



**SUSTAINABILITY IN VERNACULAR ARCHITECTURE OF IRAQ AND
ITS APPLICABILITY IN MODERN RESIDENTIAL BUILDINGS IN IRAQ
REGION**

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JUNE 2015

**SUSTAINABILITY IN VERNACULAR ARCHITECTURE OF IRAQ AND
ITS APPLICABILITY IN MODERN RESIDENTIAL BUILDINGS IN IRAQ
REGION**

**A THESIS SUBMITTED TO
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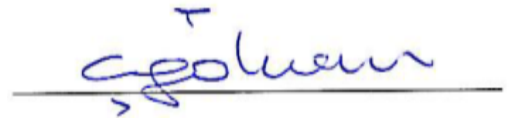
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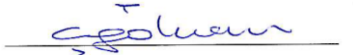


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ABSTRACT

SUSTAINABILITY IN VERNACULAR ARCHITECTURE OF IRAQ AND ITS APPLICABILITY IN MODERN RESIDENTIAL BUILDINGS IN IRAQ REGION

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Sustainability is a modern term that has been used on a large scale and at all levels of economic, social, environmental and even political, and where the issues of environment and architecture is the base engine for this thought, many attempts have emerged over the past year is to codify and framing this thought, in the form of guides and standards. Therefore, discussed the concept in his original named "sustainability", then move on to the concept of smaller and closer to architect works, "sustainable architecture", after it has been moving to the smaller circle and more deeper which had embodied the concept of sustainability Urban, (standards LEED and other global standards), even that many of the countries in the world which it has imposed as law, until it reached applied mandatory on some countries, and thus achieves an important part of the objectives of the research is to explore which benefit us of the concept of sustainability inherent in the architecture vernacular, application and make them as sources of architecture and modern buildings in generally and residential buildings in particularly. In many parts of the world, one can realize many distinctive examples of vernacular architecture, mainly houses. Although there were socio-cultural differences in each region, the design of houses

retained a common architectural language that responded to both the common hot arid zone climate and the common religious needs.

The heritage includes various forms of vernacular houses, which were developed in response to traditional, religious and cultural factors, along with the specificity of the local built environment, each architectural element in the vernacular architecture represented a solution or an answer to a different problem that appeared according to a specific condition, they were a sequence of related problems, which were met successfully to achieve a unified and a harmonious direction.

The beauty of these traditional houses represents an art form which has resulted from an understanding of a unique mode of religious and cultural human life and the architecture vernacular principles embodies of sustainable development through the close relationship between the nature and a healthy environment as well as the building materials had a local and natural renewable sources. In fact that research aims to consolidate the concept of sustainability in vernacular architecture, LEED standard, BREEAM System, Green Arch and Estidama have been selected with the concepts and methods of vernacular architecture.

Keywords: Sustainability, Vernacular Architecture, Modern Residential Buildings, LEED, BREEM, Green Arch, Estidama, and Socio-Cultural Differences.

ÖZ

IRAK GELENEKSEL MİMARİSİNDE SÜRDÜREBİLİRLİLİK VE BUNUN IRAK BÖLGESİNDEKİ MODERN KONUTLARDA UYGULANABİLİRLİLİĞİ

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Sürdürülebilirlik geniş çapta kullanılan modern bir terim olup, ekonomik, sosyal, çevresel ve hatta politik alanlarda karşımıza çıkar. Çevresel ve mimari sorunlar bu düşüncenin temelini oluşturur, ve bu düşüncenin geçmiş yıllarda kılavuzlar ve standartlar şeklinde birçok kodlanma ve çerçeveleme girişimi ortaya çıkmıştır. Bu nedenle, önce “sürdürülebilirlik”, daha sonra bunun yakın bakışı olan “sürdürülebilir mimari” tartışılır. (Standart LEED ve diğer evrensel standartlar) Geleneksel mimari, pek çok ülkede yasa olarak empoze edilmiştir, ve bazı ülkelere zorunlu hale getirilmiştir. Bu nedenle araştırmanın en büyük amaçlarından biri geleneksel mimarideki sürdürülebilirlik kavramının uygulanmasının bize faydaladığını bulmak ve bu yöntemi mimari kaynaklarda ve modern yapılarda kullanılabilecek bir bilgi haline getirmektir.

Dünyanın birçok yerinde, geleneksel mimarinin belirgin örneklerine rastlanabilir; özellikle evlerde. Her bölgede sosyo-kültürel farklılıklar olmasına rağmen, evlerin

tasarımı alışılmış sıcak kurak bölge iklimi ve ortak dini ihtiyaçlara cevap veren mimari dili korumuştur. Bu miras, geleneksel, dini ve kültürel faktörlere cevap olarak geliştirilen geleneksel evleri, yerel yapılı çevrenin özgüllüğü ile birlikte içerir. Geleneksel mimarideki, mimari unsurların hepsi, belirli bir duruma göre ortaya çıkmış soruna üretilen cevap veya çözümü temsil eder, bunlar bir dizi problemler olup, birleştirici ve uyumlu şekilde, mimari sayesinde çözülmüşlerdir. Bu geleneksel evlerin güzelliği, insanların eşsiz dini ve kültürel anlayışı sonucu ortaya çıkmıştır. Geleneksel/Yöresel ilkeler, doğal ve sağlıklı bir çevre arasındaki yakın ilişki sayesinde ve bunun yanı sıra inşaat malzemelerinin yerel ve doğal yenilenebilir kaynaklardan sağlanması sayesinde sürdürülebilir gelişimi şekillendirir. Aslında araştırmalar yöresel/geleneksel mimaride sürdürülebilirlik kavramını pekiştirme amacıyla, LEED standardı, BREEAM sistemi, Green Arch ve Estidamayı geleneksel mimari kavram ve yöntemlerine göre seçmiştir.

Anahtar Kelimeler: Sürdürülebilirlik, Geleneksel Mimari, Modern Konutlar, LEED, Breem, Green Arch, Estidama ve Sosyo-Kültürel Farklar.

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TABLE OF CONTENTS

STATEMENT OF NON PLAGIARISM.....	iii
ABSTRACT.....	iv
ÖZ.....	vi
ACKNOWLEDGEMENTS.....	viii
TABLE OF CONTENTS.....	ix
LIST OF FIGURES.....	xiii
LIST OF TABLES.....	xviii

CHAPTERS:

1. INTRODUCTION.....	1
1.1. The Research Problem.....	2
1.2. Aim of the Study.....	2
1.3. Significance and Scope of the Study.....	3
1.4. The Boundaries and the Field Study.....	4
1.5. Methodology.....	4
2. MODERN STANDING of SUSTAINABILITY.....	6
2.1. Definition of Sustainability.....	7
2.2. Sustainable Development.....	9
2.3. Sustainable Design and Architecture.....	10
2.4. Sustainable Interior Design.....	11
2.5. Sustainable Building Rating System.....	11
2.5.1. LEED Rating System.....	12
2.5.2. BREEM System.....	14
2.5.3. Green Arch.....	17
2.5.4. Estidama.....	20
2.5.5. Vernacular Architecture Style.....	22
2.5.5.1. Sustainability in Vernacular Architecture.....	22
3. VERNACULAR ARCHITECTURE.....	24

3.1.	Climatic Control in Architecture.....	24
3.1.1.	Influence of the Climate on Architecture.....	24
3.1.1.1.	Indoor Thermal Comfort Control.....	25
3.1.1.2.	Ventilation.....	25
3.1.1.3.	Evaporative Cooling.....	26
3.1.1.4.	Restriction of Infiltration.....	26
3.1.2.	The Heat Transfer.....	28
3.1.2.1.	Historical Background.....	28
3.1.2.2.	Heat Transfer.....	29
3.1.2.3.	System Units	30
3.1.2.4.	Main Methods of Heat Transfer.....	30
3.1.2.5.	U- Value.....	37
3.1.2.6.	K- Value.....	39
3.2.	Vernacular Architecture in Dry Climate.....	41
	Dry Climates / Subtropics.....	41
3.2.1.	Air-Permeable Window Covering.....	43
3.2.2.	Wind Catcher and Solar Chimneys.....	45
3.2.3.	Yards and Courtyards.....	48
3.2.4.	Sun Sails and Shading.....	50
3.2.5.	Adiabatic Cooling.....	50
3.2.6.	Thermal Mass.....	52
4.	VERNACULAR ARCHITECTURE OF IRAQ (BAGHDAD & ERBIL)..	67
4.1.	Location of Iraq.....	68
4.2.	Climate of Iraq.....	68
4.2.1.	Climate of Baghdad Region.....	69
4.2.2.	Climate of Erbil Region.....	71
4.3.	Vernacular Architecture in Baghdad Region.....	72
4.3.1.	Historical Development in Baghdad Region.....	73
4.3.2.	Features of Vernacular House in Baghdad Region.....	76
4.3.3.	Building Materials in Baghdad Region.....	83
4.4.	Vernacular Architecture in Erbil Region.....	86

4.4.1.	Historical Development In Erbil Region.....	86
4.4.2.	Features of Vernacular House in Erbil Region.....	88
4.4.3.	Building Materials in Erbil Region.....	90
4.5.	The Sustainability Measures Development Of Iraq.....	92
4.6.	Strategies of Vernacular Architecture In Iraq.....	93
4.6.1.	Planning and Dealing with the Site.....	94
4.6.2.	The Form and Mass of Building.....	95
4.6.3.	The Orientation and the Directing.....	96
4.6.4.	Environmental Design And Energy Conservation.....	97
4.6.5.	Shading.....	98
4.6.6.	Water Bodies.....	99
4.6.7.	Natural Ventilation in Vernacular Systems.....	99
4.6.8.	Daylight.....	101
4.6.9.	Exploit the Potential of the Soil.....	101
5.	ANALYSIS ERBIL CITY.....	103
5.1.	The History of Erbil City.....	103
5.2.	The Northern Iraq Vernacular Architecture.....	104
5.3.	Form Of The City.....	106
5.4.	Erbil City Zones.....	108
5.5.	The Architectural Identity of Erbil City.....	110
5.5.1.	Traditional Period Before 1930.....	112
5.5.2.	Modification Period (Colonial Period) (1930-1980).....	120
5.6.	Vernacular Architecture and its Form in Erbil City.....	122
5.6.1.	Elevation Elements of Erbil Houses	123
5.6.1.1.	Form of the Mass.....	123
5.6.1.2.	The Openings.....	124
5.6.1.3.	Shading Elements.....	126
5.6.1.4.	Architectural Materials.....	127
5.6.1.5.	Additional Characteristics.....	128
6.	CONCLUSIVE SUGGESTIONS FOR FUTURE HOUSES.....	135
6.1.	The Alley and the Street Patterns.....	136

6.2.	Exterior Spaces.....	137
6.3.	Buildings Orientation.....	138
6.3.1.	Sun Orientation.....	138
6.3.2.	Wind Orientation.....	138
6.3.3.	Shape and the Volume.....	138
6.4.	The Courtyard.....	139
6.5.	Underground Buildings.....	139
6.6.	Building Materials.....	139
6.7.	Openings and Windows.....	140
6.8.	Natural Ventilation.....	141
7.	CONCLUSION.....	143
	REFERENCES.....	R1
	APPENDICES.....	A1
	A. CURRICULUM VITAE.....	A1

LIST OF FIGURES

FIGURES

Figure 1	Three Dimensions of Sustainability.....	10
Figure 2	General BREEAM Process.....	16
Figure 3	Benefits of Green Building.....	18
Figure 4	Rate of Heat Conduction.....	31
Figure 5	The Area of Heat Transfer.....	32
Figure 6	Thermal Conductivity Law Diagram of a Sample Material.....	33
Figure 7	The Method of Heat Transfer by Convection.....	34
Figure 8	U Value.....	39
Figure 9	The Expansion of the Tropical Zone.....	41
Figure 10	Toraja Houses.....	42
Figure 11	Subtropical Areas.....	43
Figure 12	The Mashrabiyya and Good Ventilation.....	44
Figure 13	The Indian Counterpart of the Mashrabiyya.....	44
Figure 14	Badgirs in Yazd.....	46
Figure 15	Wind Catcher in Pakistan.....	46
Figure 16	“Lifeline” in India.....	47
Figure 17	Courtyard Houses in Morocco.....	48
Figure 18	Thermal Ventilation in Courtyard Houses.....	49
Figure 19	Shading of a Bazaar in Morocco.....	51
Figure 20	Typical Clay Mosque in Mali.....	52
Figure 21	Ice House in Yazd.....	53
Figure 22	Iraq Topography Map.....	67
Figure 23	Iraq Location in the World.....	68
Figure 24	Psychometric Chart for Baghdad City.....	69

FIGURES

Figure 25	Monthly Temperature Chart of Baghdad Region.....	70
Figure 26	Average Humidity in Baghdad Region.....	70
Figure 27	Monthly Precipitation in Baghdad in Inches.....	70
Figure 28	Psychometric Chart for Erbil Region.....	71
Figure 29	Monthly Temperature Chart of Erbil Region.....	71
Figure 30	Average Humidity in Erbil Region.....	72
Figure 31	Monthly Precipitation in Erbil Region in Inches.....	72
Figure 32	Ur Courtyard House.....	74
Figure 33	Ground & First Floor of a Four-Courtyard House.....	75
Figure 34	Baghdadi House Courtyard.....	76
Figure 35	The Doorways of the Entrance Corridor Mejaz.....	77
Figure 36	The Entrance Vestibule “Dolan ”.....	78
Figure 37	Urси with its Colourful Glass and Wooden.....	78
Figure 38	The Shanasheel.....	79
Figure 39	Cross-Section Showing Neem Sardab.....	80
Figure 40	Cross-Section Showing Neem Sardab.....	80
Figure 41	Ground Floor and Basement Plans.....	81
Figure 42	First Floor Plan.....	82
Figure 43	Three Levels of the House.....	83
Figure 44	“Farshi” Brick.....	84
Figure 45	Intricate Ceilings.....	85
Figure 46	The Structure of Basement.....	85
Figure 47	Erbil Citadel Windows.....	86
Figure 48	Major Alleyways.....	87
Figure 49	Rooms Windows.....	88
Figure 50	The Central Courtyard.....	89
Figure 51	The Upper Floor Rooms with Wooden Columns.....	90
Figure 52	Wooden Column with “Muqurnass”.....	91

FIGURES

Figure 53	Brick Column with “Muqurnass”.....	91
Figure 54	City Planning.....	92
Figure 55	City Planning & Unit Neighbours.....	93
Figure 56	Planning and Dealing with Site of Baghdad.....	94
Figure 57	Residential Area of Baghdad City.....	95
Figure 58	Typical Form of a Courtyard House.....	96
Figure 59	The Orientation Toward Inside the House.....	97
Figure 60	Passive Design.....	98
Figure 61	Street Shading.....	99
Figure 62	Natural Ventilation.....	100
Figure 63	Day Lighting Rooms to Courtyard.....	101
Figure 64	Exploit the Potential of the Soil.....	102
Figure 65	Erbil Citadel.....	103
Figure 66	North of Iraq.....	104
Figure 67	Erbil Citadel in 1950 & in Present.....	104
Figure 68	Erbil City Satellite Image.....	105
Figure 69	Erbil City Image.....	106
Figure 70	Maps Of Erbil City Iraq.....	107
Figure 71	Evolution Periods of the Erbil City.....	109
Figure 72	Erbil Citadel – Exterior Wall.....	110
Figure 73	Street toward Erbil Citadel.....	110
Figure 74	The New Gate of Erbil Citadel in 1980.....	110
Figure 75	Commercial Area beside the Bazar During 1980’s.....	111
Figure 76	The Public Bath of Erbil Citadel.....	111
Figure 77	External Erbil Citadel Wall with Windows and Balcony.....	111
Figure 78	Erbil Citadel- Satellite Image.....	112
Figure 79	Erbil Citadel.....	112
Figure 80	House Façades in Urban Fabric Alleyways.....	113

FIGURES

Figure 81	Geometry of Mass- Inside and Outside Erbil Citadel City.....	114
Figure 82	Courtyard House -Erbil Citadel.....	115
Figure 83	Rashid Agha, the Courtyard House Inside Erbil Citadel.....	116
Figure 84	An Old Courtyard House within the Erbil Citadel.....	116
Figure 85	Residential Structures Within the Citadel.....	117
Figure 86	Another View within the Erbil Citadel.....	117
Figure 87	Corridor within the Citadel's Maze of Residential Structures....	118
Figure 88	House in Modification Period- Erbil.....	120
Figure 89	Geometry of Mass- Inside and Outside Erbil Citadel City.....	122
Figure 90	Types of Window in Erbil City.....	124
Figure 91	Types of Window in Erbil Citadel.....	124
Figure 92	Types of Entrance in Erbil City.....	125
Figure 93	Entrance Indirect in a Traditional House-in Erbil Citadel City...	125
Figure 94	House Canopy in Erbil.....	126
Figure 95	House Balcony in Erbil.....	126
Figure 96	House Parapet in Erbil.....	126
Figure 97	Shanasheel House in Erbil.....	126
Figure 98	Brick- Basic Building Material In Traditional Period – Erbil....	127
Figure 99	Traditional Roofing Materials- Erbil City.....	127
Figure 100	Roofing at Indoor House- the Erbil Citadel	128
Figure 101	Alley and Street Direction.....	136
Figure 102	Alley and Street Shape.....	136
Figure 103	Alley and Street Endings.....	136
Figure 104	The Effect of Trees on Temperature.....	137
Figure 105	The Effect of Trees on Wind.....	137
Figure 106	Best Direction.....	138
Figure 107	Shading of Buildings.....	138
Figure 108	The Effect of the Courtyard.....	139

FIGURES

Figure 109	The Effect of Building Materials on Heat Flow.....	140
Figure 110	The Wind Catchers.....	141
Figure 111	Location Problem of Modern House Block in an Area.....	142
Figure 112	Update Location of House Block in an Area.....	142

LIST OF TABLES

TABLES

Table 1	Assessing the Performance of LEED.....	13
Table 2	The Main LEED Certifications of LEED.....	14
Table 3	The Weighting System.....	16
Table 4	BREEAM International Schemas.....	17
Table 5	BREEAM- Life-Cycle of a Building.....	18
Table 6	Thermal Conductivity (k) of Materials.....	33
Table 7	The Type of Convection of Some Materials.....	35
Table 8	The Rate of Radiation Emissivity at Materials.....	37
Table 9	Comparison between V & S Architectural - Site Section.....	54
Table 10	Comparison between V & S Architectural - Development Density & Fabric of society.....	55
Table 11	Comparison between V & S Architectural – Transportation.....	56
Table 12	Comparison between V & S Architectural - Increase of Open Spaces.....	57
Table 13	Comparison between V & S Architectural - Redeveloping Neglected Sites.....	58
Table 14	Comparison Between V & S Architectural - Control the Quantity and Quality of Rainwater.....	59
Table 15	Comparison Between V & S Architectural - Reducing the Impact of the Sun's Heat.....	60
Table 16	Comparison between V & S Architectural - Reducing Light Pollution.....	61
Table 17	Comparison between V & S Architectural - The Efficiency of Water Usage.....	62
Table 18	Comparison between V & S Architectural - the Energy.....	64

TABLES

Table 19	Comparison between V & S Architectural - Materials and Resources.....	65
Table 20	Comparison between V & S Architectural - Healthy Interior Environment.....	66
Table 21	Architectural Features of the Erbil Vernacular Houses on Traditional Period (Before 1930).....	119
Table 22	Architectural Features of the Erbil Vernacular Houses on Modernity Period (1930- 1980).....	121
Table 23	Comparison between Vernacular Courtyard Houses & Modern Houses of Erbil City - Architectural Elements.....	129
Table 24	Comparison between Vernacular Courtyard Houses & Modern Houses of Erbil City - Environmental Effect on Buildings.....	131

CHAPTER 1

INTRODUCTION

Undoubtedly, that the concept of a sustainability not a new or innovative term, but this concept is illustrated through the vernacular architecture in different zones of the world, since the ancient time by a compatibility experimental which connected directly with the environment and continue exploitation of the resources of the natural environment without any harm to the environment through the principle of true and false experience over the years on one hand, with the world's economic and population growth crisis continues, the increase of energy crisis and the environmental problems on other hand. So great challenge of this growth is to balance its rapid residential building programs with the mechanism of protecting its environment and energy conservation by using of long-term energy-efficient strategies that have a spirit of sustainability and all of that represents in the vernacular architecture strategies, that has been referred the primary forms which created by man to protect him from the cruel conditions of the external environment by exploiting of natural energy sources like the sun and the wind and the soil.

