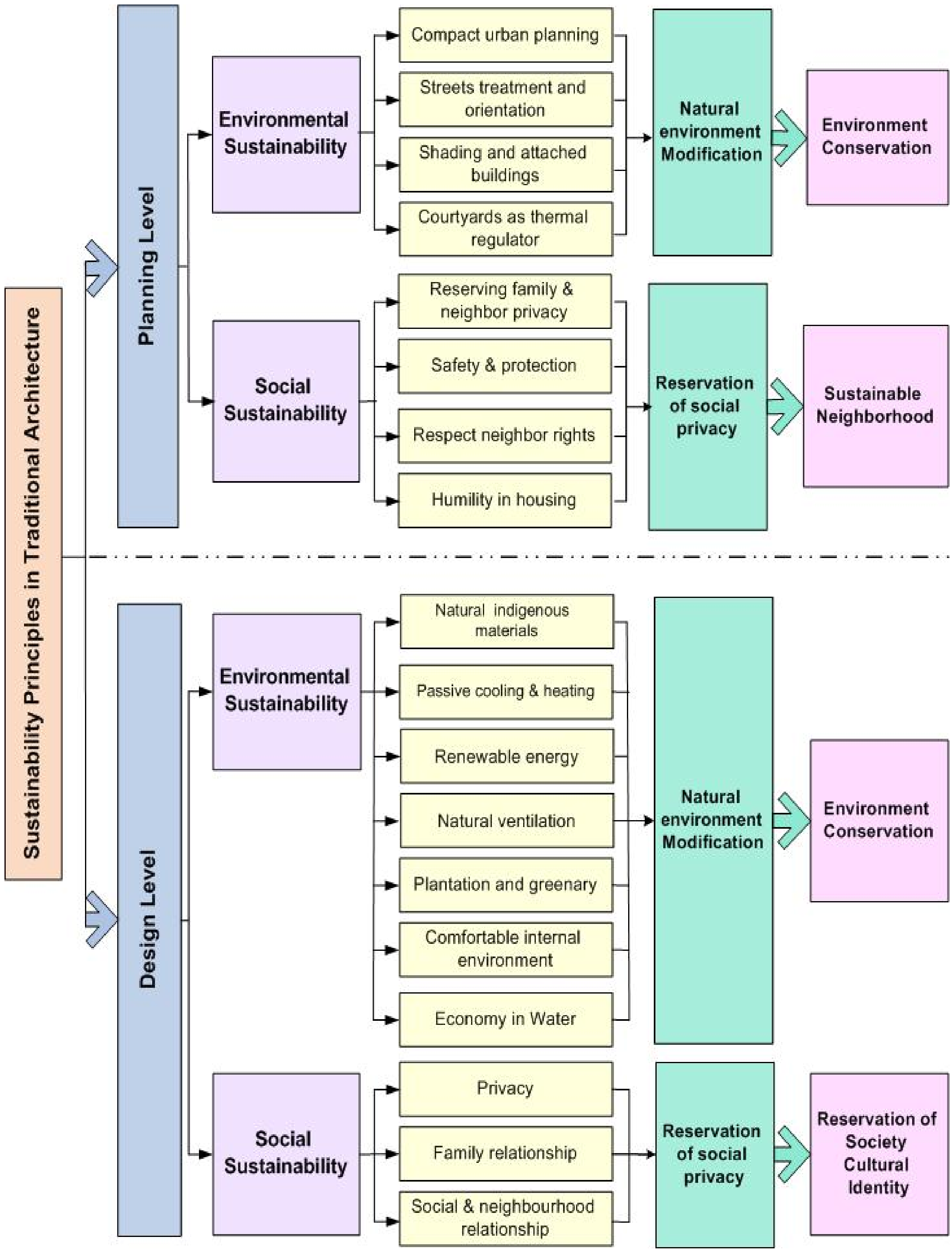


Figure 9.4- Sustainability principles in traditional architecture in the Arab World

(Source: the author)

9.2.2. Sustainability & Environmental Issues in Modern Architecture in the UAE

Literature review and field visits carried out by the author demonstrated that modern architecture in the UAE has witnessed drastic changes since declaration of the federation in 1971. At this level, the research concluded that socio-economic boom and cultural changes that took place in the UAE since the 1970s created a different type of architecture unfamiliar with the traditional architecture and climate of the country. The economical boom brought western types of lifestyle and changed a lot of society way of living and needs. This new type is distinguished with dominance of western styles and new technologies in different types of buildings. New features and trends neglecting the ambient environment and indigenous building materials characterized architectural development in the UAE since the 1970s.

Through investigating issues of sustainability and environment in modern architecture in the UAE, three main steps were identified in architecture development in the UAE. The first era was before federation where early steps towards modernity were deliberate and most of modern buildings were public. The second era was after federation in 1971 where the architectural boom in the 1970s and 1980s yearning for achieving image of modernity in contemporary architecture, utilizing up-to-date high technology in construction and services that led to neglecting environmental issues depending on artificial air-conditioning and lighting. The 1990s and new millennium witnessed qualitative changes were witnessed along with the trends of globalization, yet tendency to reveal the local identity was evident and along with emerging approach towards sustainability and environmental issues. Table 9.1 shows architectural development in the UAE.

Integrating theoretical and empirical investigations to examine sustainability potential in traditional and modern architecture represented an appropriate base for an analytical framework for investigating sustainability in architecture. At this point, it is essential to indicate that no previous studies have investigated sustainability potential in traditional and modern architecture in the UAE in such a way that modifies sustainability assessment methods for architecture, especially houses, in the Arab World. Few theoretical investigations have been carried out to trace and demonstrate sustainability in architecture in the Arab world, yet the results have not gone beyond theoretical discussions. Several studies (Mahgoub, 1997; Asfour, 1998; Ghandour, 1998; Mortada, 2003; and Al-Zubaidi, 2004 March) have discussed sustainability in architecture in different approaches; mostly about traditional architecture. This research sets an applicable approach drawing upon these theoretical investigations to test sustainability on an empirical method for traditional and contemporary case studies.

Table 9.1 –Architectural development in the UAE

(Source: the author)

Era	Significant events	Types of buildings	Architectural features	Landmark buildings
Pre 1900-1930	Coastal urban settlements establishments (Dubai, Abu Dhabi, Sharjah) United Kingdom and the Trucial States established several peace treaties.	Defensive Religious Residential Markets Public buildings	Inwards looking design Courtyard houses Traditional materials Natural climatic features Solid elevations and small openings	Fort Palace (Abu Dhabi) Sheikh Saed House(Dubai) Sharjah Fort (Sharjah) Al-Ahmadiay School(Dubai) Al-Jahli Fort (Al Ain)
1930-1950	Immigration of men because of hard economical conditions Building the 1st airport in UAE New types of public buildings began to be built	Modern public buildings	Most of the buildings remained traditional Using modern materials and construction techniques in public buildings	Sharjah airport (Sharjah) British Residency (Sharjah) Al Wakeel House Dubai) Dubai Clinic Dubai) Imperial Bank Dubai)
1950-1960	Declaration of "Coast Emirates Council" Cement was first imported The first concrete block house The 1st modern school Public services as electricity	Modern hospitals Modern Schools	Outward looking design New building materials as concrete, steel and glass Use of mechanical air-conditioning	Maktoum Hospital. (Dubai) Airlines hotel (Dubai) Municipality building Dubai) Al-Qasimiya School (Sharjah)
1960-1971	Sheikh Zayed Bin Sultan became the ruler of Abu Dhabi Commercial production and export of oil Establishment of "The Development Office of the Trucial states Council" Kuwait 1st representative office in UAE Establishment of municipalities in all emirates	Hotels & Banks Municipality buildings Public services as: swimming pools, children playgrounds, modern markets Housing projects for low-income citizens	Outward looking design New building materials as concrete, steel and glass Use of mechanical services and air-conditioning Skeleton construction systems Modern urban planning New modern roads	The Shore hotel (Abu Dhabi) Airport, Municipality building, & ADCO headquarter (Abu Dhabi) Al-Waha (Oasis) hospital(Al Ain) Dubai Airport (Dubai) The 1st City Bank of NY (Dubai) Housing project (Al Fujairah) Ras Al-Khaimah hospital

Table 2.1 –Architectural development in the UAE (Cont.)

(Source: the author)

Era	Significant events	Types of buildings	Architectural features	Landmark buildings
1971-1990	Declaration of the United Arab Emirates Economical & social boom Arab and foreign architects design many projects Opening of UAE university Building many infrastructure projects Establishment of the 1st architecture department in UAE university Establishment of Higher Colleges of Technology	Government Housing Projects Public Schools Health Projects Public services projects Shopping centres & malls Educational projects Leisure projects	Outward looking design Total neglect of environment Mass production projects Massive glazing and openings High-rise buildings	The Islamic souq (Sharjah) Al Majarra souq (Sharjah) Hilton Hotel (Dubai) Al Ittihad (Union) school (Dubai) Ruler's Court (Dubai) Creek Corniche development (Dubai) Dubai Municipality (Dubai) National Bank of Abu Dhabi the Ministry of Finance Building Baynona tower (Abu Dhabi) Manhal Palace (Abu Dhabi)
1990-2000	Establishment of new architecture departments in other universities Restoration of traditional architecture	Modern public buildings	Establishment of new architecture departments in other universities Restoration of traditional architecture	Emirates towers (Dubai) Burj Al Arab (Dubai) Marine Operating Company headquarter (Abu Dhabi)
2000- till now	Expectation of oil depletion Death of Sheikh Zayed New economical policies towards sustainable development Establishment of UAE Green Building Council 1st Building in UAE gets LEED Silver certificate	New full-service cities Landmarks buildings Sustainable buildings	Concerning environmental issues Trend towards green buildings Skyscrapers Hi-tech buildings Green building materials Thermal insulated buildings	Marina City (Dubai) Walll City (Dubai) Pacific Controls headquarters Jumairah city (Dubai) Emirates mall (Dubai) Dubai Tower (to be finished by 2008) Sahara mall (Sharjah) US Embassy (Abu Dhabi)

9.2.3. Developing Sustainability Assessment Method SAM

As a complementary part of this discussion, the research focused on environmental and social sustainability to create a basis for:

- Examining sustainability potential in traditional and contemporary architecture in the UAE
- Examining theoretical approaches and practical attempts to address sustainability
- Developing Sustainability Assessment Method (SAM) for examining sustainability performance in architecture

The research represents the first investigation carried out to examine the appropriateness of SAM as a framework to assess environmental and social sustainability potential in architecture in the UAE. Conclusions of the theoretical investigations were drawn at two levels. The first is the SAM objectives and areas of assessment and its appropriateness to deal with sustainability potential in architecture. The second is the SAM rating system needed to be reorganized to fit the UAE and the Arab World circumstances.

The way this research employed investigation of SAM at both theoretical and empirical levels represents an appropriate base for an evaluative framework for examining sustainability in architecture.

Developing Sustainability Assessment Method (SAM) aimed to examine sustainability potential in architecture in the Arab World. This required deep investigation for the concept of sustainability, in general, and the criteria of sustainability assessment methods, in particular. This research concentrated on environmental and social sustainability on one type of buildings; houses. Thus, developing SAM was based on these dimensions with reference to domestic buildings.

The proposed SEAM and SSAM are based on the research carried out in this study. It is not an authoritative statement about the development route for the sustainable housing assessing and quality indicators, but rather a general set of guidelines which can be considered by the implementation team and which may provide a useful framework for more detailed design development proposals.

9.2.3.1. Developing Sustainability Environmental Assessment Method (SEAM)

Investigating environmental sustainability in architecture constructed the base for developing Sustainability Environmental Assessment Method SEAM. This method is based on five assessment areas: Site, energy, resources, indoor environment, water and waste. Each area of assessment consisted of sub-areas of assessment criteria that are used in assessing sustainability performance of the house. At this stage, the SEAM was developed.

The proposed SEAM was refined according to analyzing three chosen EAM: EcoHomes, LEED, and Green Globes, comparing their area of assessment priorities, sub-areas of assessment, and rating systems. The research has modified the SEAM according to the previous analysis and the UAE and the Arab World circumstances and environmental conditions, such as raising the rating weight for "Water" because it is a valuable resource in UAE and the Arab World. Figure 9.5 shows structural diagram for developing the environmental assessment method.

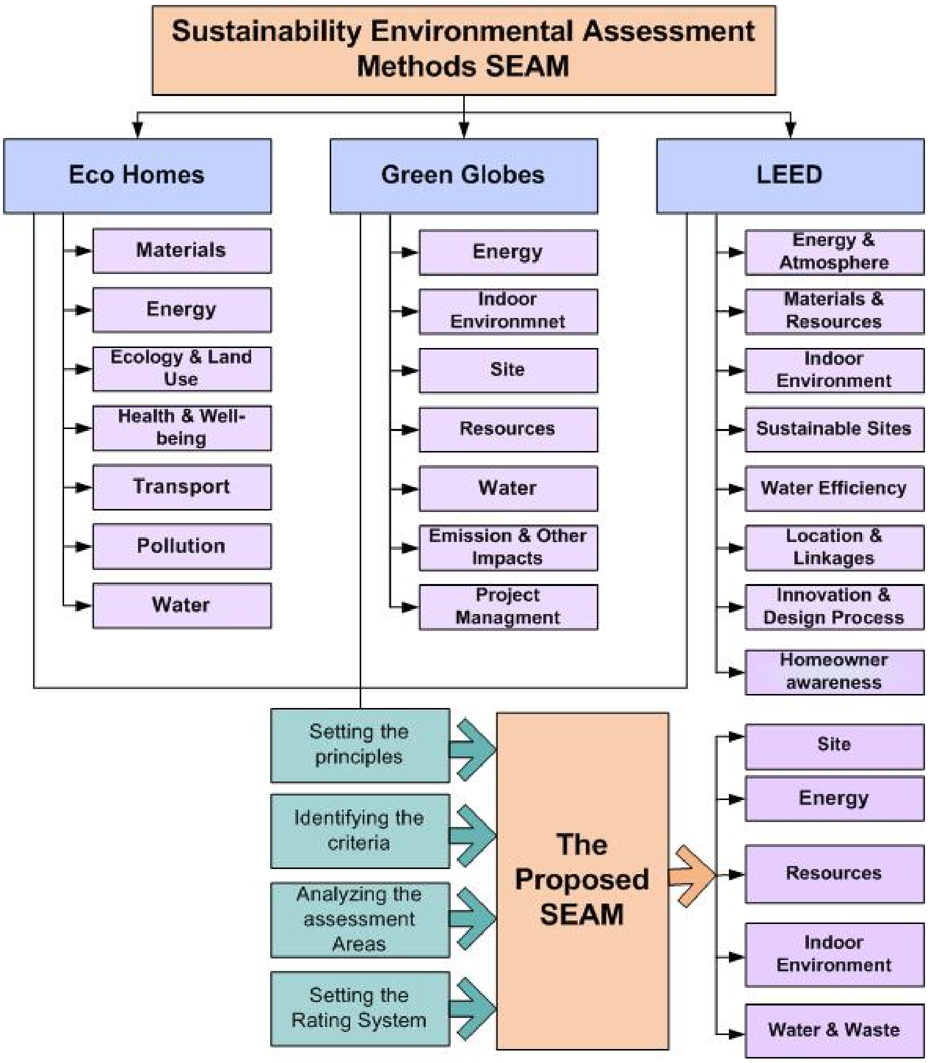


Figure 9.5- Structural diagram for developing the environmental assessment method
(Source: the author)

9.2.3.2. Developing Sustainability Social Assessment Method (SSAM)

Investigating social sustainability in architecture constructed the base for developing Sustainability Social Assessment Method SEAM. This method is based on five assessment areas: privacy, social relations, neighbourhood, family, and identity and social status. Each area of assessment consisted of sub-areas of assessment criteria that are used in assessing sustainability performance of the house. At this stage, the SSAM was developed.

The proposed SSAM was refined according to analyzing three social assessment methods: Social Impact Assessment (SIA), Social Compatibility Analysis (SCA), and Beneficiary Assessment (BA) comparing their area of assessment priorities, sub-areas of assessment, and rating systems. The investigated SSAM were not appropriate to be used to assess social sustainability of case studies (houses) in the UAE because the aiming goals of these assessment methods were mostly about the social performance of society or community. Thus, the researcher depended on developing the SSAM on the main source of social values and identity in the Arab World, including UAE, the Islamic *Shari'a* the sacred revealed law of Islam. The main *Shari'a* sources: Quran and the Prophet *Sunnah* were the reference for developing the SSAM.

However, the SAM can be developed by experts in different specialities to be usable on a wide range of dwelling types including: single dwellings, single or multiple flats in a single building, developments of various sizes consisting of mixed housing types and special needs housing of various types.

9.2.4. Testing Sustainability Assessment Method SAM

Examining sustainability potential in architecture in the UAE concluded that traditional buildings are more sustainable than contemporary. Traditional houses were more responsive to natural environment and social values. Contemporary houses neglected natural environment, yet they were responsive to social values in a way to accommodate to modern lifestyle.

From testing the SAM, it was concluded that it is an objective, reliable, and applicable method to assess sustainability potential in buildings in the Arab World. Yet, the testing process indicated that there are some assessment criteria that needed modification, which were taken in account in setting the final SAM.

The comparison in this research is conducted to obtain general conclusions not merely comparison between two objects or buildings. Thus, the results that were obtained from assessing two types of houses (traditional and contemporary) with CA methodology will be generalized as guidelines for sustainability indicators without taking the assessing figures as final findings.

Results of testing sustainability assessment for traditional and contemporary case studies are shown in table 9.2. Environmental sustainability assessment showed that the traditional house scores were higher than the contemporary was in all areas of assessment criteria. The final accreditation was 87.4/100 for the traditional house and 53.3/100 for the contemporary. These results confirmed that the traditional house was more sustainable in accommodation to ambient environment, while the contemporary houses neglected environmental issues depending on artificial condition and manufactured building materials consuming a lot of energy. Thus, the maximum difference was in “Energy” where the traditional house scored 29/30 while the contemporary scored 17/30; the difference was obvious in “Site”, “Resources” and “Water & Waste” criteria, while scores were close in “Indoor Environment”.

Social sustainability assessment showed that the traditional house scores were higher than the contemporary was in most areas of assessment criteria except “Social Relations”. The final accreditation was 87.7/100 for the traditional house and 68.2/100 for the contemporary. However, these results indicate that social sustainability is more evident in contemporary houses than environmental sustainability.

The maximum difference was in “Family” where the traditional house scored 24/25 while the contemporary scored 14/25; the difference was obvious in “Privacy” and “Neighbourhood” criteria, while scores were almost the same in “Social relations” and “Identity & Social Status”. This indicates that family relations have changed in the last few decades, and the value of “extended family” has been vanishing gradually. This trend is not sustainable. Sustainable architecture calls for economy consumption of resources through design flexibility and future expansion. Moreover social sustainability calls for preserving community coherency through keeping its basic unit; the family.

Conducting the assessment process using SSAM proved that social values are still well preserved in the UAE in spite of Western lifestyle and outward looking design. It was noticeable that contemporary houses are two-face design. They are built according to western style, while people live within traditional norms and social values. Houses were built outward but people lived inward. The traditional house is a reflection of people’s way of living. It corresponded to social values, people’s everyday activities, and ambient environment. In contemporary house, the inward way of living remained the same, but it was translated differently. The result was the conflict between lifestyle and architectural product. On the contrary, in traditional house, the architectural product was in harmony with social values and people’s way of living.