In addition, the houses represent the framework for the existence of humanity.

The vernacular architecture had been generated from the workout, which gave form and style to these buildings, measured and scaled by the human body and its experience.

In this paper, I shall take the Iraqi vernacular architecture in general and focus on Baghdad city and Erbil city in particular as a case study toward the sustainable, environment's friend modern housing.

1.1 The Research Problem

To a large degree, decisions made in the budgeting design, building materials, procurement and construction stages of a development affect the success of the building in terms of sustainability outcomes (Great Britain, Dept. of Health, 2011). Therefore, sustainability and its implications for planning and design should be considered at the onset of all new-builds, especially the strategies of vernacular architecture, as the earlier it is considered the more the sustainability benefits are maximized on the economical and healthily field, For example, the on-site layout and form of the building offer the best opportunities to improve the environmental benefits without major capital costs. In addition, choices about heating and cooling (properties of vernacular architecture), which contribute largely for saving the energy used, are important to meet targets, Failure to take the strategies of sustainability into account at the onset can result in costly alterations having to be made at a later stage and opportunities missed to include sustainable measures into the design and structure of the building (Lockie & Bourke, 2009). The strategies of sustainability puts the opportunities and risks which posed by the modern technological developments and to have an attention of architects, and decision makers, and producers of building materials to a real risk of human will suffer from it, if a negative behaviour toward the environment and Nature did not turn to a Positive clear behaviour.

1.2 Aim of the Study

This research aims to define the concept of sustainability in the references of vernacular architecture in general, and housing in particular as a strategies, to be a reference for sustainable buildings in present time and the future, through a review of the relationship between man and the environment and maintain to extraction the principles of sustainability in the vernacular housing via documents, comparing vernacular architecture and their solutions in response to various climatic conditions, to create and increase a general attention towards of vernacular architecture

especially residential buildings challenge of climate change. In addition to the economic and health benefits by using these strategies in: Increasing of human comfort, minimizing waste of spaces, reducing construction expenses, decreasing of building maintenance expenses, protecting and improving natural values.

1.3 Significance and Scope of the Study

This study will address important concerns when choosing the type of building materials and sustainable design for modern buildings which depends on the strategies of vernacular architecture of residential buildings. Accordingly, it will provide designers with the knowledge and tools needed. In addition, what will affect the local building materials on the internal environment in a positive or negative ways according to their ability to support healthy environments and their sustainability, affecting the thermal performance, air quality and air pollution. The study of the strategies of vernacular architecture in order to achieve in the internal space of modern residential buildings as health and comfort, in addition to the proper external environment. Moreover, it can't achieve the welfare of the occupants of the building and a healthy environment in the residential complexes only by following the techniques of sustainability strategies. Thus, the concept of sustainability in vernacular architecture has already become a condition of designing any building in present and the future time, especially in a residential buildings.

The scope of this research seeks to answer the following questions:

- What are the features of vernacular architecture, buildings and their sustainable materials?
- What are the criteria for selecting sustainable building design, materials to a residential vernacular architecture?
- What are the architectural thoughts and solutions which derived from the vernacular architecture in terms of sustainability and their application's success in modern buildings of Iraq?

Thus, we consider technological innovation in the context of the good life and how it

Can be supported or threatened, depending on the way technological innovations from the past (vernacular architecture) are influenced and steered by human decisions and institutions.

1.4 The Boundaries and Field of the Study

This research will address the vernacular architecture under the concept of sustainability, which means that the search will cover the sustainable vernacular architecture as a basic reference of modern buildings by depending on the theories, architectural language and solutions of construction for challenging the climate Fluctuations, in accordance with the concept of sustainability and its friendship with the environment as mainly, and how to apply the strategies of vernacular architecture in modern buildings in generally and in housing particularly and meet to the applications and practices towards energy conservation and the preservation of natural resources.

1.5 Methodology

The purpose of this study is to identify pathways to the sustainability of vernacular architecture, I have been selected this issue to define basic ideas on sustainable building and development. Literature review is expended mainly on vernacular architecture. The study consisted of two scientific levels:

- Part one is based on literature, the challenges of sustainability of vernacular architecture on an international scale and inspired the features on the sustainability of vernacular architecture at an architectural perspective and the local's materials, then efforts were devoted to the development of modern Building, towards the sustainability in these residential buildings.
- Part two is collecting and analysis of two residential cities (Baghdad and Erbil) as case study to gain the practical and scientific experiences of how residential building will be a more sustainable way, this part uses:

a) Data collection from multiple sources such as documents and proceedings from the process, brochures and information from the website.

b) Analysis of good points and weak points in each case.

c) Comparison between cases.

(Pilot projects of sustainable building, which depend upon the sustainability of vernacular architecture and these are the subject of qualitative exploratory case studies and Comparative analysis).

The possibility of developing a more comprehensive model of sustainability and a more general perception currently which stems from the local vernacular architecture concepts. The strategies of vernacular architecture which Verify the concept of sustainability through planning and architectural language to the cultures of these cities.

This study is composed of eight chapters. Next chapter introduces literature survey in sustainability concept. Sustainable architecture definition and four worldly recognized assessment rating systems LEED, BREEAM, Green Arch and Estidama are discussed within the context of sustainability and the final review demonstrates the link between sustainability and vernacular architecture.

The third chapter introduces climatic control in architecture through its influence on buildings and their interior spaces. Then discussed heat transfer means in buildings and into their interior spaces.

While chapter four review the vernacular architecture in dry climates / subtropics zone on the world and the different ways of protection at hot climatic changes of their vernacular architecture.

Moreover, the chapter five deals with the vernacular architecture of Iraq in general and (Baghdad and Erbil city) in particular, and focused on the strategies of vernacular architecture.

In addition, the chapter six analysis of Erbil city due to their ancient vernacular architecture and cultural heritage.

Furthermore, chapter seven products the Conclusive suggestions for future private houses in Baghdad and Erbil region.

Finally chapter eight includes the conclusion part.

CHAPTER 2

MODERN STANDING OF SUSTAINABILITY

In the most countries the using of energy and emissions of CO₂ is the biggest driver for the buildings. About 160 million buildings are in the EU are estimated for using more than 40% of the energy in Europe and push more than 40% of emissions carbon dioxide. The US Energy Information Administration pointed to the chair of the energy and the emissions of the greenhouse gas (GHG) that connected with building it is bigger in the US and the total emissions amount to 48% .

In many developing countries, the emission from buildings and the percent of the total emissions have increased constantly over the last 50 years. The increasing in the energy of the devices that are being used inside the buildings and the big sized of the building where been the main purposes for such growth. In the developing countries, furthermore, the total energy use and the emissions to the share of the buildings are much less. While the speed of the manufacturing and the urbanization both of the energy use and GHG emissions that connected to the buildings are rapidly increasing in those developing countries where the significant economic growth is connected with the sector of the construction boom. Therefore, there are a huge number of new constructions that are added every year in many developing countries.

Expectations for GHG emissions connected with buildings estimate that in the whole world the GHG emissions will reach by 2030 about 15 billion, while the Asian countries that contributing to about 1/3 of the all emissions. Lowering the energy and GHG effect in both the existing and the new buildings represents and therefore the main challenge and a chance to treat global warming. The companies of ICT have built and operate facilities which can be demanding a big amounts of energy and material consumption in all stages of the life cycle. The increasing in the effectiveness of the energy always main goal for the ICT companies and can start with facilities themselves. There are many plans that are adopted by worldwide, which is can be lead to the more sustainable design, building and operation of buildings.

2.1 Definitions of Sustainability

The sustainability consists of three main basics like stool, each leg presents ecosystem, economy and society. If any leg is missing from the sustainability stool it will cause destabilization, because the society, the economy and the ecosystem are complex and connected to each other.

This requires for meeting the four key objectives in the whole world at the same time by Adams [1]:

1. The social progress that admitted the needs for everyone.
2. The efficient protection to the environment.
3. The rational use of the natural resources.
4. The maintenance of the high and stable levels of the economic growth and the chance of employment.

"Sustainability" appears that the critical activities of the institution of higher education (at minimum) sound ecologically, socially and viable economically and they will continue to be going on for the future generations. These concepts in its research and curriculum should be emphasized by a truly college or university, and prepare the students to be contributing as a citizen worker in an environmentally sound and just society.

Like sustainable community the institution work, which embodies the responsible consumerism in food and energy items, healing miscellaneous members with respect and the surrounding community support these values.

Sustainability it is a point of view in the world where current or future humans are living in good health in reasonably way, the communities and the nations are booming, save and secure, there is an economic chance for all and the safety of the life that is supported biosphere is being restored and sustained to make these goals possible at a necessary level. So the four dimensions of sustainability must be directing all to achieve this vision.

It is the process that is helping to create an active economy and a high quality of life while the needs to keep natural resources and protect the environment are being respected. The principle for this it can be expressed by the future generations should

live in a world like the present generation has enjoyed with the resources but not for reducing them.

According to Yaldiz [63]. The sustainability is a conception that has multi-dimensional which having spiritual, political, cultural, environmental, economic, social. In this way, the sustainability is described as a system or in other word it means the ecosystems that is having various parts or elements that is having an interactive. Therefore, in this issue sustainability is long term case and can be used in different dimensions also in different jobs.

According to Halliday [24]. Sustainability isn't a specific or a clear single concept to deal with mathematics or based on assumption, inputs and equations. Accordingly, a specific result is not expected to finish in a specific time. Essentially, sustainability is a methodology which can be seen for representing a dynamic and continuous way for the life.

Thus the concept of sustainability arises among those who cares for the environment, and the evaluation instruments and most of literatures reflect this focus. Therefore, it is can be recognized by increasingly that sustainability can't achieve without dealing with the issues of the social justice. Without the social justice there cannot be sustainable communities and institutions. The same applies to human consideration towards of all communities of life a basically part of the real sustainability. Must on the academic institution to be committed to the sustainability and help the students to better understand the roots of the present injustices and push them to search for justice and humanity in the whole integration with the understanding the roots of degradation environment and put models in a sustainable environment.

Sustainability is the perfect end-state. Like democracy, it is a lofty goal that which can achieve perfection eludes us. That's why; there will be always defined for competition sustainability. What we know that there will be always definitions that are included with our economy, well-being of people, nature, and our social institutions, work together in an effective way for the long term by AtKisson, [7].

According to Whitehead [61]. There were two common sense assumptions that would may have command general support before classifying the various types of sustainability:

1. The sustainable process or system must be based on the resources which not be exhausted for sensible period.
2. The sustainable process or system mustn't engender unacceptable pollution internally or externally.

2.2 Sustainable Development

Sustainable development it is the development that meets the needs of present without harming the ability of the coming generation to meet their needs. (The aim of this is to ensure the productivity from exploiting the natural resources and keeping all kinds of animals and plants) by Robinson [47].

This term has been as well developed in the UN system which is usually used the term sustainable human development. The introduction of the human dimension puts the development of humans at the top of the regional integration and the development of sustainable for a country or continent. The confession of the centrality dimension of the human development, the general assembly of the UN has adopted in 1986 an announcement of the right to development indicating that the Man is the main subject of the development and call upon the members of the states to secure the access to the education, basic resources, food, employment, housing, health services and distribute fairer income (Sustainable Human Development 1995). Sustainable development consists of three parts: economy, environment, and society. If we look into the three circles overlapping and having the same size, then the connection area or the center area of the overlap of the three circles will be the well-being of the human. If the environment, economy and society become more compatible, then the overlap area will increase and the well-being of the human also.

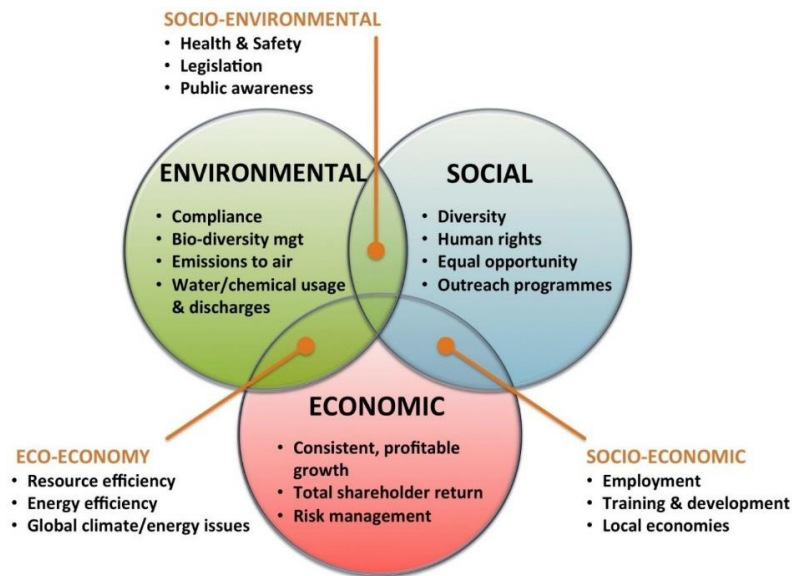


Figure 1 Three Dimensions of Sustainability [116]

According to Bretschger [10]. The sustainable Resource Usage like energy and water cannot be destroyed, but they can be used. In the form they can be changed, be difficultly in restoration or in recycling. There is a different between use it up or use a resource. Such as, the countryside. Showing the hills that are not even using the resource in the area lake, while the walking in the hills in the end will destroy them. The chart below is showing how the resources are flowing through a rural society "typical".

2.3 Sustainable Design and Architecture

The sustainable architectural term has a very large meaning, so its benefit to us to point out the sustainable architecture which has been created from the developing building connected with the environment and have benefited in economically, culturally, socially, aesthetically and more healthy.

According to Bretschger [10]. To get a comfortable, healthy and productive indoor environment for occupants and visitors of the building.

Building design, which provides the best possible conditions with respect to indoor air quality, thermal comfort, natural ventilation and daylight, and control of the audio environment.

Sustainable architecture which replies and communicates with environmental and local climate to create a suitable environmental conditions thus, reaching to ecological equilibrium.

It has the ability to continuity for adaptation to the whole changes and needs for human.

2.4. Sustainable Interior Design

According to Foster [18]. The consumers has become Interested in the environment and being more aware, socially by creating eco-aware residential buildings and that lead to a new generation of responsible people. In addition, to meet Investors demand. An orientation to inside a building which is more suitable, comfortable and more healthy, with a low cost of bills by passive building and depending on one of the LEED and BREEM systems. Put the responsibilities of buying strategies by sustainable vision and conservation of the natural resources and efficiency of energy usage, materials and minimizing waste water. Renewable source materials that have been sustainably certified:

- A- Buy locally if possible
- B- Consider a product's true cost
- C- Reclaim, recycle and reuse.
- D- Aesthetic

2.5 Sustainable Building Rating System

There are a lot number of criteria, tools and methodologies that have been chosen to help organizations to provide the excellent performance for the environment with respect to their building stock.

In this thesis, we will discuss things like LEED, Green Arc, BREEAM, Green Building and Estidama from the UAE. Also design, construction and best practices will discuss with respect to the building operations, maintenance and improvements.

While the good design can limit the energy bills by 25%, and the initial cost of the capital might not be the lowest, in order to deal with the narrow expectations for the economy. The sustainable building indicates for both the structure and the process that is responsible for more environmentally through the entire life cycle of the building. The life cycle consists of stages are:

- Choosing the location
- Design
- Construction
- Operation and maintenance
- Renovation
- Demolition

The process of sustainable building in order to reduce the effect of the surrounding environment on the building by:

- Use the resources more efficiently (like water, energy) to promote and protect the well-being and the health of the occupants.
- Minimize the negative effects (like pollution, waste, sewage).

According to Williams [62]. Sustainable buildings are the structures that are built in an environmentally responsible way through increasing the use of materials, reducing the use of resources and guarantee the well-being and the health of the occupants and the surrounding residential environment both today and for future generations, as for LEED instructions this agrees with almost all other green building instructions.

2.5.1 Leed Rating System

Under the supervision of the U.S. Green Building Council (USGBC) [56]. LEED is running and LEED means (Leadership in Energy and Environmental Design) is an ecology-oriented building certification program. LEED is focusing its efforts to improve the performance in five main areas in the environment and human health: efficiency of the energy, the quality of the indoor environment, choosing materials, water saving and the development of sustainable sites, a tool of green building that is

dealing with the whole building life cycle that is recognized by best-in-class building strategies. By the U.S. Green Building Council (USGBC) [56]. The building certification process was developed which it is a non profit organization (it is not a government agency) where it's location in Washington and started in 1998. LEED has a special classification system that applies to all types of structures, that including houses, schools, healthcare facilities and retail. Classification systems are available for new building and major renovations as well as existing buildings. LEED is depending on opinion of The USGBC define it " an acceptable nationally benchmark for designing, building and operation for high-performance green buildings " and " Building owners and operators with the tools they need to provide a direct effect and measurable influence on the performance of their buildings ".

Depending on the institute of the American Architects and LEED have initiative at the US departments in Agriculture, Defence, Energy and State drive activity at the federal level. In addition, there are different types of LEED projects which are presently ongoing in more than 40 other countries, including Canada, Brazil, India and Mexico. Where by LEED Reference Guide [34]. Which is confirmed on a whole-building approach for sustainability by assessing performance in the six main groups. The certification LEED based on the number of "points" (table) that for each building able to get in each of six areas.

Table 1 Assessing the performance of LEED Reference Guide.

N	Category	Points
1	Sustainable site development	26
2	Water efficiency	8
3	Energy efficiency	35
4	Materials selection	14
5	Indoor environmental quality	15
6	Innovation and design process	10
Total		108

Depending on LEED Reference Guide [34]. For the new building and the main renovations certifications that are awarded according to the following scale:

Table 2 The Main LEED Certifications of LEED Reference Guide.

Level	Points
Certified	40 – 49 points
Silver	50 – 59 points
Gold	60 – 79 points
Platinum	80 points and above

2.5.2 BREEAM System

BREEAM it is foremost method in the world's environmental assessment and classifying system for buildings, with 2 million registered for evaluation and with 425,000 buildings with certified BREEAM assessment ratings since it was first released in 1990.

BREEAM puts the standards for best practices in the design of sustainable building, the construction and operation has become one of the most extensive and known recognized measures in the environmental performance of a building's.

It promotes designers, customers and others to think about the efficiency of low design and low carbon and minimizing the demands of the energy that is created by a building before considering the efficiency of the energy and lower carbon technologies.

BREEAM covering a group of building types that is include: homes, industrial units, retail units, offices and schools. Other building types can be evaluated by using Bespoke BREEAM (bespoke is another word for making according to the demand). When the building is evaluated, the points are calculated for each standard and the points are added to a total score. The overall performance of the building is awarded as a "Pass", "Good", "Very Good" or "Excellent" rating based on the score [26].