Table 9.2 – Results of testing sustainability assessment for traditional and contemporary case studies

(Source: the author)

	Traditional House				**Contemporary House**			
Environmental Sustainability Assessment	Area of assessment	Sub-area	credit	Total credit	Area of assessment	Sub-area	credit	Total credit
	Site	Site selection	4.8	**12.9**	Site	Site selection	3.6	**9.6**
		Site planning	6			Site planning	3.6	
		footprint	2.1			footprint	2.4	
	Energy	Carbon dioxide	10	**29**	Energy	Carbon dioxide	9	**17**
		Renewable energy resources	10			Renewable energy resources	1	
		Building envelope	9			Building envelope	7	
	Resources	Building materials	8.1	**20.1**	Resources	Building materials	5.4	**13.2**
		Recycle & reuse	7			Recycle & reuse	4.2	
		Materials lifecycle	5			Materials lifecycle	3.6	
	Indoor environment	Natural ventilation	4.5	**11**	Indoor environment	Natural ventilation	2.5	**7**
		Indoor air quality	3			Indoor air quality	2.5	
		Thermal comfort	3.5			Thermal comfort	2	
	Water & waste	Water consumption	8.8	**14.4**	Water & waste	Water consumption	3.3	**6.5**
		Waste output	5.6			Waste output	3.2	
	Final credit (100)			**87.4**	**Final credit** (100)			**53.3**
Social Sustainability Assessment	Area of assessment	Sub-area	credit	Total credit	Area of assessment	Sub-area	credit	Total credit
	Privacy	Planning & Design Philosophy	11.7	**22**	Privacy	Planning & Design Philosophy	10.4	**17.2**
		External facades	6.3			External facades	2.8	
		Acoustical privacy	4			Acoustical privacy	4	
	Social relations	Hospitality	9	**17**	Social relations	Hospitality	8	**17**
		Guest honouring	8			Guest honouring	9	
	Neighbourhood	Strong neighbourhood relations	6.4	**17.2**	Neighbourhood	Strong neighbourhood relations	3.2	**14**
		Preservation of neighbourhood's rights	10.8			Preservation of neighbourhood's rights	10.8	
	Family	Strong family ties	15	**24**	Family	Strong family ties	9	**14**
		Extended family	9			Extended family	5	
	Identity & social status	Humility & self-advocacy	4.5	**7.5**	Identity & social status	Humility & self-advocacy	1.5	**6**
		Revealing social status	3			Revealing social status	4.5	
	Final credit (100)			**87.7**	**Final credit (**100)			**68.2**

9.3. Limitations of the Research

Regardless of the wide range of investigated issues, there are number of limitations inherent in the nature of this research:

9.3.1. Area of Research Limitations

This research focuses on environmental and social sustainability of one type of buildings; domestic buildings, in the UAE

9.3.2. Findings Generalization Limitations

This research deals with sustainability criteria in houses in the UAE as part of the Arab World. Ten private houses in urban settlements were taken as case studies, five traditional and five contemporary. These houses were chosen and analyzed according to certain criteria, and then one was chosen from each type as a representative of the type according to objective justifications. This means that findings of this research might not be relevant to public buildings, rural and nomadic areas in the region, and the multi-story residential buildings.

9.3.3. Time Limitations and Bounds

This research focuses on traditional architecture in the UAE during the first half of the 20th century until 1971 and on the development of modern architecture in UAE that was conducted from declaration of the federation in 1971 until the beginning of the 21st century.

9.3.4. Conducting the Investigation Limitations

Investigating sustainability potential in architecture focuses on environmental and social sustainability. Economical sustainability was not conducted in this research. Environmental sustainability investigation focused on certain areas: site, energy, resources, Indoor environment, and water and waste. These areas were assessed through sub-area criteria and how architectural feature acted. Since traditional houses are no longer used as residences, the investigations were based on the same standards used for the contemporary houses. The actual function or the way people used to live in these buildings was taken in account. Environmental assessment findings were set according to comparison analysis method based on standards set by the investigated SEAM and quantative analysis to available data for the case studies.

Social sustainability investigation focused on certain areas: privacy, neighbourhood, family relations, social relationships, and identity and social status. These areas were assessed through sub-areas and how architectural criteria responded to these areas. Since there were no previous studies using sustainability social assessment method for houses in the UAE, the research focused on the researcher analysis depending on social values in Islamic Shari'a' the main source of legislations in Muslim society as the UAE. Further studies are needed to conduct field questionnaires for locals to be compared to findings of this research. Social assessment findings were set according to comparison analysis based on researcher analysis and social values of Islam to determine sustainability potential in traditional and contemporary houses.

Testing the SEAM and SSAM used to assess houses performance from environmental and social sustainability standpoint. Thus, findings did not take in account economical sustainability or the building's functional or aesthetical performance.

9.4. The Research Findings Compared to Previous Studies

To clarify this research findings compared to previous studies on sustainability potential of architecture in the Arab World, the significant difference between this research findings and previous studies on sustainability and architecture in the Arab world needed to be to identified.

Several studies asserted on importance of building in harmony with ambient environment within society needs especially the house; it is the symbol of the individual where he finds himself and identity. In this regard, Hassan Fethi (1988, P.15), the Arab architect, says:

> "*The migration of an architectural style from an area to another foreign area is something that should be rejected because it will cut its relations to its heritage, traditions and culture. It leads to double personality and the loss of one's identity, thus to be a stranger in your house is the worst type of stranger.*"

In his study on "Sustainable *Architecture in the United Arab Emirates*", Yasser Mahgoub (1997) concluded, "that there is much to learn from traditional architecture if studied in the light of sustainability concept." He identifies sustainability issues evident in traditional architecture in the UAE in three aspects: Natural and Built Environmental Sustainability (climate, building materials, construction methods, building design, and planning); Psychological, Social and Cultural Sustainability (privacy, desires, identity, religion, family, and community lifestyle), and Economic Sustainability (consumption and resources). Yet the study did not suggest any methods to assess sustainability whether in traditional or in contemporary architecture.

To demonstrate sustainable architecture in the Arab World, Mahgoub asserted on importance of buildings codes and legislations as one of the strategies to adapt sustainability as a futuristic approach in architecture. Yet, his study did not formulate any practical recommendations for how to modify buildings codes towards sustainability. Findings of our research coincide with Mahgoub's conclusions that traditional architecture is more sustainable than contemporary and current practices, which are based on premises of modern architecture, are becoming obsolete and require major revisions in order to meet the needs for a sustainable future. Our research has deeply identified sustainability issues and developed sustainability assessment methods SAM. The developed SAM presents a practical basis for setting building codes and legislations to implement sustainability as an essential approach for architecture in the Arab World.

Another study held by Hisham Mortada (2003) focused on role of Islam in built environment in the Islamic World; the author identified the main two sources of *Shari'a*: Quran and the Prophet *Sunnah*. At the end of his book, Mortada calls for rethinking of Islam from sustainability standpoint. Mortada identified several principles in Islam that are identical with sustainability principles such as preservation of natural environment, preserving environmental balance, economy in resources consumption such as water, and society well-being besides social issues. Discussing these issues was demonstrated with verses from Quran and quotations form the Prophet sayings and *Sunnah*, which was the main theme of that study. Referring traditional architecture in the Islamic World to Islam was of Mortada's study objectives while relating traditional architecture to sustainability was indirect.

Our research discussed traditional architecture, as well as contemporary, through systematic framework to identify sustainability in architecture with reference to role of Islam in creating environmental awareness and forming social values that were reflected in traditional architecture, especially houses. This framework is based on: 1) understanding the concept of sustainability in architecture, 2) the aspects of environmental and social sustainability, 3) sustainability and environment philosophy in Islam, 4) social values derived from Shari'a 5) developing sustainability environmental and social assessment methods SEAM and SSAM, 6) analyzing traditional and contemporary houses from a sustainability standpoint. In addition, the proposed SEAM and SSAM were developed to be appropriate and applicable to traditional and contemporary houses and buildings in different areas and regions in the Arab World.

Eman Al-Nakib (2004) in her thesis "Sustainability as a Design Paradigm for Quality Architecture" studied the implications of sustainability indicators in commercial buildings in the GCC Countries compared to ones in Australia. The thesis investigated the major differences and similarities tacking architecture issues focusing on medium and high-rise commercial buildings. This study compared several commercial buildings in Australia and the Arabian Gulf region (UAE, and Saudi Arabia) as case studies. The comparison criteria were site planning, building form, building envelope, and internal space. The study concluded that plethora of green building assessment tools focus mainly on energy performance and management issues rather than design features. The quality of architecture solutions is rarely mentioned or evaluated. It adapted ISIA Base Chart First List for sustainability indicators by transforming it into an assessment chart to estimate the influence of sustainability indicators on building form and facades and LEED rating system was used as a base for assessment.

The main difference between the mentioned study and our research, is this research is dedicated to domestic buildings (houses in the UAE) adapting Comparative Analysis methodology between traditional and contemporary houses. Moreover, this research investigated several environmental and social assessment methods to develop sustainability environmental and social assessment methods adaptable to the Arab World conditions for assessing sustainability potential in architecture.

Other studies (Asfour, 1998A; Ghandour, 1998; and Antoniou, 1998) referred sustainability crisis in the Arab world due several factors: 1) imposing Western building types without considering their impact on the local culture and environment, 2) lack of trust in the traditional methods, and 3) loss of self-respect & identity. Yet, these studies did not formulate any policies or set practical indicators to solve this crisis. Sustainability principles needed to be formulated through a group of criteria to enable designers and policy makers to implement sustainability principles in contemporary architecture in the Arab world. Our research identified sustainability environmental indicators (site, resources, energy, indoor environment, water, and waste) and sustainability social indicators (privacy, social relationships, family relation, and identity and social status) that were set within groups of criteria and formulated within SAM. Ways to utilize SEAM and SSAM to assess sustainability indicators in contemporary houses and buildings were clarified to ensure applicability and reliability of the SAM for sustainable buildings in the Arab World.

9.4.1. Contribution to Knowledge

This research is unique and its contribution to knowledge is achieved on different levels: issues discussed (sustainability, traditional houses, and contemporary houses in the UAE), the research methodology (developing SAM) and comparative analysis criteria (using the developed SAM). The main research contribution can be summarised as follows:

- Relating between sustainability, traditional architecture, and contemporary architecture in the Arab World following a systematic methodology with special reference to domestic buildings in the UAE.
- Environment and sustainability principles in Islamic perspective and how they were revealed in traditional architecture, especially houses, in the Arab world.
- Analysing traditional and contemporary houses in the UAE from environmental and social sustainability standpoint.
- Developing Sustainability Assessment Method specific to the region and appropriate to local environment.
- Areas of study were deep and gone through detailed analysis demonstrated with data and figures that were not applied or related to architecture in the UAE before.
- Developing Sustainability Environmental Assessment Method (SEAM) based on the priority of environmental conditions in the UAE, as part of the Arab World.
- Developing Sustainability Social Assessment Method (SSAM) based upon Islamic Shari'a sources: Quran and Sunnah. This is referred to the important role of Islam in forming social values and cultural identity of Muslim society, including the UAE.
- Analysing traditional and contemporary houses in the UAE in a way that has not been analysed before according to social and environmental sustainability dimensions.

Results conducted in this research are built upon deep investigation and systematic analysis. Nevertheless, the results are to be considered as indicators. Further studies are definitely needed to be held about the issues raised and aspects investigated in this research.

Formulation of sustainable assessment methods, environmental, social and economical, requires efforts of many experts and specialists in different aspects. Further inquires, questionnaires, surveys, and social researches are needed to set up the social indicators.

9.5. Recommendations

According to this research findings, a number of recommendations are suggested. These recommendations are related to assessing and testing sustainability potential of architecture in the Arab World. Recommendations can be classified into general recommendations to achieve sustainable architecture in the Arab World, and recommendations for the SAM application.

9.5.1. General recommendations

While environmental, social, and economical sustainability is the goal, sustainable design is the means we as designers have to contribute to that goal (Mendler, & Odell, 2000, P.2). Thus, to ensure successful implementation of the scheme, guidelines for sustainable building design should be developed to provide practical assistance to building designers and encourage wider acceptance of assessment methods. Recommendations for demonstrating sustainable architecture in the Arab World can be listed as follows;

- Raising public awareness about environment and sustainability through encouraging community participation in decision making and setting development policies.
- Developing planning strategies, qualities codes, and building regulations towards sustaining local environmental, social values and cultural needs.
- Integrating concept of sustainable architecture into the design process of professional practice. A regional approach to architectural design should incorporate all aspects of sustainability.
- Foundation of a “certificate of excellence” to evaluate sustainability performance for buildings in the UAE and the Arab World. The SEAM set in this research may be adapted within the assessment framework for sustainability assessment.
- Encouraging researching and publishing on sustainability, sustainable architecture, and assessment methods with special reference to the Arab World.
- Establishment of research centres for sustainability and environmental studies to support setting local and regional development polices in the Arab World.
- Introducing the concept and issues of sustainability in architectural education. Architectural curriculum should address all aspects of sustainability as an overriding concept that influences design decisions.
- Foundation of a special award or certificate of innovation to students and young architects for projects that consider sustainability issues as design motivation.

9.5.2. Recommendations for the SAM Application

The research findings suggested a number of recommendations for the SAM application at two levels:

9.5.2.1. SAM as an assessment tool kit

- This research recommends using the SAM in evaluating buildings whether in design stage or after building completion and occupancy. The sustainability assessment methods have to be demonstrated in order to become the tool in building practice.

- The SAM can be developed by experts in different in specialities to be usable on a wide range of dwelling types including: single dwellings, single or multiple flats in a single building, developments of various sizes consisting of mixed housing types and special needs housing of various types.
- Applying the SEAM set in this research to develop an environmental sustainability assessment method, like EcoHomes or LEED, to evaluate sustainability potential of buildings in the UAE and the Arab World.
- Applying the SSAM set in this research to identify cultural identity in contemporary architecture, especially houses, in the Arab World.
- Using the SAM set in this research as an objective tool to assess and examine issues of sustainability in students' projects according to a systematic evaluation approach.

9.5.2.2. SAM criteria as design principles and guidelines for sustainability adaptation in the Arab world

The SAM criteria can be used as design guidelines for demonstrating sustainable architecture in the Arab World. These principles are derived from the SAM criteria; they can be embodied within the following aspects:

- Redefining the valid issues in traditional architecture for developing futuristic sustainability policies in the Arab World.
- Revitalising of compact urban planning and attached houses in the traditional city that accommodate to environmental conditions in the Arab World.
- According to the investigation of advantages of courtyard environmentally and socially in chapters two and six, this research recommends re-adaptation of internal courtyard in house design because the symbiotic relationship between environment and social patterns is more marked in the courtyard house than any other common building type. As identified by Edwards, Sibley, Hakmi, & Land (2006, P. 221), the loss of the courtyard housing traditions in the Arab World, is a loss of global proportion and an attack on the concept of sustainability.
- Interpreting sustainable principles evident in traditional architecture has to be modified to modern lifestyle and developed available technologies. It is crucial to mention that economical level, population, resource availability, and living standards are not similar in the Arab World. GCC countries, for instance, enjoy privileges and facilities that are not found in countries such as Sudan or Somalia. Thus, it is recommended that

applying of the SAM, as a design guidelines, to be modified according to each country conditions and requirements.

At this point, based on investigated issues, the research suggests a “Sustainability Checklist” as design guidelines for demonstrating sustainable architecture in the Arab World. Results of the research into evaluation need to be “translated” into a form that will be quickly and easily accessible to clients, designers, people responsible for policy and for checking plans and indeed everyone involved in the building process. Results are often presented in forms such as checklists, seals of approval and manuals (Voordt & Wegen, 2005, P.146).

Good judgement in using the checklist will follow from a sound understanding of its underlying principles. Sustainability is usually context-dependent: what improves a problem in one area can exacerbate others, depending on the existing circumstances. The Checklist addresses the inter-linked facets of sustainability that is the underlying environmental, social and economic concerns and principles. The suggested checklist is based on the discussed issues in this research, thus it has taken environmental and social dimensions as design indicators. Environmental sustainability checklist is illustrated in table 9.3 and social sustainability checklist is illustrated in table 9.4.

Table 9.3 – Environmental Sustainability Checklist

(Source: the author)

Site	Site selection	Choosing already developed areas Enhancing site ecological value Nearby public transportation
	Site planning	Locating mass to minimize environmental impact siting mass towards good orientation using plants to enhance shading
	Building footprint	Building on Brownfield
Energy	Carbon Dioxide	Eliminating energy consumption
	Renewable energy resources	Using renewable energy sources (photovoltaic, wind towers…) Taking advantage of climatic conditions Enhancing air movement and natural ventilation
	Building envelope	Using building materials with appropriate thermal properties Choosing walls thickness to enhance thermal resistance
Resources	Building materials	Using locally produced building materials Using sustainable materials
	Recycling and Reuse	Reuse of Building Reuse of land and infrastructure Flexible building design
	Materials lifecycle	Choosing durable and long-life Materials
	Resources consumption	Elimination of materials consumption Using pre-cast components Standardisation in design and details
Indoor Environment	Natural Ventilation	Design openings for natural ventilation Providing appliances for air exchange
	Indoor air quality	Non or low-toxic materials Using environment-friendly appliances Natural building materials
	Thermal comfort	Providing visual contact with outside Providing acoustical privacy and noise protection
Water	Water consumption	Eliminating water consumption rate Use economical-water bath fittings Economical irrigation systems
	Water recycling	Water recycling facilities Rainwater collecting
Waste	Waste output	Eliminating Waste production Using biodegradability building materials
	Waste treatment	Providing waste recycling facilities Providing a place for recycled waste

Table 9.4 –Social Sustainability Checklist

(Source: the author)

Privacy	Urban planning and design concept	Organic urban planning Inward looking design Adapt courtyard house design Identify spaces zoning according to privacy level
	External facades	Indirect main entrance Minimum outside openings
	Acoustical privacy	Highly acoustical building materials Well parting between zones
Social relations	Hospitality	Special space for guests Private entrance for guests
	Guest honouring	Proper Interior design materials
Neighbourhood	Strong neighbourhood relationships	Sustainable neighbourhood Organic compact planning Attached dwellings Public spaces within neighbourhood Integrated services within neighbourhood
	Preservation of neighbours' rights	Staggered main entrance High roof parapet High walls
Family	Strong family ties	Providing special space for family meeting Flexibility in space use
	Extended family	Design flexibility Flexibility in size of rooms Adaptable for Expansions and additions
Identity & Social Status	Humility and self-advocacy	Simplicity in elevation treatment Abstract ornamentation uncomplicated Architectural details
	Cultural Identity	Interpreting traditional architecture Using local materials Using traditional elements in Elevation

9.6. Proposed Future Researches

Issues raised in this research and conclusions and recommendations that were set were formulated according to the limits of this research. Accordingly, further researches are suggested to complete and enhance findings of this research:

- This research has studied private (single family) houses in the UAE. Further studies could examine sustainability potential in multi-family houses, low-rise and high-rise, in the UAE and other Arab countries.
- This research has concentrated on sustainability issues in design process and architectural features. Further studies are recommended to be held about urban planning and neighborhood within sustainability development strategies.
- The present research was limited to environmental and social sustainability dimensions. It is of great importance to carry out studies about economical sustainability dimensions in architecture, especially housing.
- The research has set a SAM for single-family houses. Thus, a sustainability assessment method could be developed to assess sustainability in other types of buildings; commercial, educational (schools), health (hospitals), hotels …etc.

According to the previous raised issues, this research has proposed titles for further studies and researches to enrich the discussed issues:

- Applicability of sustainable neighborhood within the social demography of the UAE
- Sustainable neighborhood and urban planning policies in the UAE
- Role of buildings legislations in demonstrating sustainable buildings in the UAE
- Indoor Air Quality in domestic buildings in the UAE
- Social and environmental dimensions in multi-family residential buildings in the UAE
- Assessment of environmental impacts of development projects in the UAE with special reference to Dubai
- Developing sustainability social assessment methods adequate to the Arab World
- Developing sustainability environmental assessment methods for multi-family residential buildings in the UAE

Epilogue

This research is a step towards better thinking of environment all around the global. The coming few years are so conclusive in the Arab World future in aspects of economy, energy, fossil fuel depletion, social aspects, and environment conservation. We have to rethink of our way of living and lifestyle. The days of dependence on unlimited resources have gone. Serious awareness about the future of our planet is necessary. The earth is a trusteeship given to us by God; it is the human being duty to handle it safely to the coming generations. Architecture is an essential filed in demonstrating environment conservation and sustainability with its comprehensive dimensions.

However, as Brian Edwards (2005, P.6) recognizes, "*Architecture alone cannot solve global environmental problems but it can make a significant contribution to the creation of more sustainable human habitats*".

Bibliography

The Holy Quran.

The Noble Quran- English translation of the meanings and commentary, King Fahd Complex for Printing of the Holy Quran, Al-Madinah al-Munawwarah, K.S.A.