The Goals:

- Reduce the effects environment for the buildings.
- Provides a reliable environmental label.
- Allow for a transparent comparison for the buildings.
- Put standards and criteria more that and above those required by legislation.
- Confrontation the market for more creative solutions.
- Stimulate the request for the sustainable buildings.
- Allow the organizations to prove their evolution to achieve their objectives in CSR.

The main types for BREEAM of criteria for design and purchases that is including the following [26]:

- Energy (efficiency, sub-metering and CO2 effect of systems).
- Water (reduce the consumption, measurement, detect of the leak).
- Health & Well-being (humidification, adequate ventilation, thermal comfort and lighting).
- Transport (alternative transport facilities, emissions).
- Management (waste recycling, commissioning, material minimization, monitoring, pollution minimization).
- Land Use (use of remediated contaminated land, previously used land).
- Ecology (minimization of biodiversity impacts, maintaining major ecological systems on the land, land with a low ecological value or minimal change in value).
- Materials (use of crushed aggregate and sustainable timber, recycling facilities, asbestos mitigation, facade or materials, reuse of structures).
- Pollution (avoid the use of ozone depletion and global warming substances, leak detection systems, local or renewable energy sources, on-site treatment, light pollution design).

Table 3 The Weighting System.

Category	Weighting
Management	12%
Health & Wellbeing	15%
Energy	19%
Transport	8%
Water	6%
Materials	12.5%
Waste	7.5%
Land USA & Ecology	10%
Pollution	10%

General BREEAM Process

The diagram below explains the process of BREAM

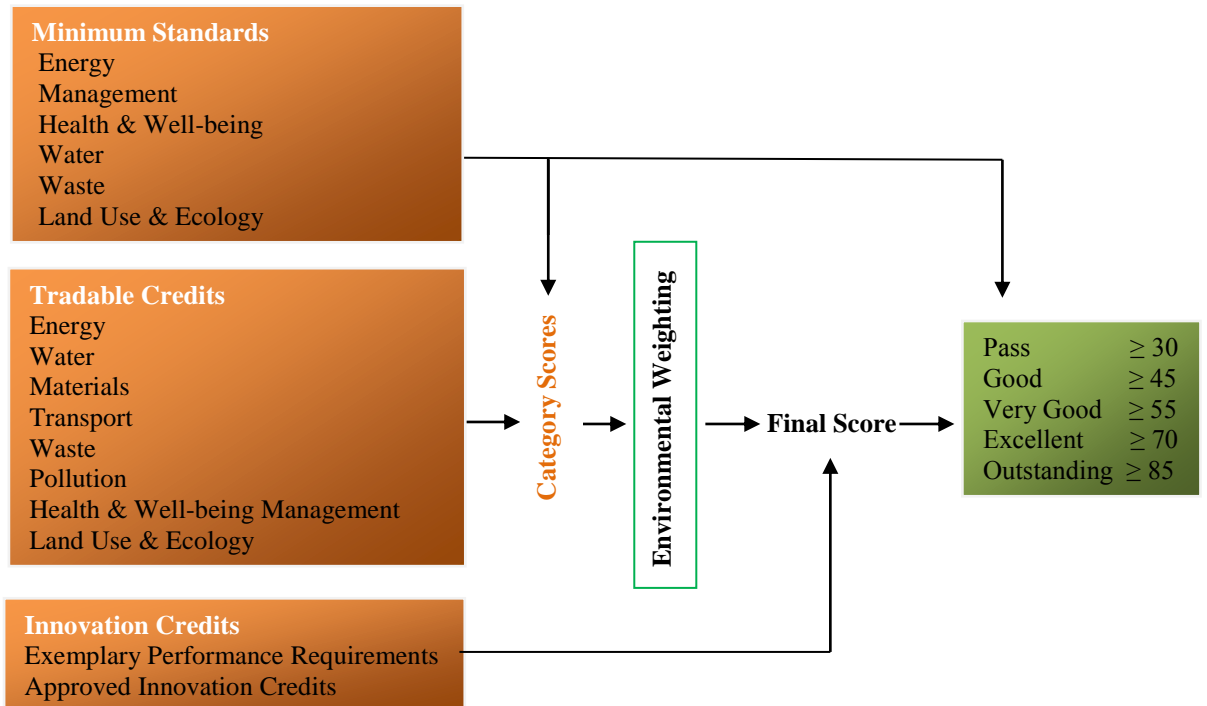


Figure 2 General BREEAM Process [87]

The benefits of adaptability BREEAM into an evaluation tool adopted at national level [26].

- The ownership of the schema
- Nationally endorsed and recognized
- Available in the local language – increase the take up
- More range of detailing to the local context
- Taking the Benefits from BRE knowledge and expertise - mean saving resources.
- Sharing best practices.
- Revenue of income
- Member in the BREEAM International family

Table 4 BREEAM International Schemas.

Category	%
*	30%
**	45%
***	55%
****	70%
*****	85% and More

2.5.3 Green Arch

The Green Building Program (GBP) is a voluntary program which started in 2005. It is supposed to confirm the possibilities of the realization for the efficiency of the effective cost of the energy of creating a conscious and provide the information, support and public confession for the top management companies that are ready for more real commitment to adoption measurement of energy efficiency in non-residential buildings. These are the important five broad areas:

- Site planning for sustainability.

- Renewable energy and Energy efficiency.
- Water efficiency and Safeguarding for the water.
- Maintenance of materials and resources.
- Indoor environmental quality.

Table 5 BREEAM- Life-Cycle of a Building.

Aspects of Built Environment	Consumption	Environmental Effect	Ultimate Effects
Siting Design	Energy	Waste	Harm to Human Health
Construction	Water	Air pollution	Environment Degradation
Operation	Materials	Water pollution	Loss of Resources
Maintenance	Natural	Indoor pollution	
Renovation	Resources	Heat islands	
Deconstruction		Storm water runoff	
		Noise	

Benefits of Green Building

Green building means the practice of creating structures and using environmental processes that are responsible and resource-efficient by a life-cycle of a building's from sitting to design, construction, operation, maintenance, renovation and deconstruction. This practice is expanding and complements fears of the classical design for buildings of durability, economy, utility and comfort. Green building is also known as a sustainable or high performance building [33-35]

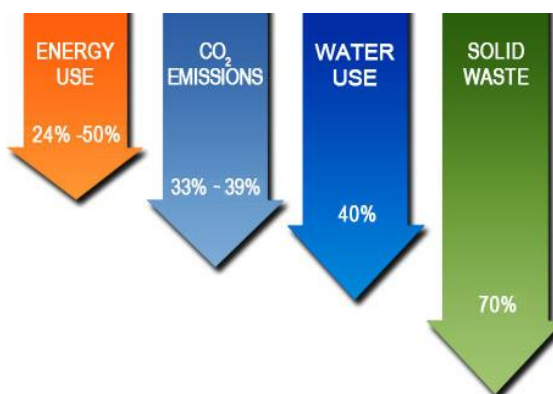


Figure 3 Benefits of Green Building [69]

A- Environmental benefits

- Limit the effects of consumption of natural resource.

B- Economic benefits

- Improve the bottom line.
- First costs of the competition
- The integrated design allows for a high benefit at low cost through achieving synergies among disciplines and among technologies.
- Decrease of the operating costs.
- Reduce costs of the utility significantly.
- Improvement of life-cycle for the economic performance.

C- Health and safety benefits

- Improve the comfort of occupants and health benefits for the community
- Decreasing the pressure on the local infrastructures and improve the quality of life.

D- Productivity Benefits

- Improve the performance of the occupant.
- National productivity losses per year estimated \$29 –168 billion.
- The performances of the students are better in day life schools.
- Decreasing of absenteeism and turnover.
- Provision a healthy workplace will improve the employee satisfaction.
- Raising retail sales with day lighting
- Studies have shown ~40% improvement

The Basics of Green Building

Building a green or high-performance home will effect in many steps in the process of home building, there are some of the most important developments that have been taking place in the finishing materials and with the structures. While the products and the practices will carry on for changing and improving, the basic concept of green building will remain the same. There are 10 guidelines: Put plans for designing the building itself.

1. Guidance and design the building, according to the site needs, local conditions and climate.
2. Optimize the use of the natural daylight.
3. Must be investigated from the building materials.
4. Reuse of the existing materials, use less materials and use building materials which that are considered to be friendly with the environment.
5. Healthy design for air quality of indoor.
6. Put high standards for lighting-efficiency.
7. Choosing the devices that are having efficient energy and saving for the water use.
8. Using cleaning products that are environment friendly and design to facilitate of maintenance.
9. Maintaining to the building systems and structural to achieve the maximum of effectiveness for the energy and the environmental.

2.5.4 Estidama

Estidama is an Arabic word means the sustainability, which is a developing initiative and reinforced by the UPC. Estidama which represent the educational inheritance of the great late Sheikh Zayed bin Sultan Al Nahyan to promoting well thought out and responsible development.

Estidama has started in 2009 which represents the first style of sustainability in the region of the middle east.

The vision of Abu Dhabi in 2030, the sustainability becomes the basis of urban master plan.

The pillars of Estidama:

- 1- Environmental
- 2- Economic
- 3- Social
- 4- Cultural

These form the heart of the Pearl Rating System:

1- Integrated Development Process:

For encouraging the team work multi specialty to control the environment and the quality during the life of the project.

2- Natural Systems:

Saving and rehabilitation of the natural environments and habitats.

3- Liveable Buildings:

Rehabilitate the interior and exterior spaces by improving the connectivity and the quality between them.

4- Precious Water:

Minimizing the waste of water and use the alternative water sources.

5- Resourceful Energy:

Saving energy by the passive energy (passive of cooling and heating) and minimizing the usage of the electricity resource.

6- Stewarding Materials:

All things have a life-cycle, so we must choose the best materials.

7- Innovating Practice:

Encouraging the innovation in all domains of life to get an easy sophisticated life for ever.

2.5.5 Vernacular Architecture

It is post-traditional, which means what comes after the traditional (or what the traditional progresses to be). There is a focus point between the two brands of architecture that is, the tradition was essentially spontaneous (with designs and construction techniques that are inherited, which means they were carried over from one generation to the next), the actual building process is a community enterprise that is devoid of specialists with the vernacular, there is greater individuality than more conscious decision-making and specialization resulting in division of labor.

There is another definition that gives a description about context of the vernacular architecture by Oliver [44].

In the context of vernacular architecture, it includes what is known as and what inherited about building, housing or settlements. It involves the wisdom that is collected and the experience for the society, and the standards that are approved by the group that as being suitable for its urban environment.

2.5.1 Sustainability in Vernacular Architecture

It has been the concept of sustainability present in the way of living in vernacular societies and their lifestyle because the environment the surrounding is the source of life, and therefore they did not use the term sustainability as an expression of the way their lives and how to provide livelihoods and the way in which they built it, But lived concept and applied it spontaneously and automatically. It has been interaction with the surrounding environment and optimal exploitation of natural resources is part of ensuring their survival on this earth and in accordance with the exploitation of the largesse of the bounties and adapt to difficult conditions such as cruel climate and the scarcity of some resources. Sustainability for them was spontaneous and automatic. Undoubtedly, the spontaneous Grandparents deal with the environment were not random or innate, but based on the legacy of profound experiences and learning through the principle of "Trial and error" is supported by a creative thought and insight into recent studies have demonstrated the depth and their usefulness over

Hundreds of years. Integrated elements of sustainable design with the thought of the design of vernacular architecture, using local building materials and by simple techniques, thoughtful, but stems from their local environment where solutions were effective and interactive with the environment and available resources without the need to convert them or control them. In this context, "Paul Oliver Paul Oliver" in his books "Encyclopedia of Architecture Traditional "attributes the success of traditional architecture or vernacular architecture to being a product of logical response with the resources available in the environment and factor climate and the needs of society Oliver [44].

CHAPTER 3

VERNACULAR ARCHITECTURE

3.1 Climatic Control in Architecture

3.1.1 Influence of the Climate on Architecture

The prevailing local climate has always influenced building methods or architecture in general. It is therefore understandable that building typologies found around the world are very diverse. Humans created protection from the climate by building shelters that were adapted to the climatic conditions they were in. The home, often very simple in its construction, and storage areas for food and other living-sustaining goods - often of higher priority to the community-attest to this principle.

A building, like the human body, is constantly undergoing a heat exchange process with the outdoor environment: the building envelope is the device through which this process can be controlled. The way buildings gain and lose heat must be examined, and methods of thermal comfort must be developed in order to ensure satisfactory performance, keeping in phase with the changing seasons.

The flow of heat through walls, floors, ceilings and windows may occur in either direction.

Convective heat loss, particularly through glazed areas, accounts for a considerable part of the winter heating load in residential buildings.

Unintentional air infiltration is probably the most important component of residential heating loads, on the other hand, Ventilation is a useful means of maintaining comfort conditions during overheated periods.

The sun can be a very significant source of radioactive energy transmitted into an interior space primarily through windows or other transparent and translucent surfaces. Winter loads of solar heated buildings can be met by as much as 100 percent (and sometimes more); overheating, though. Is most liable to occur in summer unless proper shading is provided.

Conversely, thermal radiation from a warm surface to the environment will add to a building heat loss. The adiabatic phase change process of evaporation (ordinarily coupled with convection), although not a heat transfer process in itself, has a non negligible cooling potential. Finally, internal heat gain sources include people, artificial lighting and electric appliances, and can provide approximately 25 percent of a conventional residential building's heating load: in a super-insulated solar heated building, heat gain sources can supply as much as 80 percent by Givoni [22].

3.1.1.1 Indoor Thermal Comfort Control

The fundamental thermal comfort control options consist of:

1) Admitting or 2) excluding heat gain from external energy sources, and 3) containing or 4) rejecting internal heat gain.

Application of these four heat flow control options by three mechanisms of heat transfer (conduction, Convection, radiation) plus the adiabatic phase change process of evaporation generates a matrix of sixteen hypothetical strategies of climate control. Only eight of these can be productively exploited in the design. The rest not availing themselves to use. The sun, for an example is the only global passive energy source: geothermal energy [21].

3.1.1.2 Ventilation

The effectiveness of ventilation in producing body cooling in building interiors is based on the assumption that air temperature and vapour pressure are identical indoors and out, and that the mean radiant temperature of the building interior is approximately the same as that of the air.

The upper limit is determined by the greatest wind speed that will not cause annoyance (about 1.5 m/Sec), which results in a limit approximated by an air specific volume of 0.886 m³/kg when vapour pressure exceeds 17 mmHg.

High rates of air movement become less desirable as the moisture content of the air decreases; a dry-bulb temperature of 32 degrees is accepted as a limit for vapour pressure less than 17 mm Hg.

The radiant cooling and thermal mass effectiveness The thermal mass approach to temperature control is limited by the assumption that the exterior shell is massive enough to damp out daily temperature fluctuations, and that the building is closed during daytime to minimize intrusion of heat.

The second assumption necessitates an upper limit of vapour pressure of 17 mm Hg, the maximum humidity at which one can feel comfortable in the absence of air movement; the upper temperature limit is satisfied by an air specific volume of 0.883 m³/kg.

The dry-bulb temperature limit is much greater under arid conditions because the body is comfortable at higher temperatures at low humidities, and because the diurnal temperature range increases as absolute humidity decreases [21].

3.1.1.3 Evaporative Cooling

The evaporative cooling process referred to here apply to direct evaporation of water into air drawn from the out-of-doors as it is admitted to the interior space. This adiabatic phase change is characterized by constant enthalpy (that is the sum of sensible and latent heat remains the same). One limit of the evaporative cooling strategy, therefore, is the maximum wet-bulb temperature acceptable for comfort, set at 22 degrees.

The dry-bulb boundary, which is a function of the temperature reductions that can be achieved at reasonable indoor air velocities, is taken as 40 degrees.

Whenever the ambient outdoor temperature and humidity conditions fall within the designated limits of a control strategy, then the interior of a building designed to implement that strategy will remain comfortable [13].

3.1.1.4 Restriction of Infiltration

Infiltration refers to the entry of cold air through joints. Cracks and faulty seals in construction, and around doors and windows. Infiltration is considered the largest

and most intractable cause of heat loss in a residence, once practical insulation measures have been taken. It is driven by the same two forces of wind pressure and thermal buoyancy as is ventilation. However, while ventilation of occupied spaces has been always necessary, we seek to control this by making the building as airtight as possible and providing air change through devices in which it can be regulated.

This approach allows further gains in energy efficiency when heat recovery systems are installed. Controls on infiltration can be implemented at all stages of the design process, beginning with appropriate siting and ending with protective landscaping. The Building itself can be shaped and oriented (including underground placement) to minimize its exposure to prevailing winds. Air tightness is attended to by detailing and care in construction of the building shell and in selection of window type and quality, as well as insecurely closing dampers for other ventilation devices.

Solar Gain the sun is the most significant natural source of energy available for passive heating of buildings. The feasibility of solar heating depends on the relationship between solar energy received and the winter temperatures which determine heating load. The intensity and duration of solar energy received on earth vary with latitude, local sky clearness and time of the year.

The importance of a thorough solar geometry study is obvious, especially for the implementation of a passive system in urban areas where the density and height of surrounding buildings restrict considerably solar access.

Diffuse radiation, sky component depends on the angle with which a particular point views the sky, Reflected radiation, finally, is a function of the overall surrounding surfaces' reflectance.

Average daily radiation on a horizontal and on a south facing vertical surface is recorded at local meteorological stations.

The solar gain equation depends on orientation only in the sense this latter effect of coming radiation. Solar heating can be achieved through the windows of any orientation, although exposures that are problematic in shading, hence in regulating the radioactive gain in winter and preventing overheating in summer, are usually avoided (this involves easterly and especially westerly exposures).

A considerable part of a building's heating load can be met by solar gain through north facing windows, especially in temperate climates where the average daily outdoor temperature is above the freezing mark.

This approach exploits diffuse and reflected radiation by utilizing the new selective transmitting glass generation.

Characterized by a high solar transmission to conductive-convective heat loss ratio. Low-E coated glass (heat mirror) accepts short wave radiation from the sky vault, while reflecting back into the space the long wave thermal radiation emitted by the storage mass or generated by the internal heat gain sources.

However, total radiation being greatly reduced on a northern exposure, a large glazed area is required to achieve significant solar gains: consequently, visual privacy and glare problems should be considered in order to reach an optimum solution [13].

3.1.2 The Heat Transfer

3.1.2.1 Historical Background

The Heat for as long as believed to be some feeling which results in the usual sense of the warm and it was the first thought that neither understood by the human.

Nevertheless, in the mid of the nineteenth century, we have a clear physical knowing of heat nature, which obtain by the development at that time of a theory, kinetics, which deals the molecules as a tiny balls are in motion and then Owing a kinetic energy.

The heat is known as energy connected with the random movement of the atoms and the molecules. In spite of it was proposed in the eighteenth and the beginning of the nineteenth centuries that heat represents the appearance of motion at level molecular which called the life force,

The prevailing opinion of heat until mid of nineteenth century depended on the caloric theory which Suggested by chemist Antoine Lavoisier in 1789.

The caloric theory confirms that the heat is a liquid as a substance which called the caloric that is massless, colorless, odorless, and tasteless substance that can be flowed from one body to another..

3.1.2.2 Heat Transfer

According to Mc Adams, (1954) the heat (Thermal energy) is a form of energy which can be moved through of the difference in temperature. On the issue of interaction in energy, heat transfer occurred, however if it takes place due to the difference in temperature.

Moreover, there couldn't be Any transition temperature between two systems which have the same temperature.