__________ (2006) Design of the Time, *FM Facilities Management Magazine*, Quarter2, Vol.2, PP. 38-40.

__________ (2006) *the Columbia Electronic Encyclopedia*, 6th ed. Columbia University Press, USA.

______________ (2006) Oxford Wordpower Dictionary, Oxford University Press.

______________(2006) *The World Factbook 2006*. Available at www.cia.gov/cia/publications/factbook/index.html

______________ (2005) *UAE Water Consumption One of The Highest in the World*, Available at www.drnicolemunk.de/we_demo_2/news/1013.php

______________ (2005) *Arab Region Roundtable on Harnessing Science, Technology and Innovation for Sustainability*, 16-18 April 2005, Dubai, UAE. Available at http://sustainabilityscience.org

__________ (2004, Nov. 22) Cement Production in UAE, *Middle East*, No. *9491.* Available at www.alsharqalawsat.com

_____________ (2004) *Environmental Sustainability: Business Covenant on Corporate Governance, Arab Business Council Covenants*, Marrakech, Morocco, 25-26 November 2004,

Available at: http://www.weforum.org/pdf/ABC/abc_covenants.pdf

_________ (1982) *Guide to Energy Efficiency in Masonry & Concrete Buildings*, Masonry Buildings of Canada, Canada

__________ *Significance of the Environment in Islam.*

Available at www.islamweb.net/ver2/archive/article.php?lang=E&id=46430

__________ *Ecology and Islamic Values.*

Available at www.islamweb.net/ver2/archive/article.php?lang=E&id=46430

Abel, Chris (2000) *Architecture & Identity: Responses to Cultural and Technological Change,* 2nd Ed, Architectural Press, UK.

Abu-Sway, Mustafa (1998) *Towards an Islamic Jurisprudence of the Environment.* Available on: http://homepages.iol.ie/%7Eafifi/Articles/environment.htm

Al-Abed, Ibrahim & Hellyer, Peter (2001) *United Arab Emirates: a New Perspective*, Trident Press Ltd, UK.

Al-Abdouli, Khalfan Jassim (1989), *Architectural Trends Development in the United Arab Emirates*, Ittihad Establishment for Printing and Publishing, UAE.

Al-Aswad, Al-Saed Hafidh (1996) *Folk House: Anthropological Study for Folk Architecture and Traditional Culture of Emirate Society*, UE University, Al-Ain, UAE.

Al-Azzawi, Abdulsattar (2004) *Al-Bait Al-Gharbi (The Western House)*, Department of Culture and Information, Sharjah, UAE.

Al-Mansouri, Mohammed & Al-Naim, Mushary (2005, April) Modern Architecture in UAE: A Study to Early Transformation in City before Declaration of the Federation, *Architectural & Planning Journal*, Vol.*16*, PP.83-100.

Al-Mansouri, Mohammed & Al-Naim, Mushary (2004, May) From Al Husin Palace to Baynoona Tower, *Adnoc Distribution*, *No.35*, Adnoc Distribution Company, PP.16-17.

Al-Mansouri, Mohammed (1997) *Government Low-cost Housing Provision in the United Arab Emirates: the Example of Federal government Low-cost Housing Programmed*, unpublished PhD thesis, University of Newcastle Upon Tyne, UK.

Al-Nakib, Eman (2004) *Sustainability as a design Paradigm for Quality Architecture: Implications for Commercial Buildings in the Arabian Gulf Countries and Australia*, PhD thesis submitted to University of New South Wales, Australia.

Al-Nawawi, Abu Zakaria Yahia (2002) *Riyadh Al- Salihin min Kalam Saied Al-Mursaleen* (Good People Heaven from the Prophet Speech), Al-Maárif Establishment for Printing and Distribution, Beirut, Lebanon.

Al-Rostomani, Ahmed H. (1991). *Dubai and Its Architectural Heritage,* Al-Safeer Publishing & Advertising Establishment, Dubai, UAE.

Al-Zubaidi, Maha (2004 December) Identity via Sustainability: Guidelines from Traditional Architecture, *1st International Conference on Heritage, Globalization & the Built Environment,* 6-8 Dec. 2004, Bahrain, PP. 73-85.

Al-Zubaidi, Maha (2004 March), Sustainable House: Futuristic Approach for Sustainable Architecture, *Housing Symposium II* - Al-Riyadh Development Authority, 28-31 March, Riyadh, Saudi Arabia , PP. 344-352

Al-Zubaidi, Maha (2002 September) Mass-Effect Passive Cooling: an Environmental Friend Technology for Future Buildings, *Towards Better Built Environment: Innovation, Sustainability and Technology,* IABSE Symposium 2002, 11-13 September, Monash University, Melbourne, Australia.

Al-Zubaidi, Maha (2002 June) The Efficiency of Thermal Performance of the Desert Buildings, *30th Annual Conference of Canadian Society of Civil Engineers,* 5-8 June, Montreal, Canada.

Ali, Ali Abdel Kadir (2001) *Internal Sustainability and Economic Growth in the Arab States*, UNESCO Encyclopaedia of Life Support Systems (EOLSS), Hague.

Amery, Hussein A. (2001) Islam and the environment, in Faruqui, Naser I.; Biswas, Asit K. and Bino, Murad J. (editors) *Water Management In Islam*, United Nations University Press, Tokyo, New York, Paris.

Anderson, Graham (1995) *Sharjah, U.A.E.: The Urban Conservation Dilemma*, Information & Culture Institute, 1st Ed, Sharjah Government, UAE.

Antoniou, Jim (1998 May) The Architectural Review in the Gulf: Conference on Sustainable Architecture and Construction in the Middle East, *The Architectural Review*, Vol. CCIX, No. 1213.

Ardalan, Nader (1993) Innovation and Traditions: New design's relevance to Cultural Heritage, *Archaeology and the Arts in the United Arab Emirates, Arts & Islamic World*, *Special Issue (23)*, 37-40, Islamic Arts Foundation London, UK.

Asaad, Eman (2006) *Architectural Heritage and the Sustainable Value*, Dubai Municipality monthly meeting, Dubai, UAE.

Asfour, Khalid. (1998 A) Cultural Crisis: Cut & Paste Leads to Disaster in the Middle East, *Architecture Review*, Vol. CCIII, No. 1213.

Asfour, Khalid, (1998 B), Architecture Discourse in the Arab World, *Sustainable Architecture and Construction for the Middle East Conference*, conference booklet, March 30-31, 1998, Abu Dhabi, UAE.

Asquith, Lindsay & Vellinga, Marcel (2006) *Vernacular Architecture in the Twenty-First Century: Theory, Education And Practice*, Taylor & Francis, London, UK

Asseidi, Abdulhakeem Abdulateef, *Environment in Human Thought and Religious Reality*, Lebanese-Egyptian Press House, Cairo, Egypt.

Aswad. Al-Saed Hafidh (1996) *Folk House: an Anthropological Study of the Folk Architecture And Traditional Culture of the Emirates Society* , U.A.E University, UAE

Badran, Rasem (1998) On the Poetics of Place: The Communicability of an Architectural Image**,** *Sustainable Architecture and Construction for the Middle East Conference*, conference booklet, March 30-31, 1998, Abu Dhabi, UAE

Bagader, Abubakr Ahmed; El-Sabbagh, Abdullatif Tawfik; Al-Glayand, Mohamad As-Sayyid; Samarrai, Mawil Yousuf Izzi-Deen (1993) *Environmental Protection in Islam*, Meteorology and Environmental Protection Administration (MEPA), Saudi Arabia.

Bagnid, A. (1989) Indigenous Residential Courtyards: Typology, Morphology & Bio-Climate, *C.E.D.R.* Vol. 6, PP. 40-56.

Balkir, Ibrahim; Hassan, Fatma ; Al-Segini, Sabri (2006) Determinants of Fund Allocations Out of Housing Programs in the UAE, *Journal of Economic & Administrative Sciences*, Vol. 22, No. 1, June 2006, PP.25 – 40.

Bani Essa, Abdullah (1999) the Traditional Emirate House: Economical, Healthy, and Durable, *Turath (Heritage) Journal*, Vol. 15, PP. 26-32.

Battle, Guy & McCarthy, Christopher (2001) *Sustainable Ecosystem & Built Environment*, Wiley-Academy, London, UK.

Beatley, T., (1995), The Many Meanings of Sustainability, *Journal of Planning Literature*, Vol. 9, No. 4, PP. 339-342.

Bertelsmann Foundation (2002) *The EU and the GCC- A new Partnership*, Centre for Applied Policy Research, Munich, Germany.

Best Practice Energy Efficiency (2005) *Building a Sustainable Future: Homes for an Autonomous Community*, General Information Report 53, UK.

Birkeland, Janis & Lubanga, Regina (2005) Environmental Quality Indicators, in Birkeland, Janis (editor) *A Sourcebook of Integrated Eco-Logical Solutions*, Earthscan, UK.

Blinca, Robert; Zidans, Aleksandereka; & Slausb, Ivo (2006) *Sustainable Development after Johannesburg and Iraq: The global Situation and the Cases of Slovenia and Croatia*. Available at www.scincedirect.com

Bourgeois, Jean-Louis (1983) *Spectacular Vernacular: a New Appreciation of Traditional Desert Architecture*, Gibbs M. Smith, Inc., USA.

Boyle, Carol () *Sustainability Assessment: a Management Tool beyond LCA*. Available at www.icser.auckland.ac.nz/graduate/BoyleSA.doc

Branch, Kristi; Hooper, Douglas A.; Thompson, James; & Creighton, James C. (1983) *Guide to Social Impact Assessment*, Westview Press, Boulder.

BRE (2005), *EcoHomes 2005 –The Environmental Rating for Homes,* Issue 1.1, Building Research Establishment Ltd., March 2005, UK.

Brown, Judy & Frame, Bob (2005) *Democratizing Accounting Technologies: the Potential of the Sustainability Assessment Model (SAM)*, Working Paper Series Working Paper No. 15, New Zealand. Available at www.law.vuw.ac.nz/vuw/fca/sacl/files/SAMCBAArticleBrownJandFrameBWPNo152005.pdf

Brown, Lester (2001) *World Economy Expands,* Vital Signs 2001, Worldwatch Institute, W.W. Norton & Company.

Brudge, Rabel J. (1994) *A community Guide to Social Impact Assessment*, Social Ecology Press, Middleton.

Buchanan, Peter, (2005) *Ten Shades of Green Architecture & the Natural world,* The Architectural League, New York, USA.

Bukhash, Rashad. (2000) *Managing Restoration Projects in Dubai - United Arab Emirates*, M. Phil. thesis submitted to the Faculty of Art, University of Manchester, UK.

Bunton, John (1977) United Arab Emirates, *Construction News Magazine*, Issue *3*, Vol. 11, PP. 9-20.

Cain, Allan, et al (1975, April) Indigenous Building and the Third World, *Architectural Design*, Vol. 45, No. 4, PP. 207-224.

CAMRE (2005 June) *Sustainable Building & Construction in the Arab Region*, League of Arab States, Egypt.

Cantacuzino, Sherban & Browne, Kenneth (June 1977) The United Arab Emirates, *The Architectural Review*: *A Special Issue, 161(964)*, 325-397.