The heat transfer is an effectiveness which allows the inner energy from one substance transfers to another.

The Thermodynamics is the heat transfer's study and the alteration which occurred by it [20].

In hot climate as Iraq (Baghdad) climate, the building materials must be:

- 1- To get rid of unwelcome heat from the sun rapidly once time and it has started to cool down such as the lightweight walls.
- 2- Get away from the heat during the day such as the Proper insulation and choosing colors.
- 3- Don't save the heat and release it into the home for a long time at night as a wall made by block.

The problem of transfer the heat and how can we decrease it:

Good building materials and using the insulation in Townsville.

We must know:

- Some ways of heat transfer occurred by: Roofs, Walls, Floors and windows.
- All method of the heat transfer needs the presence of a different in temperature, and all styles are graded from high to low-temperature.

Heat can be transferred in three different modes:

- a- Conduction
- b- Convection
- c- Radiation.

3.1.2.3 System Units

We must know some of the terminology and units which deal with all equations. So we will use the SI units [13].

Q= Rate of heat flow, the unit is Watts (W) and multiples such as (kW) and (MW).

q= heat flux which means (flow of energy as heat flow per unit area)

Note

$q \propto Q/A$ when:

A = area through heat flows, units of heat flux are (W/m²).

(Temperatures affect in heat transfer study.

Symbol T= temperature, units of temperature are Kelvin or Celsius: (K) and (°C).

3.1.2.4 Main Methods of Heat Transfer

According to Binggeli [12]. There are possibility moved inside our home:

Conduction

The conduction is energy transferred from a high active of small parts in article to at least one beside it because of the interactions between these particles.

Conduction can be realized in gases, liquid and solid.

The conduction occur In the gases and liquids, because of the collisions and spread of molecules through their motion's random; In the solids, the cause is the mix of the vibrations of lattice molecules and transport of energy through the free electrons.

The rate of conduction heat by the broker which consist of the broker's geometry, its thickness, and the broker's material, instead of differences of temperature through the broker. Fixed of the heat conduction during large thickness of wall.

Thickness x (L (long) and A (area), while T= the difference of temperature through the wall) T₂ # T₁.

More experiments have proven that:

Q (The rate of heat transfer) during wall is twice at T during wall or A in the direction of heat transfer is doubled, Through the wall is doubled when the

temperature difference T , across the wall or the area A normal to the direction of heat transfer is doubled, While is be a half when thickness wall (L) is doubled.

We can result the rate of conduction heat during a surface layer commensurate with the difference of temperature through the layer and the area heat transfer and inversely with thickness of layer [60].

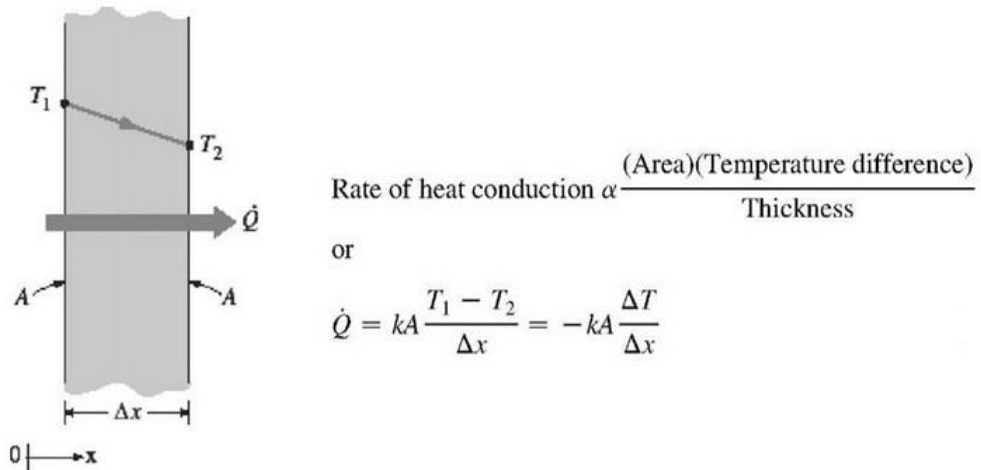


Figure 4 Rate of Heat Conduction [60]

While Proportionality constant (k) refers to thermal conductivity of materials, Which represents a measure of the capability of a material to heat behavior.

The limiting issue of

$\Delta x \rightarrow 0$ decreases to a differential of form:

$$\dot{Q} = -kA \frac{dT}{dx}$$

The area of heat transfer (A) is the usual to of heat transfer direction.

For an example:

Losing heat of the wall: a 5m (long), 3m (high) and 25cm (thick) $A = 15 \text{ m}^2$.

Wall thickness not influence on A .

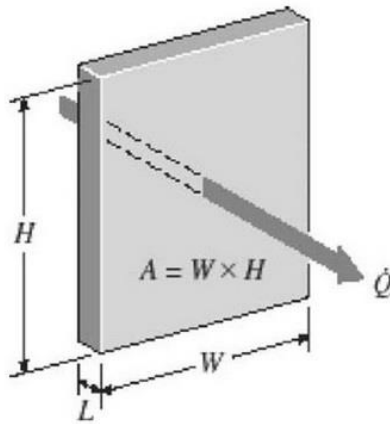


Figure 5 The Area of Heat Transfer [60]

Thermal Conductivity

Every material has different amount of storing the heat (cp), which knows the characteristic of certain heat and it means the capability of materials for storing thermal energy [13].

For example:

$cp(\text{water}) = 4.18 \text{ kJ/kg K}$ and

$cp(\text{iron}) = 0.45 \text{ kJ/kg}$

Note: At the same room temperature

That refers to water has the ability to store 10 times of energy than iron can per mass unit.

As well as the thermal conductivity(k)

$K(\text{water}) = 0.608 \text{ W/m}$

$K(\text{iron}) = 80.2 \text{ W/m}$

Note: At the same room temperature

That led to conducting heat of iron faster, more than 100 times of water; so we can say the water is worse conductor of heat [13].

Table 6 Thermal Conductivity (k) of Materials

Material	K, W/m K ^a
Diamond	2300
Silver	429
Copper	401
Gold	317
Aluminum	237
Iron	80.2
Mercury	8.54
Glass	0.78
Brick	0.72
Water	0.613
Human Skin	0.37
Wood (Oak)	0.17
Helium	0.152
Soft Rubber	0.13
Glass Fiber	0.043
Air	0.026
Urethane (foam)	0.026

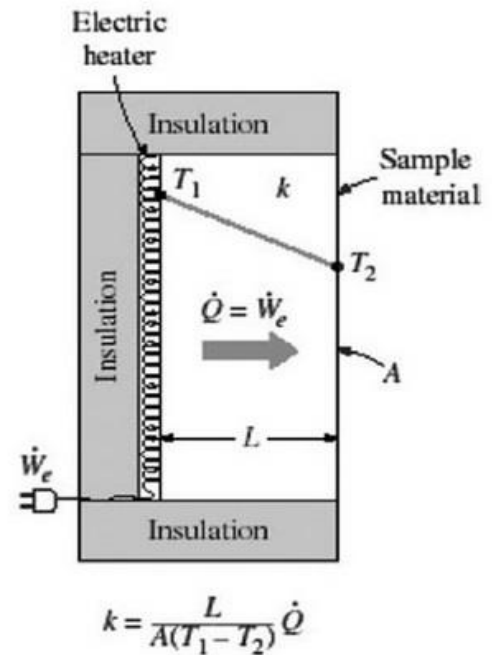


Figure 6 Thermal Conductivity Law Diagram of a Sample Material [13]

Convection

Convection is a method of the transfer energy between the solid's surface and with the next liquid or gas which in motion and relates the total implications of connection and motion fluid.

To increase the fluid movement, led to a high heat transfer convection.

In missing of motion fluid in large quantities; the transfer of heat, between solid's surface and with the next liquid through a clear connection;

The existence of motion in large quantities of liquid, reinforces the transfer of heat between the solid surface and the liquid, however it always will complexity from fixing rates of heat transfer; The looking into cooling of the hot mass through blowing the cool air above the upper surface.

Firstly transfers the heat to a layer air, which locates beside the mass through conduction.

And next went out the heat from a surface via the convection,
 This is the total implications of connection with the air because of the randomness of air molecules motion and a large amount of air macroscopic motion; which tear out the unwanted hot air within easy reaches surface and exchange with the cooler air [20].

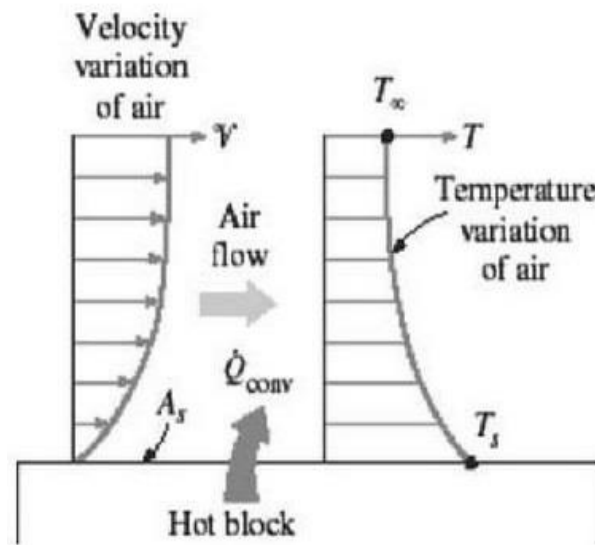


Figure 7 The Method of Heat Transfer by Convection [20]

If there is no fan in one place of the building, the transfer of heat emitted from the surface of a hot mass through a natural convection because every motion in the air in that case is because the up from warmer (therefore be lighter); air close to the surface and the downfall of the cooler (therefore be heavier) which Replaced by air.

Transfer of heat via conduction between the mass and ambient air if the difference of temperature between them not so great enough to get over an impedance air to the movement then the natural convection currents starting,

The processes of heat transfer which include changing of the stage of a liquid to be convection due to the process's motion of liquid which happened through it.

The rate of heat transfer convection is commensurate with the differentiator of temperature and it expressed through the law of Newton in cooling [20-60].

The Convection Equation

The convection equation

The conducting of heat, which made by the solid makes en route to the ambient environment.

In many cases the supplying of heat to the solid will arrives from the ambient areas. So that refers to the transfer of heat from the room air into walls of Rome, during the walls and then to outside air.

The Equation of Newton

$$Q = (T_s - T_\infty)$$

- T_s : Temperature of wall surface
- T_∞ : Temperature of the fluid away from wall
- A: The heat transfer area

Table 7 The Type of Convection of Some Materials.

Type Of Convection	Unit (K, W/m ² K ²)
Free Convection Of Gas	2-25
Free Convection Of Liquids	10-1000
Forced Convection Of Gas	401
Forced Convection Of Liquids	50-20.000
Boiling and Condensation	2500-100.000

Radiation

Radiation is the energy emitted through article as an electromagnetic waves or photons as an effect of a variation in variation's electrons of an atom or the molecules; in different with the conduction and convection of heat.

The heat transfer through the radiation not need the existence of any broker.

Indeed, the transfer of heat through the radiation is so fast (as light speed) and its decrease in space.

And this is the method of the sun's energy reaches to the earth, In my study of transfer of heat, we are concerned within the thermal radiation, which is a form of radiation released via human bodies due to their temperature and It differs from other forms of an electromagnetic radiation.

Any bodies in a Universe which have temperature above the absolute zero will emit the thermal radiation.

Radiation is the volumetric phenomenon and all kinds of solids, liquids, and gases absorb or broadcast radiation in differing degrees; but, the radiation is the surface phenomenon for the solids which are non transparent of the thermal radiation like metals, wood and rocks during the radiation emitted through the interior regions of this material which could reach upper surface, and absorbed of radiation from these bodies among a few microns of the surface.

To know the maximum rate of radiation, which be emitted from a surface at the thermodynamic temperature T_s in (K or R): via Stefan Boltzmann law as Bejan [9].

$$\dot{Q}_{\text{emit, max}} = \sigma A_s T_s^4$$

Table 8 The Rate of Radiation Emissivity at Materials.

Material	Emissivity
Aluminium	0.07
Anodized Aluminium	0.82
Polished Copper	0.03
Polished Gold	0.03
Polished Silver	0.02
Polished Stainless Steel	0.17
Black Paint	0.98
White Paint	0.90
White Paper	0.92-0.97
Asphalt Pavement	0.85-0.93
Red Brick	0.93-0.96
Human Skin	0.95
Wood	0.82-0.92
Soil	0.93-0.96
Water	0.96
Vegetation	0.92-0.96

3.1.2.5 U- Value

U value measures of the heat loss in the elements of building element like a wall, floor and roof. It represents an ‘overall heat transfer co-efficient’.

To know the amount of heat transfer through the building by an Inverse proportional process and that will lead the higher U value refers the worst at a thermal performance, a low U value means the best level of the insulation.

And it's so beneficial to know the behaviour of the whole building instead of depending on the characteristic's elements of building one by one [21].

Why Use U Values

U values are so significant because of they make up the standard basis reduction of each energy or element carbon.

The knowing of U value at the beginning of designing stage avoids us an expensive cost money later by reworking again (choosing the test the feasibility, economic of project before starting any project to guarantee the target of the project in a short time and cost less with the regulatory frameworks) [20-21].

How to Use U Values

We must:

1- To know how we calculate U value of any building elements like a wall, a floor and the roof or others, we must know the build up of these elements and their thickness in sequence.

2- Need to know is the conductivity of all materials in the building; and refers to "K" value which means the measurement of its inherent ability to simplify the passage of a heat by using the publications like a New Metric Handbook and 'Architects' Pocket Guide.

3- Concentrate on the characteristics of the internal and external faces of constructional element in each building; and which are called the external resistances and are the fixed values, by using the following formula:

$$R = (1/k) \times d$$

Where:

k= The conductivity of building material

d = Thickness of material

The equation of U value is

$$U(\text{element}) = 1 / (R_{so} + R_{si} + R_1 + R_2 \dots)$$

Where:

R_{so} = fixed external resistance

R_{si} = fixed internal resistance

$R_1 + R_2 + \dots$ = sum of all the resistances of the building materials in the constructional element [21].

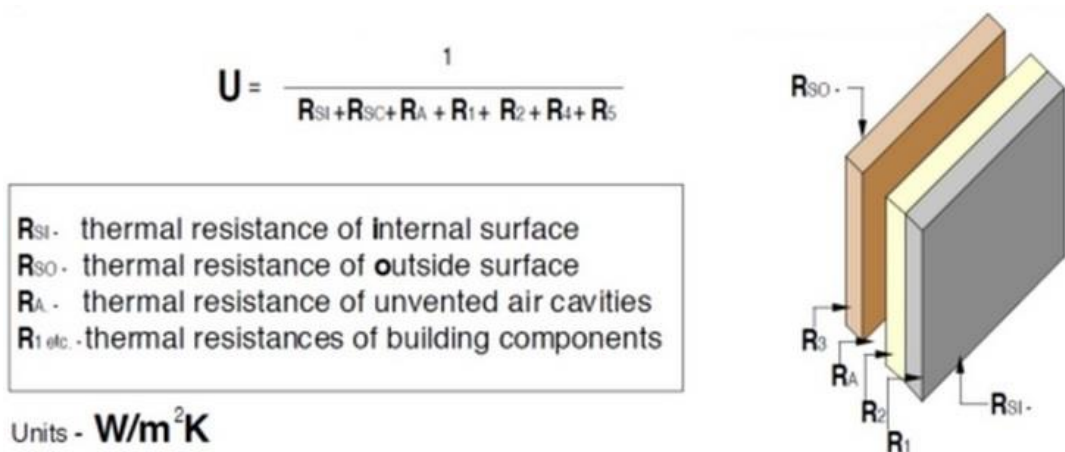


Figure 8 U Value [21]

3.1.2.6 K Value

(k) Value, or (coefficient of the heat transfer) means the amount of heat flow, which be transferred via (1 m^2) area at (1 K) differences of temperature and it measured by (W/m^2K) by Subrahmanian [53].

Where:

(K) Value = energy / (area x difference in temperature x time).

According to watt [59]:

K value uses to measure the efficiency of Heat Insulation at Buildings and especially use in the Passive Buildings; to be considered energy efficient the K value must be at least $0.16 W/m^2K$.

The decreasing of the K-value for a material, the better in its insulates.

For example

The thickness wall (mud brick) = 36.5 cm with $K = 0.45 W/m^2K$

To be considered energy efficient $K = 0.16 W/m^2KT$

The wall thickness = 1.10 meters.

The Less (K) value

If (K) value of any material is known (Materials Guide) so we can identify the (R) value

(R) value per inch = $1/K$ value).

The best its performance as the insulator

K value= The heat flow value which be transferred via 1 m^2 (area) at 1 K (differences of temperature).

Unit of K value = $\text{W}/\text{m}^2\text{K}$. K-value = energy / (area x temperature difference x time)

3.2 Vernacular Architecture in Dry Climate

The following details principles of climate-adapted building or vernacular architecture organized by their prevalence and affiliation with a climatic zone, the focus hereby lies on principles that allow for effective application related to the building envelope or functional building services components. In some cases, entire buildings are explained.

There are variety of climatic zone classification by Oliver [44]. Classifies different zones as:

- a- Snow climates / polar region
- b- Boreal or snow-forest climate / moderate climate
- c- Warm moderate rain climates / moderate zone
- d- Tropical rain climates / Tropics
- e- Dry climates / Subtropics

Dry Climate / Subtropics

Dry climates are those mobile climates between the tropics and temperate regions. They arise belt surrounding the globe with warm steppes and deserts, hot and humid summer climates and areas of continuing rain in the winter. Usually called subtropical areas, despite the fact that this word may be deceptive because this area also includes the hot dry desert climates.

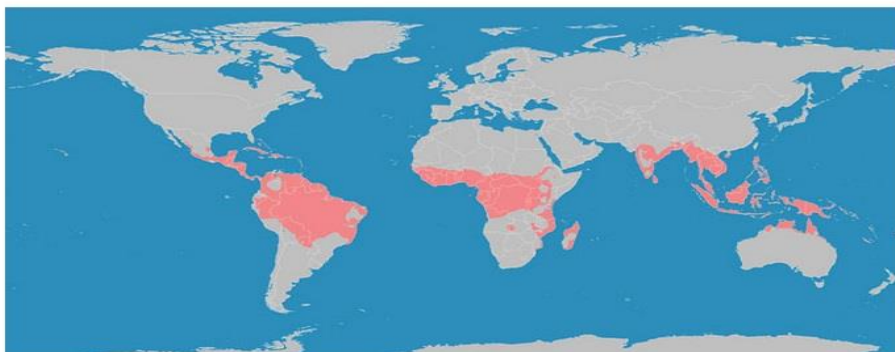


Figure 9 The Expansion of the Tropical Zone [44]



Figure 10 Toraja Houses [117]

Desert climate usually includes deserts and semi-deserts and steppes and semi-arid lands, dominated by drought and heat also called dry climates. According to geographic regions encompassing North and South Africa, the southern parts of South America as well as the west coast of North America. The Near East, as well as parts of China and a large section of Australia from the typical desert areas. Dubai and Las Vegas is one of the cities where these climates contain a high amount of heat, moisture air relatively few up to 10-50% and the amount of very little rainfall in a short period of intensely powerful Oliver [44].

One benefit in these regions is low temperatures during the night and sometimes up to the extent of freezing making a living in these areas live in extreme environments. The low humidity increases the likelihood of a hot climate, however, must be protected from the sun during the day, which a temperature reaches approximately 50°C. The contrast in the temperature between day and night in this region provides the basis of the principles of a particular building to suit this extreme climate. All the buildings that have been built in this area aims to maintain the living environment from ambient temperatures. Cooling principles in this area can be divided into two parts: First, the process of evaporation of water (heat cooling process is constant). Secondly, through the exchange of warm air with cold air creates air movement feel comfortable rights and works to reduce body temperature.

The human body sends warmth in normal circumstances with 30% as convection, 45% as radiation and 25% in the form of evaporation.



Figure 11 Subtropical Areas [44]

The air movement is working to increase the evaporation and convection also dry heat makes water dissolves in the air very quickly and produces sweating process which makes the heat loss in a very efficient evaporation process.

3.2.1 Air-Permeable Window Covering

In hot dry climates often perforated lids are placed on the windows to maximize natural ventilation. In the Near East and Egypt used wooden lattice windows called Mashrabiya, these windows consist of carved wooden poles to be mapped when the window is opened. Often distinguish such lattice are Mashrabiya. Hence the term "drinking place " are coming. Non painted strokes clay are placed and filled with water on the windows and Mashrabiya so the water evaporates on the surface and cooling the coming air. Heat loss as a result of the evaporation process adds a comfort of the place in particular Oliver [44].

Mashrabiyya meet the following functions:

- Control over supply of light transmission through the day.
- Works on protection from direct sunlight.
- Works to control the flow of air through the different-sized retinal holes.

- Working on special protection because of the possibility of looking at the outside and difficult to see what is inside.
- India has similar windows called Jali are built in addition to wood, brick or stone. Jali word came from the Sanskrit language and means netting or lattice and as in Mashrabiyya the Jali works to maximize natural ventilation. Because Jali often used in homes with ground floor, they work on protection from theft, also the slot on the size of the Jali never be bigger than a fist, open form and engineered working to speed up the flow of air and thus increase the cooling process, and there are many superstructure homes other that have Mashrabia properties.

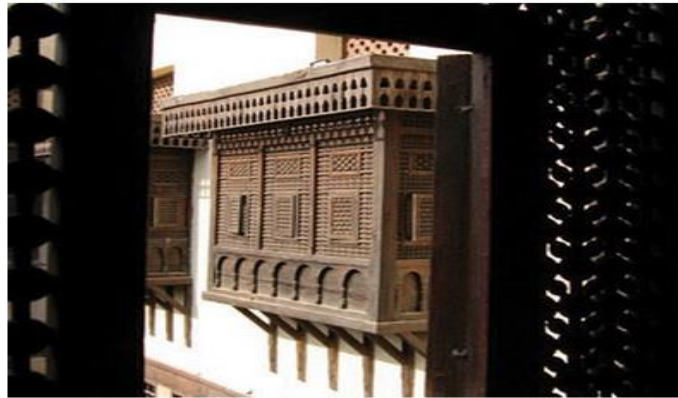


Figure 12 The Mashrabiyya and Good Ventilation [44]



Figure 13 The Indian Counterpart of The Mashrabiyya [44]

This superstructure already working on delivering a light to the deep rooms in the house because their direction is often toward the sun and also a source of natural ventilation and known as Sahrighi by Oliver [44].

Benefits that are derived from the Mashrabia and Jali is the natural ventilation, as well as protection from the sun.

3.2.2 Wind Catcher and Solar Chimneys

Wind catches is placed on the roofs of buildings for the purpose of wind channeled through the pillars and the channels to the place of living and called badgir and can vary significantly, The simplest models have a slot towards the main wind and it is responsible for the process of wind channeled through the hole in the ceiling into the room, which is located below it. The most thoughtful ideas about the Badgers have found in the city of Yazd, which is located in Iran, some of them take the form of an octagonal towers as high as 30 m, working to re-direct the wind from any direction and thus provide adjacent spaces by cold air. Wind catchers were known in the Middle East since 2000 BC, as documented in the Egyptian burial sites. Since of the opium trade deployed in the Middle East have been used the solar chimney and the presence of large numbers of badgirs indicate wealth, in very hot and dry climates that reach temperatures of 50 degrees. The main purpose of badgirs or catches wind is exhausted negative air humidity or unpleasant odors as a result of members of large families of up to 20 people, which were collected from the lower levels. Wind catcher works to connect fresh air to the living space on the ground level in warm climates that reach temperatures of approximately 40 degrees. Sweating process during the day to provide a comfortable cool by evaporation of sweat from the skin by convection. Relatively large cooler air during the night time works to cooling comparatively.



Figure 14 Badgirs in Yazd [68]



Figure 15 Wind Catcher in Pakistan [122]

Buildings during the night time working to cool large buildings for the next day. In the Gulf region, which is hot and humid climate companion temperatures higher than the temperature of the body, the only way to achieve adequate rest by evaporating sweat. This process requires moving the wind to the maximum extent. It therefore leads to pull the wind significantly in all directions Oliver [44]. In the southern part of Sindh province in Pakistan has a long and very hot summer. However, during the evening there is a cool breeze coming from the southern regions of the ocean that can be felt up to 100 km inner. During the nine months of the year there is a period of cold breeze that is used to cool about all the buildings in Sindh. It's easy to agree

completely the wind catcher with the wind because he continuously in one direction, while the upper part of it worked to direct air through the night in the building. Wind catchers are put in the highest part of the building in order to be less as possible the introduction of dust into the building. The principle of guided air flow which is used for the purpose of cooling the buildings used in all dry and warm climates. The term "lifeline" which is used in the southern part of India, which flows through the house and used for air ducts porch provides maximum ventilation throughout the building. A figure below presents the Standard footprint of residential buildings in the southern part of India, the air is leaking through the envelope entrance through the corridors to the courtyard. To cool the building process takes place through the ceramic pots filled with water, and through the fountains of water and pour them in the space of living next door. Air flowing works on the house refreshing breeze during the day and works as well as to cool the massive walls during the night. In addition to the needs of her galleries feature that provide shade that helps to reduce the high temperatures during the day. Initially, it will help the continuity of the flow of air inside the building.

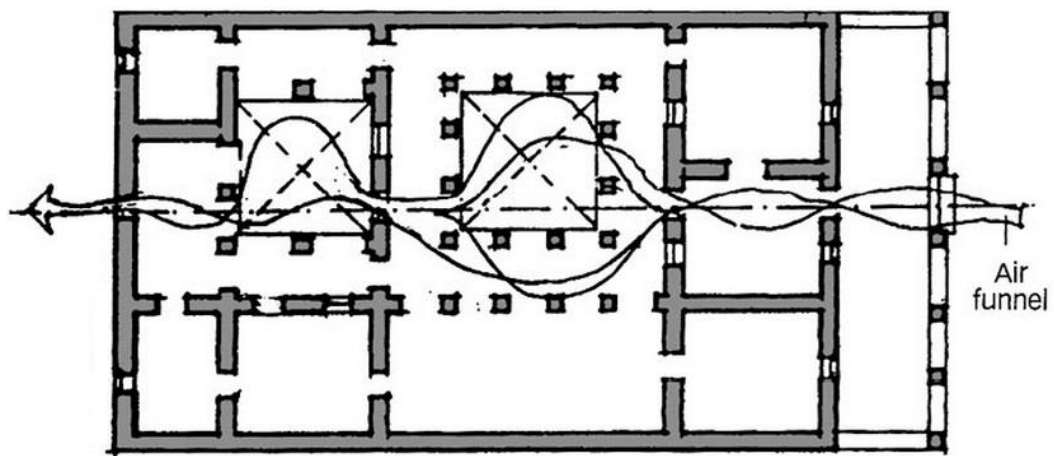


Figure 16 "Lifeline" In India [44]

3.2.3 Yards and Courtyards

The central courtyard in hot and dry climates works on cooling a large buildings and can help to cool the whole house, where cold air trapped in the yard works on cooling the building blocks next to it. Either in the daytime they're the house members do not feel by great warmly because of the shade provided by the building itself. Since the cold air mass is heavier than warm air mass, so it is not only cools the building blocks, but he penetrates into neighboring rooms and working on calling them too. Warm air is accompanied by cold air in the yard during the day and because of the shade provided by the building itself, the wall facing the courtyard be protected from the heat during the day, nonetheless usually patios not be too large. This principle works well in climates where the difference between the temperature between day and night is very large, and for the continuity of this principle should be packing the walls in front of the yard or make it huge and also avoid large openings that can be contained in the yard. Buildings do not provide enough breeze that helps to get rid of cold stored inside the building because there are other factors that may be affected in the cold, the most important is the size of the yard and the amount of cold stored in adjacent rooms. Factors that prevent air movement are alleys and narrow streets, such as those in Morocco.

Principles that can derive is the exploitation of the cold air pockets as well as the cold air on the ground sinks and more importantly, is the use of large building blocks to store the cold night air [44]. There is another principle can be exploited for the purpose of thermal cooling is to exploit the heat generated from the ground if the height of the building and the size of the yard is not enough to shade the entire building.

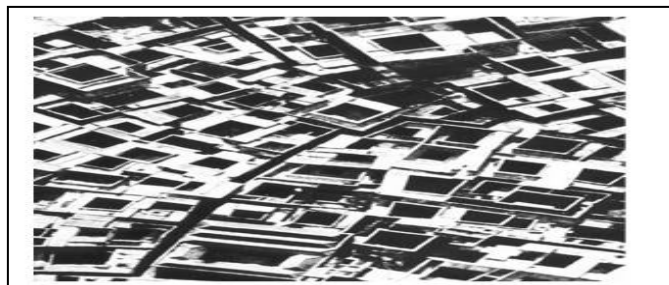


Figure 17 Courtyard Houses in Morocco [44]

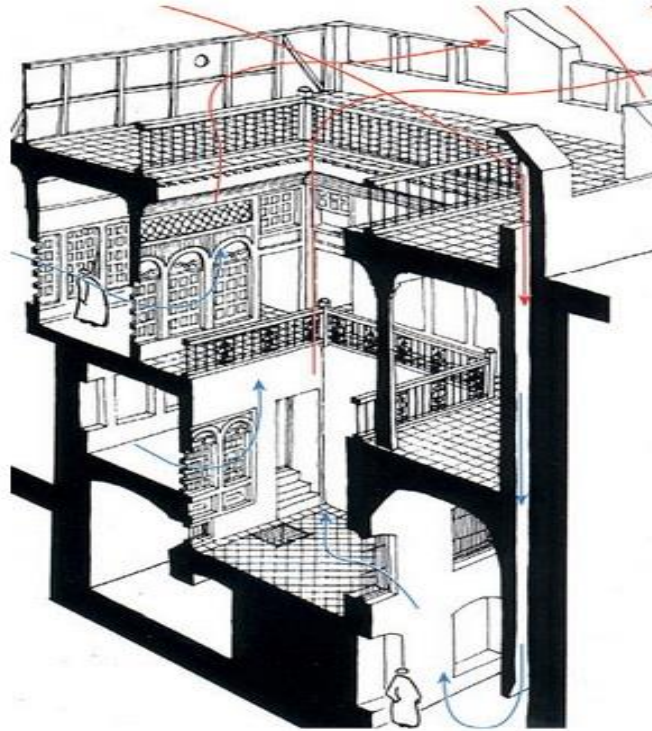


Figure 18 Thermal Ventilations in Courtyard Houses [44]

The lower layer of air heating along with the ground, it starts to rise and generates air flowing out of the building at the same time being dispensed the cold of waste from the massive walls. From the results of that being going to create a breeze at home to the top of the yard. According to that principle, the yard is not used during the day but can take advantage of the stored heat that provides moderate degree and comfortable in the heat for a long night, there is another principle can take advantage of the heat produced is to use the heat generated by natural ventilation by Oliver [44]

3.2.4 Sun Sails and Shading

Could provide the simplest forms of shading by design crowns. In many settlements, such as settlements in the African savannah be directly decorated with trees that provide shade dramatically. Trees are often the central gathering area, the Arab regions dominated by drought and high temperatures are often winding alleys and lanes by mats made of straw to cope with rising temperatures dramatically. Since the alleys in Arab areas are usually narrow, it is easy to build wooden structures extending from the edge of the roof to the other edge is covered by mats of straw, palm fronds or coarse linen sheets. The purpose behind it is to promote air circulation through the creation of permeability to air, while in India it is very common is to put the sails of the sun in front of the windows for the purpose of protection from the sun. In certain cases, have usually put a rope on the bottom edge of the sail for the purpose of moving it and introducing a breeze air into the room. There are similar models around the world to this building where umbrellas or sunset sails for the purpose of providing shade for cafes or stores Oliver [44].

Principles derived from it is to provide shade for the purpose of protection from the sun.

3.2.5 Adiabatic Cooling

Adiabatic cooling also called as the evaporative cooling, and draws on the principle of cooling the human skin by sweating. The warmth generated from the water evaporation process is done through generating a sense of cool on the skin. It was formerly the use of non-coated vessels filled with water for the purpose of cooling, as in the Mashrabiyya. Another advantage of the benefits of adiabatic cooling is the process of moisturizing in the dry tropics, cubic meters of dry air can be cooled by 0.5cm of water. There are other ways of cooling through window hoods made of palm rods that are sprayed with water for the purpose of cooling in the Arab or Egyptian provinces.

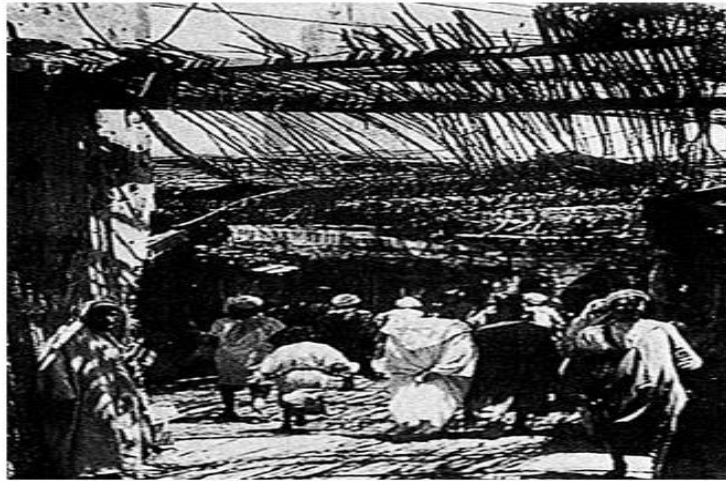


Figure 19 Shading of a Bazaar in Morocco [44]

There are other solutions have been developed for the cooling process, such as wet curtains that are substantiated on the exterior walls for cooling air that incoming as well as the liquidation of dust, it was also the use of the central water supply in some hot dry cities in the Middle East. It was also the use of the central water supply in some hot dry cities in the Middle East.

The water is collected through bridges and canals were fed to the highest point in the city. Here are solutions for complex situation dramatically for the purpose of benefiting from Adiabatic cooling. For example, buildings in Isfahan in Iran as well as in Damascus, Syria feature sloping ramps or a specific walls that are kept constantly moist. Such cooling the walls is called, " Salsabil" or called " Spring in Paradise", in order to increase their efficiency their stone surfaces was designed with motifs and patterns that created unrest in order to increase the amount of cooling influence. Often use water fountains around the world for the purpose of cooling the surrounding environment, especially in hot, dry climates are placed in the yard if available water supplies. As well as the use of pools of water for the same purpose, where these basins and fountains add great psychological comfort to the human mind Oliver [44].

A principle that has been achieved is the adiabatic cooling.

3.2.6 Thermal Mass

Method of construction a large-scale considered is one of the advantages of this climatic zone. One of the factors that reduce the impact of solar radiation are huge walls because inflicted of energy on the walls must first penetrate the walls and then slowly spread to the inside. Due to the scalability of storage for building materials that use of dried mud bricks, the heat of the day does not penetrate these walls until the evening, as well as provide a moderate degrees and comfortable temperature during the cold nights, these traditional buildings are used until today in the building of mosques in Mali in West Africa, where inside these mosques colder than the area which is located in front of the mosque [44].

Used large buildings in the desert areas for ice houses or to store ice. The ice collect of mountain peaks or imported from as far away on the roofs of some buildings areas. For example, ice is stored in the Iranian city of Yazd while the outside temperature may reach 50 degrees Celsius, where they are stored on large amounts of ice in order to maintain the degree of homogeneous heat as well as reducing the temperature at altitude. Cold air will help in those areas to cooler building blocks during the night.

Principles derived from it is the use of large buildings blocks for the purpose of thermal energy storage to reduce the temperature amplitude and phase transformation temperature into the night.





Figure 20 Typical Clay Mosque in Mali [120]



Figure 21 Ice House in Yazd [92]

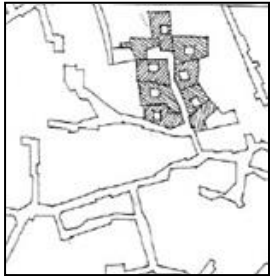
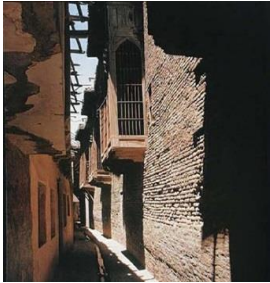
Table 9 Comparison between Vernacular Architecture Sustainable Architecture- Site Section.

In this comparison there are some features that had been chosen depending on the similarity and differentiation between vernacular architecture and modern sustainability.

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The sustainability of the site	1. Site selection	<p>Avoid development of inappropriate sites</p> <p>Reducing the negative environmental impacts resulting from the presence of the building on the site</p>	<p>Choosing the suitable sites for cities and utilities which inside it by applying a number of principles including:</p> <ul style="list-style-type: none"> - Push harms of the city. - To Bring benefits to the city - Address the environmental impacts of buildings inside the city 	<ul style="list-style-type: none"> - Make the city site in elevated areas so as not to be subject to sinking - Establishment of small rivers to refresh the air and let a city more beautiful - Not be allowed to build in the natural reserves - Not be allowed to build in public places such as streets and courtyards - Choosing a suitable sites where the air moderation and air quality - Availability of a nearby water source in the city or to build on limbs near the source of water - Provide food and clothing or self-regions (rural areas) adjacent or through trade and exchange one of the following ways: <ul style="list-style-type: none"> ▪ Link cities with rural areas ▪ link cities with the road of main commercial ▪ link the cities with marine sites <p>isolate the Industries areas faraway the city because of the resulting environmental damage</p>	 <p>Village photo</p>  <p>Aerial photograph of a residential area of Baghdad city</p>	<p>The features of choosing the ancient cities locations are air quality and air quality are selected through the use of a fresh meat a week without harm</p>



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Table 10 Comparison between Vernacular Architecture Sustainable Architecture - Development Density & Fabric of Society

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The sustainability of the site	2. Development Density & fabric of society	The development of urban areas using the existing infrastructure and encourage and development a high Density so as to preserve the open space and limit urban sprawl	<p>Emphasis on the unity of the neighborhood and the principle of solidarity and non-discrimination</p> <ul style="list-style-type: none"> - Centralized services. - Organic planning and gradient space and functional 	<ul style="list-style-type: none"> - The division of the territory of the plans according to the needs of the people. - The division of land and the role according to the rules of inheritance. - The existence a major nucleus represents the heart of the city includes public buildings and markets. - Aggregation services around places of worship. - Linking public squares with houses of worship for the establishment of social, cultural and religious events. - Dividing the city into sections where all basic services available. - The convergence of the buildings so that represents an architectural one block to resist Climatic factors. - Use a nested pattern of urban fabric pattern is the juxtaposition jowl and residential buildings to achieve the security point of view to isolate between dwelt and strangers. - Alleys and winding roads network (which includes roads closed) inside the camp housing. 	 <p>City planning & unit neighbors</p>  <p>Baghdad Shanasheel</p>	The vernacular city neighborhoods were not separated from some of the barriers or dividers, with Organic form, houses were contiguous as one building and the narrow streets and back ending street, Due to aspects of climatic, social (security) to prevent strangers and to achieve social Privacy.