Carabias-Hütter, Vicente.; Winistörfer, Herbert; & Joos, W. (2003) Assessing and Improving Social Compatibility in Ludwig, C. (editor) *Municipal Solid Waste Management*, Springer Editions, Berlin

Carabias-Hütter, Vicente & Winistörfer, Herbert (2003) *Awareness of the Social Dimension of Sustainable Development*, Centre for Sustainability, Zurich University of Applied Sciences, Switzerland. Available at www.zsa.zhwin.ch

Carabias-Hütter V and Winistörfer H. (2001) Tools needed for sustainability evaluation: the Social Compatibility Analysis (SCA), *8th International Waste Management and Landfill Symposium*, S. Margherita di Pula, Cagliari, Italy.

Centre for Applied Policy Research (C·A·P) (2005) *a Portal on Sustainability: A History of Sustainability*, Research Group on the Global Future, C.A.P., Germany. Available at www.cap-lmu.de

Cole, Raymond (2005) Building Environmental Assessment Methods: Redefining Intentions And Roles, *Building Research & Information* (2005) 35(5), PP. 455–467

Cole, Raymond (2000) Building Environmental Assessment Methods: Assessing Construction Practices, *Construction Management and Economics* (2000) 18, PP. 949–957. Available at www.tandf.co.uk/journals

Cole, Raymond (1998), Emerging trends in building environmental assessment methods, *Building Research & Information* (1998) 26(1), PP. 3–16.

Cooper, Ian (1999) Which Focus For Building Assessment Methods - Environmental Performance Or Sustainability, *Building Research & Information*, 27(4/5), PP. 321–331.

Cost, Paolo M., (1994) *Studies in Arabian Architecture*, Variorum, UK.

Crawley, Drury; Aho, Ilari (1999) Building Environmental Assessment Methods: Applications and Development Trends, *Building Research & Information,* 27(4/5), PP. 300–308.

Damluji, Salma Samar (2006) *the Architecture of the United Arab Emirates,* Garnet Publishing, UK.

Deakin, Mark; Curwell, Steve; & Lombard, Patrizia (2002) Sustainability Assessment of Urban Development Plans, PP.1-18. Available at www.ndmodelling.scpm.salford.ac.uk/intelcity/documents/Docs/deakin_paper.pdf

De Chatel, Francesca (2003) *Prophet Mohammed: a Pioneer of the Environment*, available on www.islamonline.net.

Defra (2005), *Sustainable Indicators 2005,* Department for Environment, Food & Rural Affairs publications, June 2005, UK.

Derbyshire, Ben, (2000) Greenwich Millennium Village: a Case Study of Sustainable Housing, in Edwards & Turrent (editors), S*ustainable Housing: Principals and Practice*, E. & F. N. Spon, London, UK.

Dickie, I. & Howard, N. (2000) *Assessing Environmental Impacts of Construction: Industry Consensus*, BREEAM and UK Ecopoints, BRE Digest No. 446.

Doukas, Haris ; Patlitzianas, Konstantinos D.; Kagiannas, Argyris G.; Psarras, John (2006) Renewable energy sources and rationale use of energy development in the countries of GCC: Myth or reality?, *Renewable Energy*, Vol. 31, PP. 755–770

Dubai Municipality (2007A) *Dubai: Concise and History*, Public Projects Administration, Historic Buildings Section, Dubai, U.A.E.

Dubai Municipality (2007B) *Historic Lectures*, Public Projects Administration, Historic Buildings Section, Dubai, U.A.

Dubai Municipality (2004) *Traditional Architecture in Dubai*, Historical Buildings Section, Project and Maintenance Department, 1st ed., Dubai, UAE.

Dubai Municipality (1996) *Elements of Traditional Architecture in Dubai: Reference Book*, General Project and Maintenance Dept., Historical Buildings Section, Dubai, U.A.E.

Dubai Municipality (no date) *Dubai,* Dubai Municipality, UAE.

Dyck, Gertrude (2004) *The Oasis: Al-Ain Memories of Doctora Latifa*, Motivate Publishing, Dubai, UAE.

ECD (2004) *Green Globes Design for New Buildings and Retrofits*, ECD Energy & Environment Canada Ltd, December 2004, Toronto, Canada,.

Edwards, Brian; Sibley, Magda; Hakmi, Mohammed; & Land, Peter (2006) *Courtyard Housing: Past, Present, & Future,* Taylor & Francis, USA.

Edwards, Brian, (2005), *Rough Guide to Sustainability*, 2nd Edition, RIBA Enterprises Ltd, UK.

Edwards, Brian (1998) *Green Building Pay*, E& FN Spon, UK.

Edwards, Brian & Chrisna du Plessis, (2001) Snakes in Utopia: a Brief History of Sustainability, *Green Architecture: Architectural Design (AD)*, Vol. 71, No. 4, July, Wiley – Academy, UK.

Edwards, Brian & Turrent, David (2000) *Sustainable Housing: Principles & Practice*, E & FN Spon, UK.

Elkington, J. (1999) Triple Bottom Line revolution: Reporting for the Third Millennium, *Australian CPA*, Vol. 69, P. 75.

Emirates Heritage Club (2001) *Zayed: Journey in Photos*, Emirates Heritage Club, Zayed Centre for Heritage & History, Abu Dhabi, UAE.

Energy Resource Environmental & Sustainable Management (2004), *Green Millennium Village*, Nov. / Dec. 2004, DEFRA Publications, UK.

Esty, Daniel C.; Levy, Marc; Srebotnjak, Tanja; & de Sherbinin, Alexander (2005) *Environmental Sustainability Index: Benchmarking National Environmental Stewardship*, Yale Centre for Environmental Law & Policy, New Haven, USA. Available at www.yale.edu/esi.

Esty, Daniel C.; Levy, Mark A.; Winston, Andrew (2003) Environmental Sustainability in the Arab World, in Cornelius, Peter (editor) *the Arab World Competitiveness Report 2002-2003*, Oxford University Press, New York.

Evans, Martin (1980) *Housing, Climate and Comfort*, 1st Edition, the Architectural Press, London, UK.

Falah, M. & Bederdin, B. (1999) Modern Homes for Bedouins Low-cost Public Housing Developments in Abu Dhabi, *2nd International Conference on Sustainability in Desert Regions,* UAE.

Farmer, John (1996) *Green Shift: Towards a Green Sensibility Architecture,* Butterworth-Heinemann, UK.

Faruqui, Naser I.; Biswas, Asit K.; and Bino, Murad J. (2001) *Water Management In Islam,* United Nations University, Tokyo, New York, Paris.

Fethi, Hassan (1988) *Natural Energy And Vernacular Architecture*, 2nd Edition, United Nations University, Tokyo, Japan.

Fethi, Hassan (1973) *Architecture for the Poor,* Chicago Press, USA.

Flyvbjerg, Bent (2006) Five Misunderstandings about Case Study Research, *Qualitative Inquiry*, Vol. 12, No. 2, April 2006, pp. 219-245.

Fox, Warwick (2000), *Ethics and the Built Environment: Professional Ethics,* Routledge, London, New York.

Freudenburg, William R. (1986) Social Impact Assessment, *Annual Review of Sociology*, Vol. 12, PP. 451-478.

Friedman, Arnold; Craig, Zimring & Ervin, Zube (1978) *Environmental Design Evaluation*, Plenum Press, New York, USA.

Gamal, Mohamed & Loehlein, Gisela (2007) Sustainability in Traditional Houses in the UAE Potentials and Improvement of Buildings Abilities, *the 2nd International Conference of Architectural Conservation: Opportunities & Challenges*, 19-21 February 2007, Dubai, UAE, PP 196-208.

GBC (2004), *LEED Policy Manual*, USA Green Building Council, summer 2004, USA.

Gelil, IA & Kandil, S. (2004) Renewable Energy Resources in the Arab Countries, *International Conference on Renewable Resources and Renewable Energy*, Italy.

Ghabbash, Rafia (2003) *Emirates and the Socio-cultural Change*, the Society, Vol. 42/1, Culture & Science Symposium, UAE.

Ghandoour, Marwan, (1998), Reflections on the Architecture Review Conference in Abu Dhabi, *Urban Design International*, Vol. 3, No.3.

Ghoneim, Kareem (2000) *The Quran and the Environment*, available at www.islamonline.net

Giovani, Baruch (1998) *Climate Considerations in Buildings & Urban Design*, JohnWiley & Sons, Inc., USA.

Gissen, David, (2003), *Big & Green: towards Sustainable Architecture in the 21st Century*, National Building Museum, Princeton Architectural, New York, USA.

Global Reporting Initiative (2000) *Sustainability Reporting Guidelines*, Global Reporting Initiative June 2000, Amsterdam.

Global Sustainability (2001) *Global Sustainability: the History/Time Line of an Idea*, RMIT, Melbourne, available at RMIT's Global Sustainability website, http://www.global.rmit.edu.au/resources/historyofanidea_25.07.01.pdf

Golany, Gideon S. (1983) *Earth-Sheltered Habitat: History, Architecture & Urban Design*, Van Nostrand Reinhold Company, New York, USA.

Green Building Initiative (2005) *Green Globes Design for New Construction*, Green Building Initiative, Inc., Canada.

Groat, Linda & Wong, David (2002) *Architectural Research Methods*, John Wiley & Sons, Inc.

Gutman, Robert & Westergaard, Barbara (1974) Building Evaluation, user Satisfaction, and Design, in Lang, J; Burnette, C.; Moleski, W; and Vachon, D. (eds), *Designing for Human Behaviour: Architecture and the Behavioural Sciences*, New York, PP. 320, 322.

Guy, J. N., (1990) *Records of the Emirates,* Archive Edition, Vol.1.

Hagan, Susannah (1998) the good, the bad and the juggled: the new ethics of building materials, *The Journal of Architecture*, Vol.3, summer 1998, PP. 107-115.

Halcrow, William & Partners (1969) *Town Planning for the State Capital of Sharjah*, Sir William & Partners, London, UK

Hall, Tony (2005) A General Method for Designing Sustainable Settlements, *GBER*, Vol. 4 No. 3 PP. 12 -18.

Hakim, Basim (1986) *Arabic Islamic Cities: Building and Planning Principles*, KPI, New York, USA.