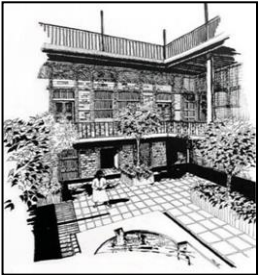

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Table 11 Comparison between Vernacular Architecture Sustainable Architecture - Transportation

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The sustainability of the site	3.Transportation	<p>The reduction of the pollution caused by the use of cars</p> <p>Reducing the space used for cars</p>	<p>Taking into account the movement and the method of transportation (animals) within the city and reduce the harm caused</p> <p>Protection and classification roads according to use them</p>	<ul style="list-style-type: none"> - The use of ways of transportation, such as Beauty and horse to transport and travel through cities and all ways of transportation not harm to the environment - The allocation of places for parking and transportation, called Merabedh - Cleaning those places periodically And take advantage of the waste transport in fertilize the ground - Not crowding the roads, obstructing pedestrians of people Building large doors to the streets and lanes - Diversity between the street and the alley and Small neighborhoods , each one has a special function and special offer street width 4 meters either Small neighborhoods 2-3 Meters and alley 1.5-2 meters - Protect the roads environmentally directing the streets of cities in the tropics, for example in hot cities (from the north to the south to gain the shadows) - The end of the narrow streets and places a little wide (metaphors) play the role of the yard and working stored cold air on the night 	 <p>Transportation in old Baghdad</p>  <p>Tramway in Baghdad</p>	<p>One of the most ancient cities vernacular characteristics is movement system , which begins with the clogged roads and ends to the city center through series of Zigzag roads and graduated in width.</p>

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Table 12 Comparison between Vernacular Architecture Sustainable Architecture - Increase of Open Spaces

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The sustainability of the site	4. Increase of open spaces	Increase the percentage of open space to optimal use and contain water fountains and green plants	<p>Space gradient open spaces in vernacular cities</p> <p>Attention landscaped and attention to issues of agriculture to benefit from the fruits or take advantage of the shade, or even what give the aesthetic value.</p>	<ul style="list-style-type: none"> - The Logical sequence and the gradient in terms of capacity and functions of the squares. - Choose the appropriate dimensions and squares of the human scale and climatic factors and the needs of people. - Allocate the plazas or courtyards per group of buildings - Allocate courtyards inside most of the houses - Gardens planning in a rectangular shape about a longitudinal axis. - Use waterfalls in the gardens and fountains in the inner courtyard of houses. - The cultivation of a roof, as in some cities, such as the city of Sana'a. - Use colorful mosaics and the use of stained glass. - The use of wood and decorated wood which manmade. - The use of engineering units known arabesque decorative Arabic. 	 <p>Baghdadi house courtyard</p>  <p>The doorways the entrance corridor Mejaz</p>	The courtyard is an open space from the top surrounded by the walls of building or adjacent to the building, which contains the green plants and a fountain, all rooms are overlooking in it.

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Table 13 Comparison between Vernacular Architecture Sustainable Architecture - Redeveloping Neglected Sites





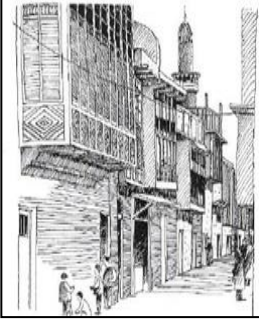

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The sustainability of the site	5. Redeveloping neglected sites	Preservation of natural areas	Protect the natural environment.	- protect the surrounding environment and its impact on the form of the city		
		Repair dilapidated areas and return to the first status	The concept of neighborhoods. The idea of natural reserves.	- Avoid building in places devoted to agriculture - Revive dead land and reclamation - Provide some places as nature reserves		
		Provide custom places of living organisms and to encourage biodiversity			Sustainable land management	
					Sustainable land management	

Table 14 Comparison between Vernacular Architecture Sustainable Architecture - Control the Quantity and Quality of Rainwater

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The sustainability of the site	6. Control the quantity and quality of rainwater	<p>Take advantage of the rainwater in irrigation, agriculture or recycling</p> <p>Aims to reduce the environmental pollution caused by the weakness of rainwater drainage</p>	<p>The exploitation of rainwater and use them as the ancient people relied on rainwater for daily needs</p> <p>Remove the damage caused by rainwater</p>	<ul style="list-style-type: none"> - Building sand dams, ponds and valleys to retain rainwater for a long time - Use the pond to save the rainwater through canals - The use of wood and pottery utensils to collect rainwater and save them for the time of need - Use a gutter: A course of is placed on the roofs of vernacular houses for rainwater drainage and often made of tree trunks 	 <p>Benefit from rain water</p>  <p>Gargoyle</p>	

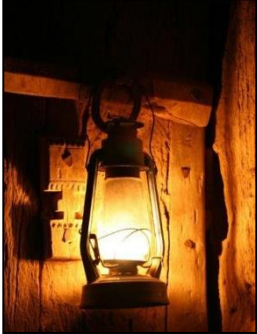

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Table 15 Comparison between Vernacular Architecture Sustainable Architecture - Reducing the Impact of the Sun's Heat.

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The sustainability of the site	7. Reducing the impact of the sun's heat.	Reduce heat stored as a result of exposure to sunlight and reduce the effects of the sun on the human body and housing	Provide Shades to protect from the sun.	<p>Establish the narrow streets and internal courtyards.</p> <p>The Winding streets and disparity rise buildings led to be shade and shadows.</p> <p>Use of building materials with thermal insulation, such as bricks.</p> <p>The use of wood in the work of a roofs</p> <p>Use domes to give protection from the sun more than flat roofs.</p> <p>Cultivation of the courtyard and put a fountains in the middle.</p>	 <p>Planning and dealing with site</p>  <p>Planning and dealing with site</p>	The beauty of vernacular cities in the fresh its air and shadows across the narrow winding streets and architectural harmonious with nature.

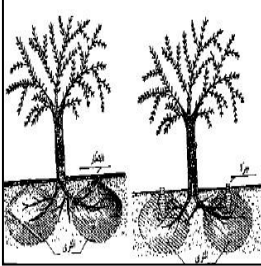

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Table 16 Comparison between Vernacular Architecture Sustainable Architecture - Reducing light Pollution


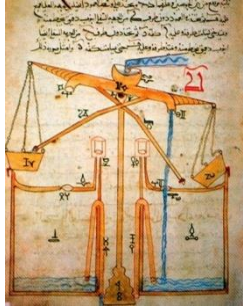
Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The sustainability of the site	8. Reducing light pollution	<p>Reduction of light scattering from the building and the site and improve the Night Vision severe reduction of lights.</p> <p>Reduction of natural light intensity.</p>	<p>Provide appropriate lighting either natural or industrial.</p> <p>Reducing the impact of natural sun rays.</p>	<ul style="list-style-type: none"> - The use of ways of lighting by oils and absolute fire, the fire is considered the foundation of all functions. - Use a lamp and a skylight openings penetrate walls may be narrow from the inside and wide from outside as Zahra Palace in Andalusia - The use of marble which carved geometric shape, and written forms <p>The use of stained glass in the windows was named Moonlet</p> <ul style="list-style-type: none"> - Use Mashrabiya allow the entry of the fresh air to the house and adjusts the passage of direct sunlight 	 <p>The beginnings of lighting</p>  <p>The Mashrabiyya and good ventilation</p>	

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Table 17 Comparison between Vernacular Architecture Sustainable Architecture - The Efficiency of Water Usage



Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The efficiency of water usage	A. Reduce water consumption	Reduce use of water by 50% reduction or not use the Potable water for irrigation parks	<p>Reduce the use of water and do not use excessive</p> <p>Divide Water in equitably without extravagance</p>	<ul style="list-style-type: none"> - The allocation of a certain amount of water for each region -The use of special measurement to water control in the vernacular architecture - The use of drip irrigation method - The division water between the partners of the Land 	 <p>Scientific ways of irrigation</p>  <p>Nile scale</p>	

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Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The efficiency of water usage	B. Water Distribution	The efficiency of the distribution of water and do not use Drinkable water for irrigation	Delivery of water to homes and other parts of the city	<ul style="list-style-type: none"> - Digging trenches and establishment dams and channels, such as the city of Baghdad and Cairo - Incision channels for some cities which depend on wells and springs and rivers - The use of the theory of the pounding utensils In water delivery as a network of pipes to homes 	 <p>Pierre water</p>	
	C. Wastewater	Reduction of sewage	Re-use of water Sewage separation	<ul style="list-style-type: none"> - The use of channels moving underground, the water moving by a force of gravity - Drilling water wells in houses, faraway the sewage, due to not affected by it - Ajpab where drilling waste collects and cleans by specialize workers 	 <p>Equation</p>	



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Table 18 Comparison between Vernacular Architecture Sustainable Architecture - The Energy

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
The energy	a-Improving energy use	Improving the use of energy and reduction of environmental impacts of energy use in buildings	Shade care in all parts of the urban fabric that we see clearly in the vernacular architecture in the rationalization of energy, the shade contributes to energy saving up to more than 30%	<ul style="list-style-type: none"> - The reasons for the appearance of the buildings conjunctival or Intertwined is guidance to the inside of the house or the city - The environmental results for narrow streets and Zigzag to reduce the exposed areas of the sun and that lead to thermal stability and keep the stagnation cold air - Directing lanes and streets in the old city, the majority take the north-south direction because it helps the roads and facades of houses overlooking to not exposed for a long time to the sun - The heights of buildings commensurate with the Street View has reached 1: p or 1: 4 - The use of footpaths and be short and narrow and winding and shaded - Roofing streets and lanes, and the emergence of interfaces - The use of some of the solutions in the aisles by shading trees and fabrics - The use of the phenomena of the tides 	 <p>Unit Neighbors of Baghdad city</p>	<ul style="list-style-type: none"> -The buildings conjunctival : convergence of city's buildings with each other as one building -The difference in height of the buildings adjacent led to the shading and protection from the sun. -With the movement of the sun from east to west, so the streets directing in warm areas of the north to the south, either, the opposite is true of the cold regions.
	b- Renewable Energy in Site	Encourage the development and use of renewable energy sources	The advantage of solar energy and natural phenomena		 <p>City planning</p>	

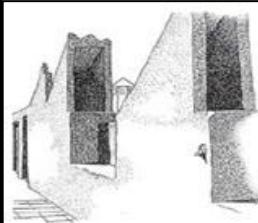
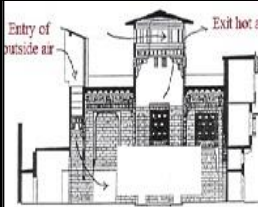

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Table 19 Comparison between Vernacular Architecture Sustainable Architecture - Materials and Resources

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
Materials and resources	The use of local materials	Increased demand for construction materials locally manufactured	Respect for tradition and respect for the environment	<ul style="list-style-type: none"> - The Building walls From a local materials and thickness ensures resilience and resistance to heat and humidity. - Use of local materials such as palm fronds, stones, reeds. - Use of the mixture of gypsum and lime in burnt brick industry and the use of hard stones such as granite and marble. 	 <p>Mud Templates</p>	<p>The use of gypsum material of environmental processors.</p> <p>Architects take advantage of science and knowledge In those ages, such as mechanics and chemistry.</p>
	Waste management of buildings	Reducing waste and environmental impacts of manufacturing raw materials	Invent new ways to facilitate construction	<ul style="list-style-type: none"> - Innovation types of mechanical machinery for lifting big weights using pulleys, the machines such as Krahn and sieve. - The use of animal waste in orthopedic walls. - Use of cane, wheat, barley and corn in the arming of bricks - The use of parts of the Dead trees in roofing. 	 <p>Mud Buildings</p>	
	Re-use materials	Redirecting recyclable materials	Take advantage of the simple materials in construction	<ul style="list-style-type: none"> - The use of livestock manure mixed with lime in thermal insulation. - Waste collection solid waste from homes and fuel use for public bathrooms and manure for plants. 		

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Table 20 Comparison between Vernacular Architecture Sustainable Architecture - Healthy Interior Environment

Sustainable Architecture			Vernacular Architecture			
Requirements	Criterion elements	Application goals	Principles and criteria	Application methods	Illustrations	Remarks
Healthy Interior Environment	Take advantage of the outside air	Increased external sources of ventilation to ensure the indoor environment ventilation	ventilation of buildings by natural innovative ways	<ul style="list-style-type: none"> - Use Mlaagaf air: It slots ceilings represent the entrances to the air and pushes into the room to come out from the inner courtyard to complete the movement of air, and be triangular aspects - Use mashrabiyya: an architectural treatment that allows air to enter the wind to refresh of inside buildings - The use of windows and openings: the window is opening penetrate the wall and be narrow from the inside and wide from the outside to expand Vision angle and prevent the direct sunlight from entering - The use of plaster or marble engraved in large openings window sizes with geometric forms which called the sunshades named either less named moonlet - The use of the courtyard (Hush) which was an open space from the top and house chambers overlooking on it 		
	Increased ventilation	<p>The use of natural lighting inside the building</p> <p>Control of thermal comfort to increase the comfort of the occupants inside the building</p>	The introduction of natural lighting		 <p>Natural ventilation</p>  <p>Badgirs in Yazd</p>	

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CHAPTER 4

VERNACULAR ARCHITECTURE OF IRAQ (BAGHDAD & ERBİL)

Iraq is a country in Western Asia is spanning most of the north western end of the Zagros mountain range; it is an almost landlocked country lying between Turkey on the north, Iran on the east, Saudi Arabia on the south and Jordan and Syria in the west. Iraq has a very short coastline on the Persian (Arabian) Gulf. Most of the country is flat and low-lying and consist of the low plateau of the eastern part of the Syrian Desert and the northern part of the Arabian Desert [58].



Figure 22 Iraq Topography Map [95]

4.1. Location of Iraq

Total land area as 438,446 km² (169,285 mi²) Iraq latitude & longitude is 33°14'N 44°14'E. The altitude above sea level is 34 m (112 ft.).

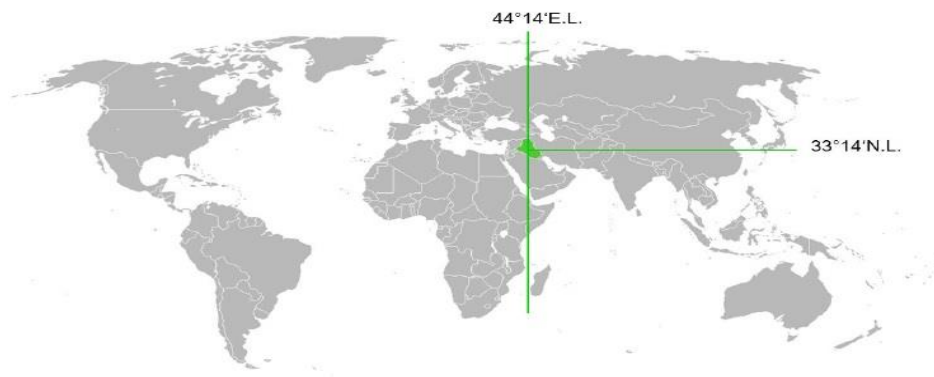


Figure 23 Iraq Location in The World [94]

Iraq topography is far from being a completely desert. It is diverse ecologically, with habitats as varied as dry mountain forest in the north eastern Kurdish area and the alluvial [58].

4.2 Climate of Iraq

Iraq is considered a triangle of mountains, desert, and fertile river valley. The country has arid desert land west of the Euphrates, a broad central valley between the Euphrates and the Tigris, and mountains in the northeast.

The climate in Iraq is hot and dry where temperatures are usually high by day and often high by night, with low humidity, the average temperatures in Iraq range from higher than 49°C (122°F) in July and August to below freezing in January. There is no great difference in summer temperatures from north to south. A majority of the rainfall occurs from December through April and is more abundant in the mountainous region and may reach 100cm (39in) a year in some places. Most of the

country has a desert or steppe climate with annual rainfall below 20cm (8in). Winter is very mild in the south, but become cooler towards the north. Frost and snow occasionally occur at low levels in the north and snowfall may be heavy in Kurdistan area, the summer months are marked by two kinds of wind phenomena: the southern and south easterly “Sharji”, a dry, dusty wind with occasional gusts to 80k (50mi) an hour, occurs from April to early June and again from late September through November; the “Shamal”, a steady wind from the north and northwest, prevails from mid-June to mid-September. Very dry air, which accompanies the “Shamal” permits intensive sun heating of the land surface, but also provides some cooling effect [25-58].

4.2.1 Climate of Baghdad Region

Located along the Tigris River, Baghdad has low humidity which is important when the temperatures get above 48.8°C (120°F). It gets very hot in the summer, usually has some good rain in the fall, but there is really no spring there, average temperatures for climate in Baghdad range from higher than 120°F in July and August to below freezing in January. Most of the rainfall occurs from December through April. Most of the annual rainfall occurs between November and April. The remaining six months, particularly the hottest ones of June, July and August, are dry, there will be no rain and usually no clouds [25].

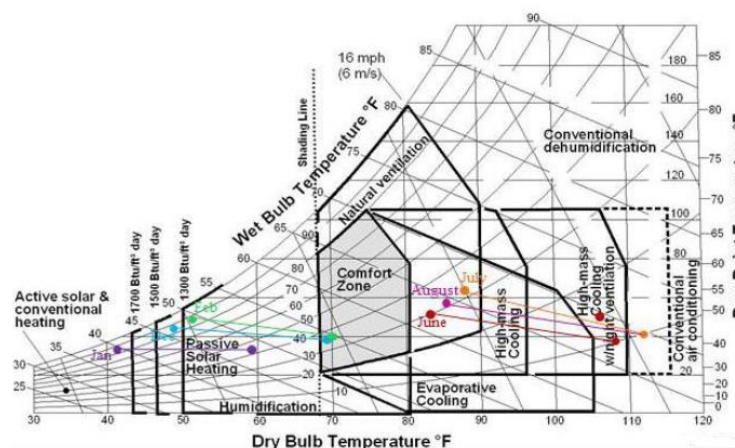


Figure 24 Psychrometric Chart for Baghdad City.

Monthly Temperature In Baghdad Region

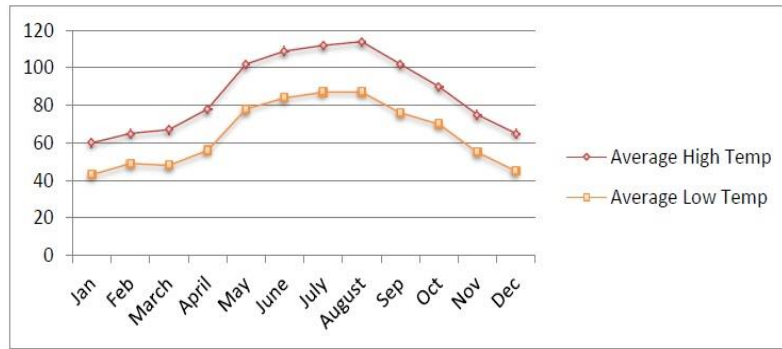


Figure 25 Monthly Temperature Chart of Baghdad Region.

Monthly Relative Humidity in Baghdad Region

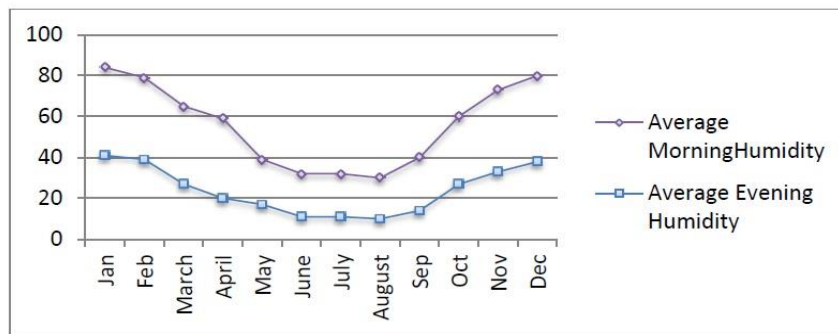


Figure 26 Average Relative Humidity At Morning And Evening in Baghdad Region.

Days of Precipitation in Baghdad Region

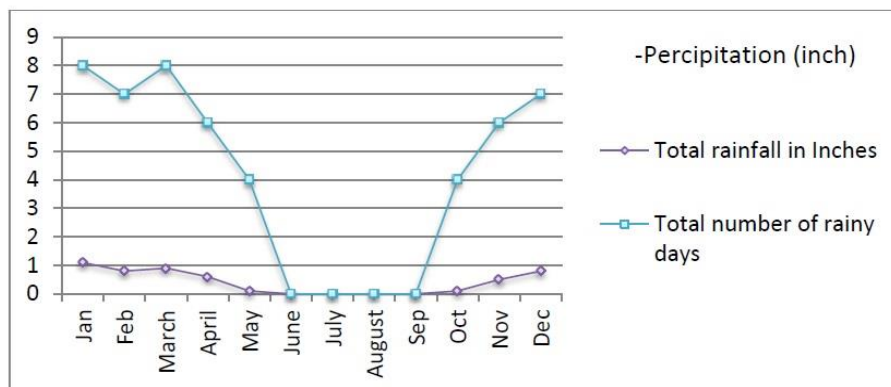


Figure 27 Monthly Precipitation in Baghdad in Inches.

4.2.2 Climate of Erbil Region

The Erbil's climate is typified by a continental climate, hot in the summer, cold in the winter. The geographical areas are differentiated by various climate conditions; the mountain areas which have a mild summer and rigid winter, while the plain areas characterize with hot summer and mild winter. Therefore, in the mountain areas during the winter, it is easy to have snow and low temperature. The rainy season is quite unpredictable and torrential.

Winds of variable strengths blow accompanied sometimes with dust and sand storm in the plain area [25-58].

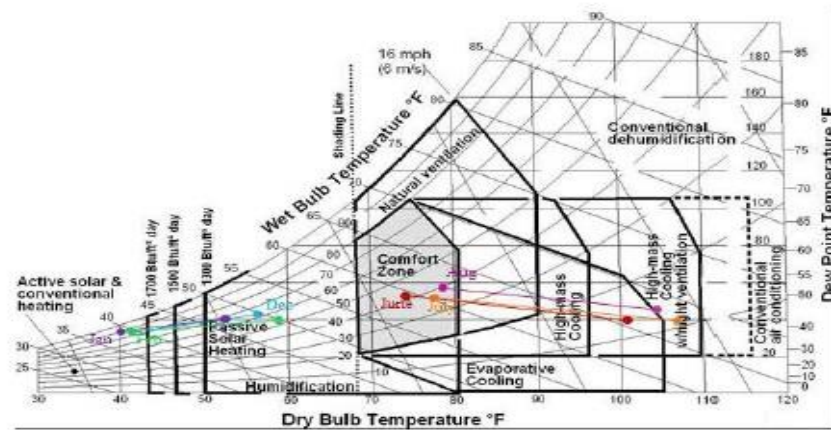


Figure 28 Psychrometric Chart for Erbil Region.

Monthly Temperature in Erbil Region

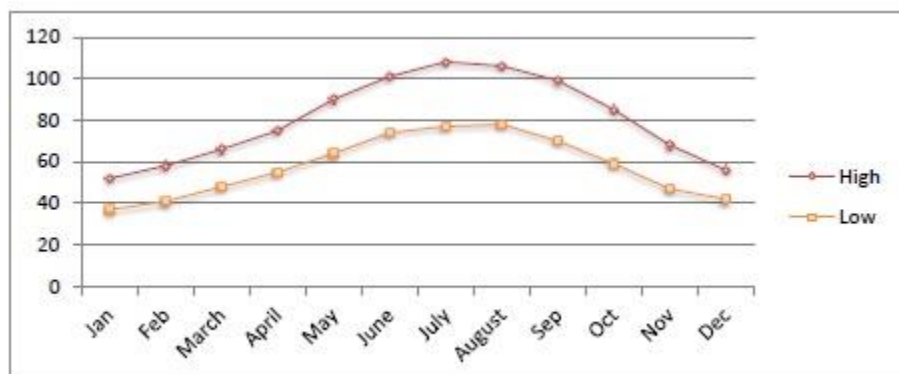


Figure 29 Monthly Temperature Chart of Erbil Region.

Monthly Relative Humidity in Erbil Region

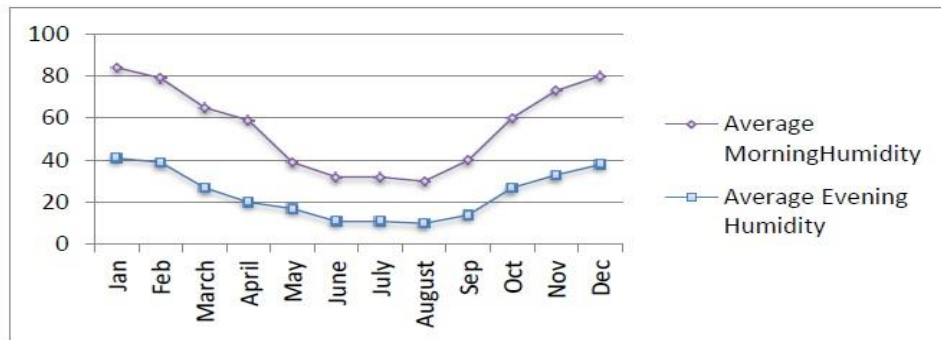


Figure 30 Average Relative Humidity at Morning and Evening in Erbil Region.

Days of Precipitation in Erbil Region

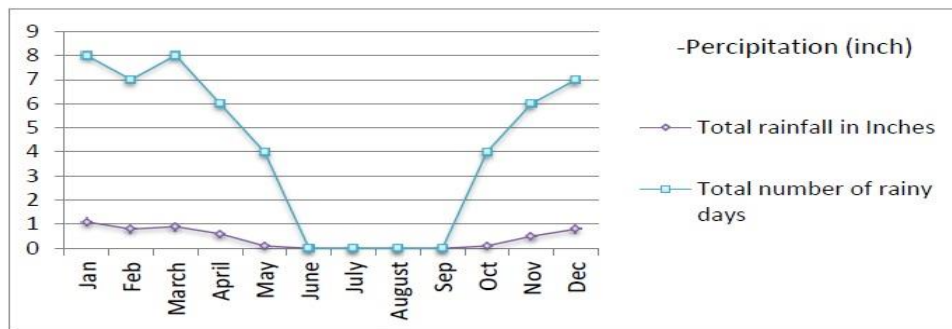


Figure 31 Monthly Precipitation in Erbil Region in Inches.

4.3 Vernacular Architecture in Baghdad Region

The vernacular architecture of Baghdad is still one of the masterpieces of world architecture, due to their achievements and architectural solutions to climate resistance, by the thick mud brick walls and the courtyard.

In addition to the Tigris river breeze and with architectural solutions to seize the cooling air inside the rooms house and to replace the air conditioner to get the comfortable and healthy environment for residents and their narrow street and all rooms which overlooking to inside courtyard as an example of privacy and safety and because of the development of technological happening since the nineteenth

century, and so far, such as the evolution of technology and the emergence of new materials, as well as the emergence of the modern movement.

All sections of life have been affected, including the vernacular architecture and especially Baghdadi house, led to the loss of architectural identity and to keep up with the times most of the elements of the House-Baghdadi has changed so many architectural problems have emerged.

4.3.1 Historical Development in Baghdad Region

The development of the city of Baghdad during the eighth century, and developed a strategy and put it there because of the Tigris and Euphrates curve in this region hold strong. Old houses in Baghdad, according to the colloquial meaning is of ancient times, and is worth mentioning that the homes that have been chosen for this study have been built in the ninth century [58].

Through evolution, which dominated the people there were homes development also were integrated with the qualities and features that prevailed on that successive generations, the character of the houses was taken its shape as a result of a combination of experience and climate impact as well as the Islamic lifestyle. Newer homes structure about 100 years ago has taken the history of the traditional style, the construction of houses has been the development of the rural defence decade as told by one of Citations, and therefore this complexity in the early dates has brought functional benefits in the cultural and physical environment, long process of evolution in that environment was led to durable homes in Baghdad with distinctive detailing and elegant. Therefore, there are many reasons to keep the construction style that is found in the first cities in the region. But the production of urban neighbourhoods was a small courtyard plan. During Larsa period before four thousand years, according to that, people was baptized to build their homes in the winding alleyways, which is in the same courtyard houses in Baghdad, because the antiquities that have been discovered in the lower layers, much like those found in Baghdad, which was built in the nineteenth century. "Architecture is never static.

Dynasties change, conquerors come, strange influences infiltrate and new techniques are gained.” [45].

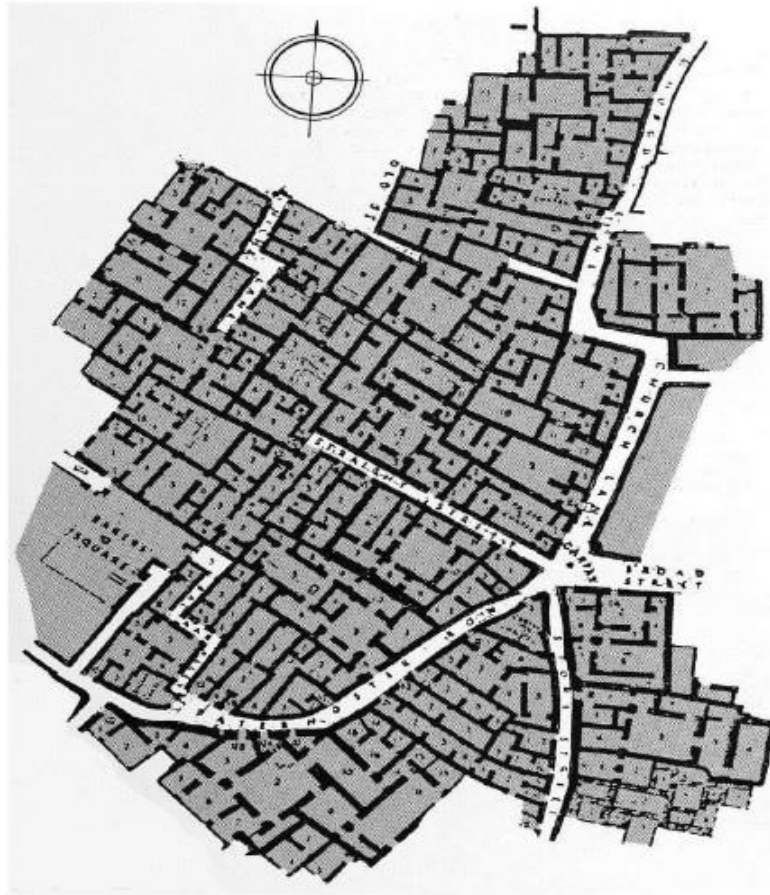


Figure 32 Ur Courtyard House [58]

Baghdad houses responded several times to architectural development that is happening in the world, so the houses that have been built in the nineteenth century is seen in the end as a human settlement development. Development in urban planning in subsequent periods was not planned, but it was cumulative and organic. The division of cities has passed gradually, without having the exact shape of equal size, even in residential areas, the homes did not take the same size, shape or orientation, but they followed some guidelines so it is installed in a coherent and non-regular. The general pattern is the natural form of the unit, which gave the city the regular contact. Houses in Baghdad built globally in quadrangular with a court in the middle, as well as the corridor leading to other rooms. When trying to describe

the courtyard Baghdadi houses we cannot describe the traditional home-Baghdadi Model yard, but its distinctive features is the presence of the yard. All Baghdadi houses share the same concepts of yard in terms of form, addressing the height, and the construction techniques used as well as the details. According to Al-Azzawi, using partials within the courtyard that is found on every Baghdadi home side by side, Baghdadi courtyard houses can be divided into four categories:

One-Courtyard Houses: Which includes the Haram, that represents a family-quarters, a great feature for the majority of Baghdad homes, as well as the presence of large houses from the same category include the existence of one or two rooms to receive guests.

Two-Courtyard Houses: Which contains the quarters of the guests and called the “Haram”, or “Diwan-Khana”, as well as the kitchen, which is called “Bayt al-Matbakh”.

Three-Courtyard Houses: Which contains the "Haram"; “Diwan-Khana”, or “Bayt al-Matbakh”, and the "Istibil".

Four-Courtyard Houses: That includes the “Haram”, the “Diwan-Khana”, “Bayt al-Matbakh”, and the “Istibil”.



Figure 33 Ground & First Floor of A Four-Courtyard House [45]

Homes with large areas seem like a large house from the outside. Sometimes these are recognized externally while elements can clearly distinguish these parts from the inside as well be separated physically.

Every part of the housing is uninhabitable with four parts separated from each other and thus have four sides with different sizes. There is also a connection between these parts on the ground floor or the first or both through entrances or hallways or the halls. Usually return home that contain more than yard to the families of considerable social standing in the society as well as the rich and are usually large homes and contain many of the housing rooms and spaces on each floor of the decks.

4.3.2 Features of Vernacular House in Baghdad Region

Baghdad houses feature a central courtyard around the so-called “Hoash” or “Fina”, all the rooms and spaces removable assembly for housing around the so-called “Tarma” and “Talar”. Houses surrounded by high walls composed of solid pieces to provide privacy and stay away from the bustling street living situation. So these rooms and spaces suitable for housing to be in an isolated space which through which you get the ventilation and daylight and sunlight, as well as the physical and the visual connection.

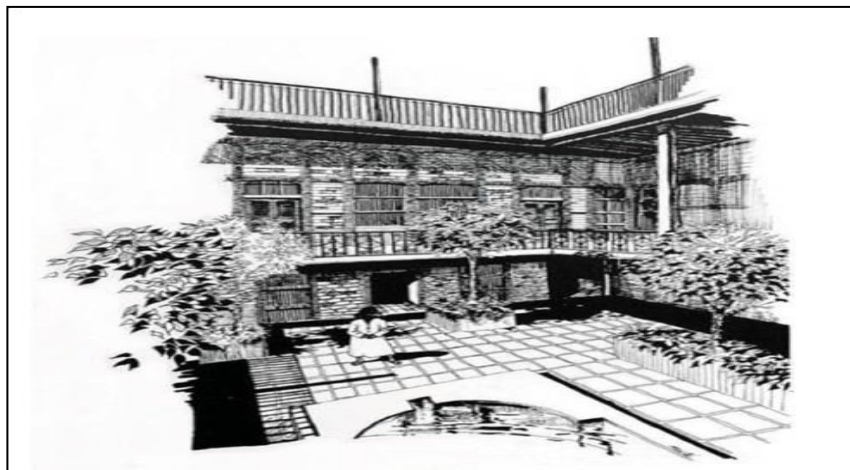


Figure 34 Baghdadi House Courtyard [58]

The Islamic character who dominated the Baghdadi community led to the division of the houses to the “Diwan-Khana” which is designated to receive the male guests as well as “Haram” for the female guests as well as for housemaids. “This preoccupation with internal arrangements and privacy contributed perhaps to the general disregard

of external elevation treatment.” “The interior was always more important than the exterior and the street, thus became a mere channel contained by the rigid blankness of lower walls built over hang by a filigree of ginnery which extended private life through a viewing platform into the public area.” [6-45].

The entrance is the first place you enter into the house of Baghdadi when coming from the street, which is called “Mejaz” It is a small corridor, as well as a narrow lead in the end of a yard wide open. Usually the entrance containing a curtain so the person standing abroad cannot watch what is in or behind the curtain entrance

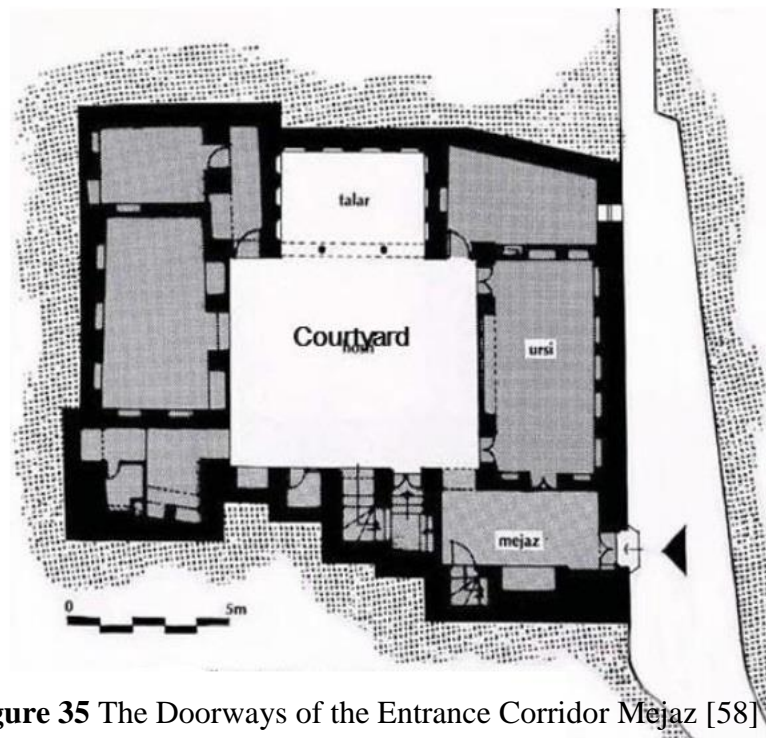


Figure 35 The Doorways of the Entrance Corridor Mejaz [58]

and exist on a large scale within Baghdad homes. But in the big house, it's different the entrance often leads to the door that leads to the dome be square or octagonal shape, it is worth mentioning the entrance may contain a room where live concierge home.

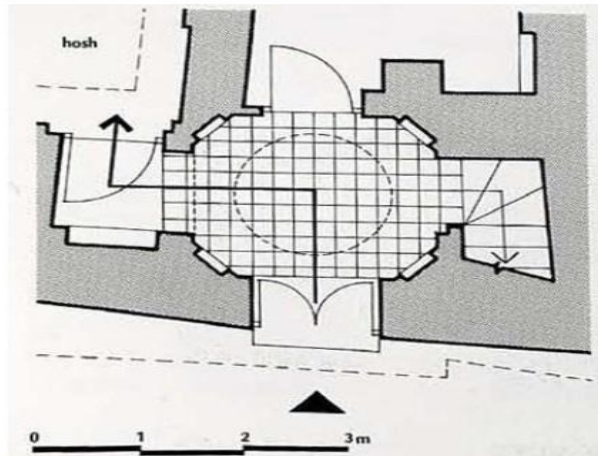


Figure 36 The Entrance Vestibule “Dolan ”[58]

Often taking the courtyard at the home Baghdadi square figure in vernacular construction, but can take other forms depending on the size of the house as well as the shape of the earth. In the ideal home, yard contains a central hole “Talar” (a habitable internal portico containing one, two or three air-scoops “Bad-Geer” facing each other across the courtyard and two long “Ursi”, (family room in winter) windows opposing the courtyard in between them. Can be seen wooden beams with octagonal cornice, from all points of the courtyard from the first floor and called “Muqarnas”.