Hancock, Trevor (1993) *Social Sustainability The "soft infrastructure" of a Healthy Community*. Available at www.newcity.ca/Pages/social_sustainability.html

Hantrais, Linda (1995) Comparative Research Methods, *Social Research*, Vol.22, Summer 1995, Department of Sociology, University of Surrey, UK. Available at www.sru.soc.surrey.ac.uk/SRU13.html

Harrison, Andrew; Wheeler, Paul & Whitehead, Carolyn (2004) *The Distributed Workplace*, Spon Press, UK.

Heard-Bey, Frauke (2004). *The United Arab Emirates: Statehood and Nation-Building in a Traditional Society*, Middle East Institute, Retrieved July 20, 2006, from http://www.mideasti.org/articles/doc314.html

Heard-Bey, Frauke (1982). *From Trucial States to United Arab Emirates*, Longman London, UK.

Heard, Frauke (1978) the People of the United Arab Emirates, *Bulletin,* 05 July 1978.

Heartfield, Ian & Heartfield, James (2001) *Sustainable Architecture in the Anti-machine* Age, Wiley-Academy.

Heaton, Janet (1998) Secondary Analysis of Qualitative Data, *Social Research*, Vol.22, Autumn 1998, Department of Sociology, University of Surrey, UK.

Available at www.sru.soc.surrey.ac.uk/SRU22.html

Herzog, Martin, (2004),*The Architecture of Iraq: The Lost Art of Clay Construction,* available at: http://www.brainworker.ch/Irak/architecture.htm

Hinds, P.S., Vogel, R.J., Clarke-Steffen, L. (1997) The Possibilities and Pitfalls of Doing a Secondary Analysis of a Qualitative Data Set, *Qualitative Health Research*, Vol. 7(3): 408-24.

Hinrichs, Craig L., (1987) T*he Architecture of the Courtyard House as Generated by Passive Solar Energy & Other Factors*, MPhil Thesis, Faculty of Arts, School of Architecture, the University of Manchester, UK.

Hotten, Robert (2003) *Sustainable Architecture - 12 Things You Can Do to Build Effective Low Cost House.*

IUCN/UNEP/WWF (1980) *World Conservation Strategy: Living Resource Conservation for Sustainable Development*, IUCN/UNEP/WWF, Gland, Switzerland,

Izzi Deen, Mawil (1990) Environmental Islamic law, Ethics, and Society, in J. R. Engel and J. G. Engel (editors.) *Ethics of Environment and Development: Global Challenge, International Response*, Belhaven Press, London, UK.

Jacobs, Michael (1999) Sustainable Development: a Contested Concept, in Dobson, A. (editor), *Fairness And Futurity: Essays on Environmental Sustainability and Social Justice*, Oxford University Press, Oxford.

Johansson, Rolf (2003) *Case Study Methodology Reflected in Architectural Research*. Available at http://www.infra.kth.se/~rolfj/Foufaces2003.pdf

Joshi, M. (2002) *Sustainable Consumption: Issues of A Paradigm Shift*, Indian Council of Social Science Research, Occasional Monograph Series, No.1, New Delhi.

Karim, Luiza (1999, Sep.) *Modernity and Tradition in Dubai Architecture*, *Al-Shindagah*, available on www.alshindagah.com/september99/architecture.htm

Kay, Shirley (1993) Domestic Architecture, in Kay, Shirley and Zandy, Dariush (ed), Architecture, Archaeology, & the Arts in the United Arab Emirates*, Arts & the Islamic world,* Special Issue, No.23, Islamic arts Foundation, London, UK.

Kay, Shirley and Zandy, Dariush (1991), *Architectural Heritage of the Gulf*, Motivate Publishing, 1st Ed, Dubai. U.A.E.

Kay, Shirley (1989) *Land of the Emirates*, Motivate Publishing, Dubai, UAE.

Kennedy, Joseph F. Ed (2004) *Building without Borders*, New society Publishers, Canada.

Kharoufi, Mustafa, *Urbanization and Urban Research in the Arab World,* Management of Social Transformations MOST, Discussion Paper Series - No 11, available at http://unesdoc.unesco.org/images/0010/001056/105621e.pdf

Khawaja, Muhammad Atif (2002) *DAR AS-SAKINA: Reinterpreting the Traditional Emirate House in the Design of a Modern Apartment Building in Sharjah*, Final Project Research & Design, American University of Sharjah, UAE.

Kim, Jong-Jin & Rigdon, Brenda (1998A) *Sustainable Architecture Module: Introduction to Sustainable Design*, National Pollution Prevention Centre for Higher Education, Michigan, USA.

Kim, Jong-Jin & Rigdon, Brenda (1998B) *Qualities, Use, and Examples of Sustainable Building Materials,* National Pollution Prevention Center for Higher Education, Michigan, USA.

Klinker, Susan, (2004) Shelter and Sustainable Development, in Kennedy, Joseph F. (editor) *Building without Borders*, New society Publishers, Canada.

Koch-Nielsen, Holger (2002) *Stay Cool: a Design Guide for the Built Environment in Hot Climates*, James & James (Science Publisher) Ltd, UK.

Krayem, Hasan; Nehme, Adib; Abdul Hadi, Ezzat (2000) *Development in the Arab World and the Role of the Arab NGOs*, Social Watch. Available at http://www.socwatch.org/en/informesTematicos/3.html

Kulterman, Udo (1999) *Contemporary Architecture in the Arab States: Renaissance of a Region,* McGraw-Hill, New York, USA.

Lang, J; Burnette, C.; Moleski, W; and Vachon, D. (1974) *Designing for Human Behaviour: Architecture and the Behavioural Sciences*, Dowden, Hutchinson, and Ross, Pennsylvania, USA.

LAS & ESCWA (2005) *Arab Region State of Implementation on Climate Change*, Commission on Sustainable Development (CSD), Session 14 report, League of Arab States & Economic and Social Commission for Western Asia.

Leanne Barron and Erin Gauntlet (2002) Housing and Sustainable Communities Indicators Project, *"Sustaining our Communities" International Local Agenda 21 Conference*, 3–6 March 2002, Adelaide.

Available at www.adelaide.sa.gov.au/soc/pdf/barron_gauntlett.pdf

Lele, S. M. (1991) Sustainable Development: a Critical Review, *World Development,* Vol. 19 (6), PP. 607-621.

Ludwig, C. (2003) Municipal Solid Waste Management, Strategies and Technologies for Sustainable Solutions, Springer-Verlag, Berlin.

Available at www.srk.co.uk/pages.asp?pagename=socialimp

Macintosh, Duncan (1973) *the Modern Courtyard House*, Lund Humphries Publishers Ltd., London, UK.

Mahgoub, Yasser (1997), Sustainable Architecture in the United Arab Emirates: Past and Present, *CAA-IIA International Conference On Urbanism & Housing*, GOA, India.

Maitra, Jayanti & Al-Hajji Afra (2001) *Qasr Al Hosn: the History of the Rulers of Abu Dhabi 1793-1966*, Centre for Documentation and Research Abu Dhabi, UAE.

Marina & Custom Department (2000) *Past Echo: Dubai in Half Century*, Marina & Custom Department, Dubai, UAE.

Matsushita, Kazuyuki (1980) New Dubai Municipal Building, *Japan Architect*, Vol. 55, Part 55(277), PP. 7-14.

McKenzie, Stephen (2004) *Social Sustainability: Towards Some Definitions*, Hawke Research Institute, Working Paper Series, No 27, University of South Australia. Available at www.hawkecentre.unisa.edu.au/institute/working.htm

Melnick, Don; McNeely, Jeffrey; Navarro, Yolanda Kakabadse; Schmidt-Traub, Guido & Sears, Robin R. (2005) *Environment and Human Well-Being: A Practical Strategy*. The UN Millennium Project, Australia.

Mendler, Sandra. , Odell, William (2000) *The HOK Guidebook to Sustainable Design*, John Wiley & sons, INC., USA

Ministry of Economy (2006) *Preliminary Results of Population, Housing and Establishments Census 2005*, Ministry of Economy, UAE.

Ministry of Information & Culture (2006) *UAE Year Book*, Abu Dhabi, UAE.

Mohammed, Tarek Abdelsalam (2002) *Architectural Identity in Eastern Arab Cities: Developing an Assessment Method with Particular Reference to the Aga Khan Awards*, PhD thesis submitted to the School of Art, Design, & Architecture, The University of Huddersfield, UK.

Moore, Fuller (1993), *Environmental Control Systems,* International Edition, McGraw-Hill, Inc, New York, NY, USA.

Naarden, Sarah (2006) Green Horizon, *FM Facilities Management Magazine*, Quarter1, Vol.2, PP. 34-39.

Nasr, Seyyed Hussein (1978) The Contemporary Muslim and the Architectural Transformation of the Islamic Urban Environment, in Toward an Architecture in the Spirit of Islam, proceedings of seminar One in the series : *Architectural Transformations in the Islamic World*, held in Aiglemont, Gouvieux, France, April 1978.

National Academy of the Humanities, *The Humanities and Australia's National Research Priorities*, available at www.humanities.org.au/policy/Priorities/HumanitiesRPreportfinal.pdf. p.13

Newman, Peter () *The Social Side of The State Sustainability Strategy*. Available at www.sustainability.dpc.wa.gov.au

Oliver, Paul, (2003), *Dwellings: the Vernacular House World Wide*, Phaidon Press Ltd, London, UK.

Oliver, Paul, (1997), *Encyclopedia of Vernacular Architecture***,** Phaidon Press Ltd, London, UK.

Olsson, Johanna Alkan; Aalbu, Hallgeir; Hilding-Rydevik, Tuija; and Bradley, Karin (2004) *Indicators for Sustainable Development***,** Paper for discussion Cardiff, 23-24 March 2004 by http://www.sustainable-euroregions.net/policy_studies.php

Osmond, Glen & Dijksterhuis, Alexis (2006) $ 892 Billion FM Market, *FM Facilities Management Magazine*, Quarter1, Vol.2, PP. 4-7.

Ouf, Ahmed M. (2000) *Urban Conservation Concepts for The New Millennium in the United Arab Emirates*, Zayed Center for Heritage and History, Al-Ain, UAE.

Ozkan, Suha (2002) Modernity & Tradition: Problem or Potential, in Pertruccioli, Attilio & Pirani, Khalil K. ed, *Understanding Islamic Architecture*, Routledge Curzon, New York, USA.

Peel, J. D. Y. (1987) History, Culture and the Comparative Method, In Holy, L. (editor) *Comparative Anthropology*, Blackwell, Oxford, UK and New York.

Pepperdine, Sharon () *Social Indicators of Rural Community Sustainability: an Example from the Woady Yaloak Catchment*. Available at http://www.regional.org.au/au/countrytowns/strategies/pepperdine.htm

Polése, M. & Stren, R. (1999) *The Social Sustainability of Cities: Diversity and the Management of Change*, University of Toronto Press, Toronto, Canada.

Popay, J., Rogers, A., Williams, G. (1998) Rationale and Standards for the Systematic Review of Qualitative Literature in Health Services Research, *Qualitative Health Research*, Vol. 8 (3): 329-40.

Ragette, Friedreck (2003) T*raditional Domestic Architecture of the Arab World*, Axel Menges, Stuttgart, Germany.

Ragin, Charles (1989) *The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies*, University of California Press, USA.

Rahman, Saifur (2006) Property Boom, *The Gulf News*, 19/02/2006, UAE.

Rashid. Noor M. (2004) *Castles & Forts in the United Arab Emirates*, Cultural Foundation, Abu Dhabi, UAE.

Reynolds, John S., (2002) *Courtyards: Aesthetics, Social, and Thermal Delight,* John Wiley & Sons, Inc., New York, USA.

Roaf, Sue; Thomas, Stephanie; & Fuentes, Manuel (2003) *Ecohouse2: A Design Guide,* Architectural Press, Oxford, UK.

Roodman, D. M. & Lenssen, N. (1995) *A Building Revolution: How Ecology and Health Concerns are Transforming Construction*, Worldwatch paper 124, Worldwatch Institute, Washington D.C., USA.

Ross, Helen (2005) Sustainability and Aboriginal Housing, in Birkeland, Janis (editor) *A Sourcebook of Integrated Eco-Logical Solutions*, Earthscan, UK.

Salmen, Lawrence, F. (1995) *Beneficiary Assessment: an Approach Described*, Environment Department Papers, Social Assessment Series, Paper No.23, July 1995, World Bank's Environment Department, Social Policy & Resettlement Division.

Sarana, G. (1975) *Methodology of Anthropological Comparisons*, University of Arizona Press, Tucson, USA.

Sawat, Ali M. (2004) Thermal Insulation in Green Sustainable Buildings, *Applications of Thermal Insulation in GCC Countries Symposium*, 17-21, April, 2004, Riyadh, Saudi Arabia.

Schoeauer, Norbert, (2000), *6000 Years of Housing,* W.W. Norton, New York, USA.

SEEDA (2005), *Sustainability Checklist*, South East England Development Agency. Available at www.sustainability-checklist.co.uk.

Selim, Gehan & Abouelfadl, Somya (2004) Case Study of the Housing Policies in the United Arab Emirates, *Housing Symposium II,* Al-Riyadh Development Authority, 28-31 March, Riyadh, Saudi Arabia , PP. 101-116

Shukla, Ramesh (1999) *The UAE Formative Years 1965-1975*, Motivate Publishing, Dubai, UAE.

Sibley, Magda (2006) The courtyard Houses of North African Medinas: Past, Present, & Future, in Edwards, Brian; Sibley, Magda; Hakmi, Mohammed; & Land, Peter (editors) *Courtyard Housing: Past, Present, & Future,* Taylor & Francis, USA.

SimPro (2004) *Introduction to LCA with SimPro*, Ecology Consultants. Available at www.pre.nl.

Slessor, Catherine (2000) Physics and Phenomenology, *the Architectural Review*, January 2000.

Smith, Peter I. (2003) A*rchitecture in a Climate of Change: A Guide to Sustainable Design*, Architectural Press, London, UK.

Smith, L. Graham (1993) *Impact Assessment & Sustainable Resource Management*, Addison Wesley Longman Ltd, UK.

Spiegel, R. & Meadows, D. (1999) *Green Building Materials: A Guide to Product Selection and Specification*, John Wiley & Sons Inc., New York, USA.

Stang, A. & Hawthorne, C. (2005) *The green House: New Directions in Sustainable Architecture*, Princeton Architectural Press, New York.

Steele, James (1997) *Sustainable Architecture: Principles, Paradigms, & Case Studies*, McGraw-hill, USA.

Stonehouse, Roger (1998) Dwelling with the Environment: The Creation of Sustainable Buildings & Sustaining Situations through the Layering of Building Form & Detail,, in Scott (ed) *Dimensions of Sustainability: Architecture, From, Technology, Environment, Culture*, E. & F. N. Spon, London

Sutton, Phillip (2000) *Sustainability: What Does It Mean*, available at Green Innovations website http://www.green-innovations.asn.au/sustblty.htm

Tang, Antony; Han, Jun; Chen, Pin (2004*) A Comparative Analysis of Architecture Framework*, Swinburne University of Technology, 25 August 2004, UK.

Taylor, C. Nicholas; Bryan, C. Hobson; & Goodrich, Colin C. (1990) Social Assessment: Theory, Process and Techniques. *Studies in Resource Management*, No. 7, Centre for Resource Management, Lincoln University, New Zealand.

The Global Ecovillage Network, *Community Sustainability Assessment (Csa)*, Ecovillage Network of the Americas, USA. Available at www.ecovillage.org

The Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment (1994) *Guidelines and Principles for Social Impact Assessment Prepared*, U.S. Department of Commerce National Oceanic and Atmospheric Administration National. Available at http://www.nmfs.noaa.gov/sfa/social_impact_guide.htm

Thomas, Derek (2002), *Architecture and the Urban Environment: a Vision for the New Age, Architectural Press*, Oxford, UK.

Thomas, R. Murray (2003) *Blending Qualitative & Quantitative Research Methods in Theses and Dissertations*, Corwin Press, Inc., USA.

Todd, Joel Ann; Crawley, Drury; Geissler, Susanne; and Lindsey, Gail (2001) Comparative Assessment of Environmental Performance Tools and the Role of the Green Building Challenge, *Building Research & Information* 29(5), PP. 324–335

Utzon, Jorn (2004) *The Courtyard Houses*, Logbook, Vol. 1, edition Blondal.

Vancouver City Council (2005) *Definition of Social Sustainability,* Director of Social Planning, in consultation with the Manager of the Sustainability Group, Canada.

Voordt, Theo TM & Wegan, Herman BR van (2005) *Architecture in USE: an Introduction to the Programming, Design, and Evaluation of Buildings*, Architectural Press, UK.

WCED (1987) *Our Common Future*, the World Commission on Environment and Development, Oxford University Press, New York.

Weeramantry, C. G. (1988), *Islamic Jurisprudence: An International Perspective*, St. Martin's Press, New York.

Wells, Malcolm (1982) *Gentle Architecture*, McGraw-Hill Book Company, U.S.A.

Wersal, Lisa (1995 September) Islam and Environmental Ethics: Tradition Responds to Contemporary Challenges, *Journal of Religious & Science*, Vol. 30, Issue 3.

Williams, Malcolm (2002) Generalization in Interpretive Research, in May, Tim (ed.) *Qualitative Research in Action*, SAGE Publications Ltd, UK.

WWF (2006) *Living Planet Report 2006*, World Wildlife Fund, Global Print Network, Switzerland, also available at www.panda.org/livingplanet

Yin, Robert K. (2002) Case Study Research. Design and Methods. 3rd edition, Applied Social Research Method Series, Vol. 5, Sage Publications, California, USA.

Yunis, Mohammed Ahmed (2003) *Environment Protection in Islamic Viewpoint*, Culture and Science Symposium, Dubai, UAE.

Yunis, Mohammed Ahmed (2001) *Broad Lines of the Islamic Approach to Environment Protection*, available at www.isesco.org.ma/pub/ISTD/Eng/20/P7

Zahla, Rosemarie Said (1989) *the Making of the Modern Gulf States: Kuwait Bahrain, Qatar, the United Arab Emirates and Oman*, Unwin Hyman Ltd, UK.

Zandy, Daruish (1993), Development of Architecture in the Gulf**,** in Kay, Shirley and Zandy, Dariush (ed), Architecture, Archaeology, & the Arts in the United Arab Emirates*, Arts & the Islamic World,* Special Issue, No.23, Islamic Arts Foundation, London, UK.

Web sites

www.sustainablemeasures.com
www.sustainable-development.gov.uk
www.answers.com/topic/sustainable-architecture
www.worldlife.org
www.en.wikipedia.org
www.un.org/geninfo/bp/enviro.html
www.griffith.edu.au
www.arch.hku.hk/research/BEER/sustain.htm
www.dest.gov.au/priorities
www.fac.unc.edu/eag/Definitions.htm
www.entrix.com/resources/glossary.aspx
www.ces.vic.gov.au
www.cap-lmu.de/index.php
www.iisd.ca/consume/oslo004.html
www.dbc.uci.edu/~sustain/state/chapter1.htm
www.buildsustainably.org
www.sustainabilityscience.org
www.unesdoc.unesco.org
www.dm.gov.ae
www.oecd.org
www.foxnews.com/wires/2007Jan16/0
www.quran.alislam.com
www.islamweb.net/
www.hadith.al-islam.com
www.uae.gov.ae
www.travel-island.com
www.uaemaps.com
www.uaeinteract.com
www.alertnet.org
www.worldfacts.us
www.infoplease.com
www.uaeone.com
www.sdci.gov.ae
www.uaezayed.com
www.dubaitourism.co.ae
www.sheikhmohammed.co.ae
www.dubaiairport.com
www.everyculture.com

www.alsharqalawsat.com
www.worldgbc.org
www.middleeastelectricity.com
www.trane.com
www.dexigner.com
www.ameinfo.com
www.eeuae.com
www.pbase.co)
www.oecd.org
www.ecifm.rdg.ac.uk/inofsd.htm
www.ew.govt.nz/enviroinfo/indicators/community/index.htm
www.sustainable-euroregions.net/policy_studies.php
www.icser.auckland.ac.nz/graduate/BoyleSA.doc
www.regional.org.au/au/countrytowns/strategies/pepperdine.htm
www.ecovillage.org
www.socialimpactassessment.net
www.srk.co.uk/pages.asp?pagename=socialimp
www.bre.co.uk/greenguide
www.dewa.gov.ae
www.youthxchange.net
www.drnicolemunk.de
www.globe-net.ca/market_reports/index
www.architectureresearch.org
www.en.wikipedia.org/wiki/Qualitative_method
www.thecarbontrust.co.uk/foundation/0302GWP.html
www.youthxchange.net