Figure 37 Ursi with its Colourful Glass and Wooden [58]

Walls emerging from the first floor are continuing with the windows and called "Shanasheel" overlooking the alleyway at beyond the external walls at ground floor; the roof terrace likewise project at attics level outward beyond the external walls at

first floor. Therefore, the alleys are fairly wide in the ground side and become narrower at the first floor and narrower than that at the surface level. This means that the alleys provide enough space for movement and walking on the ground floor when needed as it allows adequate ventilation and daylight at the first floor, also leave enough gap to sunlight to penetrate into the alley. Sometimes these gaps are so tight that touch the houses opposite each other at the level of attics.

When talking about the first floor is employed internally inside the courtyard outside the walls overlooking the courtyard on the ground floor, this is a projection of the corridor and leading to "Tarma" in the first floor [58].

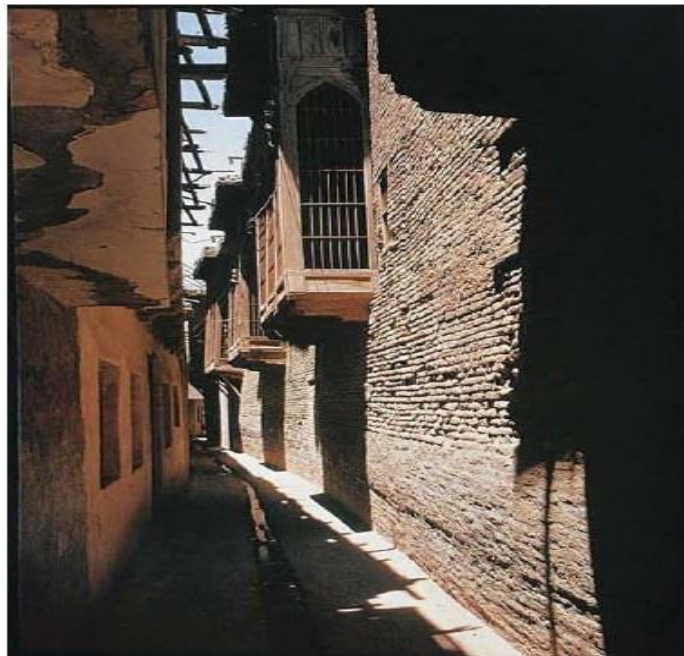


Figure 38 The Shanasheel [58]

Another advantage of the alleys, it has a slanted corner at the intersection between one alley or more, and sometimes this becomes rounded corners instead of being tilted. This retained or oblique angles to avoid accidents between pedestrians who walk across the angles on each other and join in on the same corner as they improved their vision line. According to Azzawi (3). Organic development and non-specific process for this alleys in terms of narrow and unpaved surfaces and oblique angles or retained was also known in ancient times in populated areas to the Sumerian

civilization of Ur in southern part of the land of Iraq before 1800 years BC. Ceiling usually runs along flat based on two, three or four sides in the upper part of the yard. The surface usually contains a barrier wall up to eye level to prevent vision by neighbors because the surface is often used for sleep, especially in the summer. According to Azzawi, often courtyards of traditional houses contain almost a basement is located under the yard and called “Sardab”, often contain room located under the land of the yard while the semi-underground level known as “Neem Sardab” and contains a room or two or three [6].

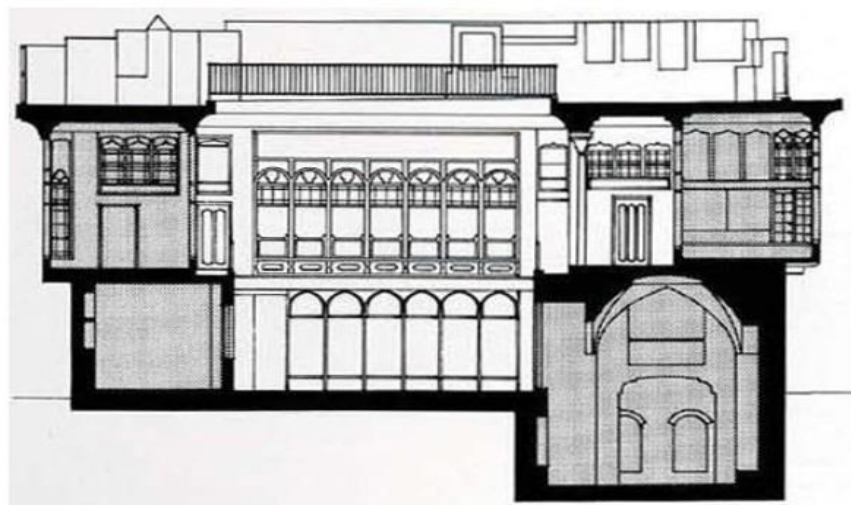


Figure 39 Cross-Section Showing Neem Sardab [45-58]

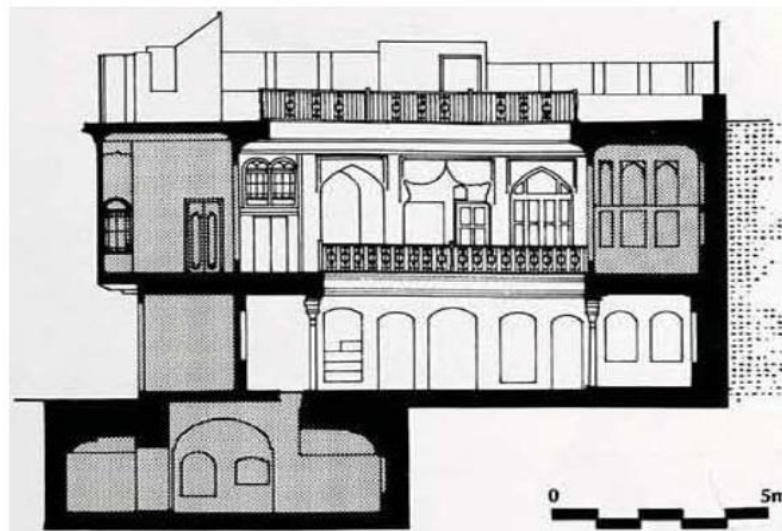


Figure 40 Cross-Section Showing Sardab [45-58]

As well as contain in each room windows. The “Neem Sardab” may be double height and be located below ground level, both two rooms are gaining ventilation and light through the yard. The basement is a solution Dual to escape from the heat during the summer when the temperature increases from 48.8°C (120°F). Most people spend the afternoon period in these rooms beneath the ground, because it keeps the cool temperature due to the difficulty of the arrival of warm sun rays to it, because they contain thick walls as well as the ground surrounded from all sides. We conclude from the above that the basement was an essential part of Baghdad home. Rooms around the courtyard is divided into multiple distinct partitions. Function rooms are placed on the surface of the earth from which the stores, toilets and kitchens with the minimum level of the firsts Ground floor consists of reception room overlooking the courtyard, which often contain high finishes wooden columns with balconies, also contains an internal courtyard room is open to the sky and living rooms as well as complementary rooms that combine two or three ribs from its areas toward the yard. These rooms are open continuously and physically over the courtyard, whether directly or indirectly, from the internal gallery housing the “Tarma”.

The first floor up to the alley behind the outwardly exterior walls almost with continuous bay windows called “Shanasheel”. The first floor up to the porch internally facing walls on the ground floor of this projection shove access to the walkway which is named “Mamsha”, around the courtyard on the ground floor.

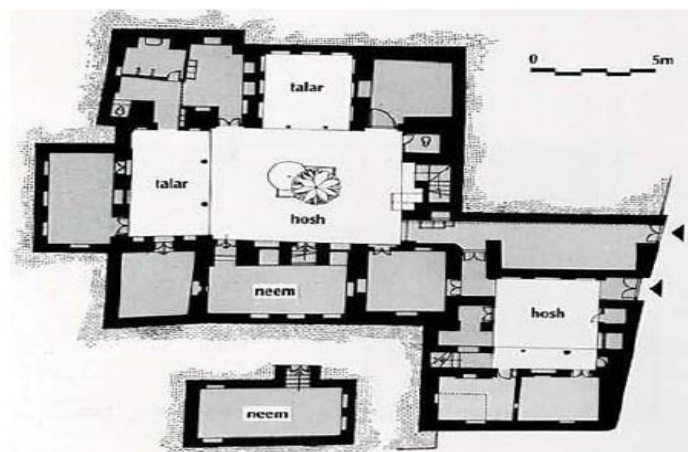


Figure 41 Ground Floor and Basement Plans [45]

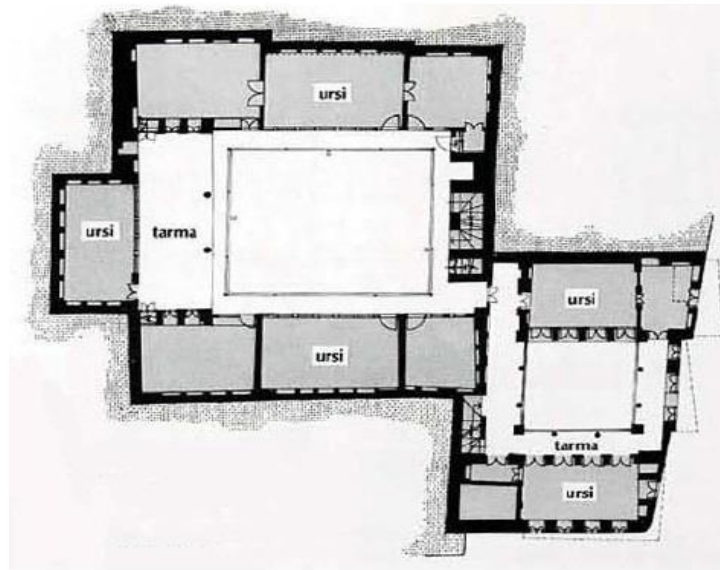


Figure 42 First Floor Plan [45]

At the level of attics, projects of external balconies overlooking to abroad By Reuther, the use of the rooms inside these houses identifies by the seasons, day or time from the basement until the attics. As well as the manifestations of behavior change also, for example, in the summer there are two bedrooms shall be sleeping on the surface in the cold early hours of the day and in the basement or cellar during the afternoon, but at other times of the year shall be sleep and spend the whole night in a single room. So, the house with columns is the home of complex climates where it uses everywhere and every part at the best form and the yard represents axis of the life and here main column in the house room located between the yard and the street and be open to the neighborhood through its window prominent which is found on the first floor Such windows Baghdadis call them as “Shanasheel”, it is common in the Islamic world. These windows have not brought just the air to occupants of the house, but is a way to monitor what is happening on the street, with its presence in

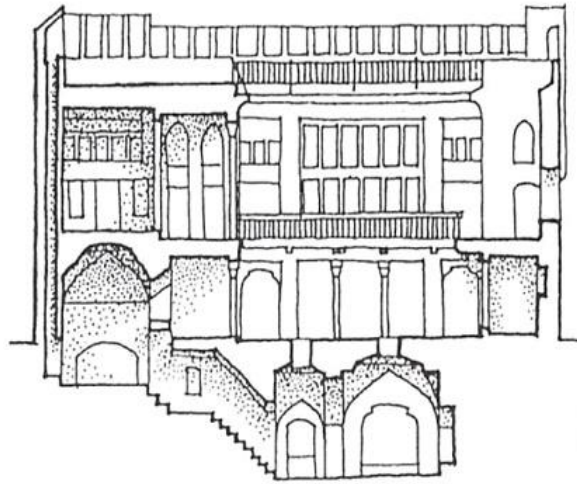


Figure 43 Section Showing the Relationship between Three Levels of the House [3-45]

Short distance from the others it has become a way to communicate with the street itself. This was the widely special famous oriels. Far away to the north, where the Tigris curls beneath the basalt walls of Diyarbakir, the projecting room jettied out on heavy corbels of basalt carries the name Baghdadi.

4.3.3 Building Materials in Baghdad Region

The building materials that were used in Baghdad were mostly manufactured locally, including brick, which was the most common. According to Max that brick that was made of clay, may take the place burned brick oven at the beginning of the twentieth century. According to Warren &Fethi, that brick that was made of clay, may take the place burned brick kiln at the beginning of the twentieth century. “Mortars were made with lime from a gypsum base “Juss” which imparted hydraulic properties sometime accentuated by wood ash”. Plaster was used as another, and loads of sediment in the Euphrates River and was also present in great abundance in addition to the stones that were brought from Mosul in the northern part of Iraq. The ceilings are isolated by placing clay with a straw. The building materials, which were also used wood, including teak“Saj”, which was representing the most important wood because it was resisted termite attack. The palm wood is also used in case you need to coarse wood. We can say that the use of wood in the regular traditional buildings was confusing to use at Baghdad home despite resistance termites, and also is considered a weak

conductor of heat [4]. It is worth mentioning that many of the builders and homeowners use the wood to build houses so far, because of the advantages enjoyed by the wood as well as the abundance and it's cheap economically, and also because it is lightweight, so the ceiling light load and do not constitute a threat to the relatively weak walls. One of the other capabilities of the wood is consistency, not only when the walls, but when the soil is poor for high endurance capabilities, IE, when they are continuing the intermittent levels of groundwater. Other advantages of wood are that it is insensitive material to moisture (meaning it gives acquires water to achieve a balance with the external surrounding environment). The best solution to take advantage of the organizational structure of the cold winter, the first floor rooms that the heat reaching them from the sun in winter, which penetrates the room through the colored and non-colored“Ursi”[6].

Among the metals that were used for the manufacture of doors and windows is a copper and bronze, who were made local. . The ornate iron fences are the most commonly used for packaging floors were "Farshi" made from mud, making it the ideal thermal mass, because the thermal mass absorbs heat energy when the surrounding areas are the highest temperature of the cluster and gives thermal energy. . In the extreme summer heat days the homeowners spray water on the floor of the house in the afternoon to cool their homes in the evaporative cooling process. . Water used in evaporative cooling system are present in the center of the courtyard [4-32].



Figure 44 “Farshi” Brick Which Covered the Ground Floor with Vegetation [6]

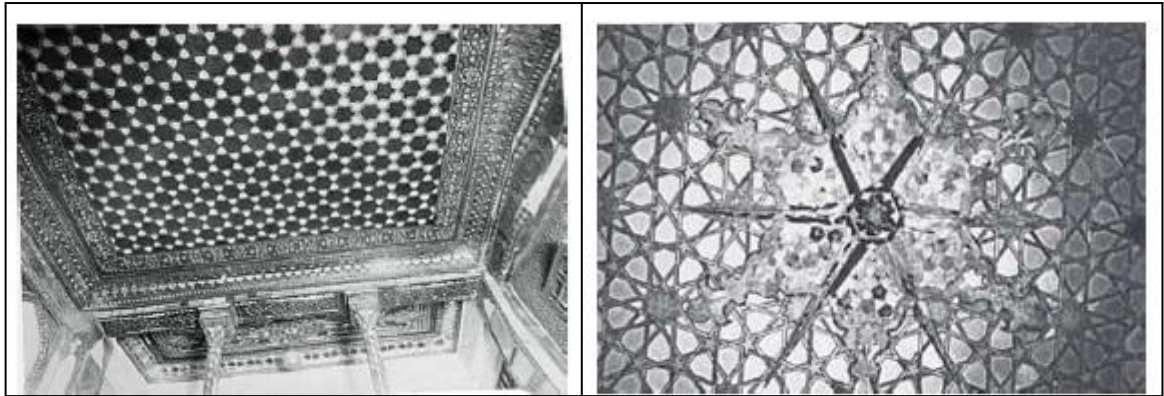


Figure 45 Intricate Ceilings, the Timber Mosaic Mirror Ceilings, Sparkling in Bright Silver through Geometrical Shape [3]

According to [3-4]. Plaster was not commonplace in a big way, it was not used in the decoration operations or a part of it. It was not known how to use plaster with wooden slats, the only place that was placed upon the plaster is walls. Great use of plaster was the “Muqarnas” frieze, in an excellent shape, which was established by the Baghdadi constructors under the ceilings in the main room on a half meter of distance, which was a feature in the upper layers of society. According to Max, the rooms in the basement or cellars are fully different from those on the first floor, because the rooms on the first floor are slatted wood, hanging of segments covering internal joints, while in the basement walls and wooden surfaces, which are superior to the ceiling and arched dome shape of the basement is all construction.



Figure 46 The Structure Material in the Basement is All Masonry [4]

4.4 Vernacular Architecture in Erbil Region

Before six thousand years ago, Erbil city witnessed a major development which included vernacular buildings, especially the north side, In spite of geographical and cultural proximity to Turkey and Iran, but the buildings similar to some buildings of Baghdad when it was under the same climate, culture has had one purpose to resist the changing climate to provide a comfortable and healthy atmosphere for residents. There are two styles of building, the first one is the vernacular buildings which stems from the principle of trial and error and not dependent on the pre-planning and the second one is architecture style who based on the scientific planning and design, each one has own style that sets it apart

4.4.1 Historical Development in Erbil Region

The castle consists of a large number of traditional courtyards of home. . Large houses are usually located on the peripheral wall of the castle and some of which are located within the town. The peripheral wall dominated by the modern city of Erbil and giving it the fortified outlook. Wall surrounds the castle consists of houses built in different periods of up to a hundred homes. A tissue found is of extreme interest and vernacular architecture and urban, where homes have repeatedly been built on top of the existing institution, where the existing fabric has contributed to restoring constantly [41].



Figure 47 Erbil Citadel, All Windows or Openings on the Upper External Walls [80].

There is inside this castle town surrounded by an external and independent wall, and occupies as well as traditional courtyards of homes up to a maze of narrow alleys. There are so far houses at the wall bottom built during the eighteenth century or a little earlier, existing homes in the northern section of the wall is less exposed to the sun, it is natural to be uncomfortable in the winter, so be less attractive for residents who are present there. In addition to that most of the homes on the north side back to the period 1930s and 1940s. It turns out that growth was the oldest civilization in the southern side of it over to the north side. Their style is evident in the architecture through the use of jack-arching, jack-arching was not known to a large extent before 1920s in Iraq [49].



Figure 48 Major Alleyways Acted as Distributors and Continued to Penetrate the Residential Quarters until They Intersected another Major Alleyway, Dead-End Alleys [98]

Spread pedestrian alleys which vary in width between 1 to 2.5 meters, on the pattern looks like a tree across the city and was one of the logical solution, because all the

alleys start from the main gate and spread in all directions. All residents were moving in and out through the gate because it is the only port. The nature of the alleys irregular and sinuous as a result of the increased unplanned growth in the absence of any pre-defined plans. The scale of construction is based on the financial capacity of the person and not based on planning or any other consideration, so rich families were chosen large territory and poor families choose the small territory of course, to build their homes.

4.4.2 Features of Vernacular House in Erbil Region

Plans center of the houses in Erbil province is patios with restrictions in the form of land. If the interface is broadly the courtyard placed with the long axis in the middle (if rectangular) perpendicular to the alley. The plan is divided in such a case into two versions, the corridors are placed with several rooms on one of the sides. Another variation is to copy the plan to two houses are alike (twins), but with a single entry, which in turn is divided into two parts. Lanes will take the form of the character L. The upper story repeats with cities or the "Tarma. The party is using the wall to divide the two houses twin.



Figure 49 All Rooms Windows Overlooking to the Centered Courtyard [107]

Patios are usually planned to be rectangular, square or geometric shape. This figure represents a sharp contrast to the piece of land devoid of any angles and are irregular dramatic. This shows that the master mason "Usta", which represents the designer

himself, has put the shape and location and size of the yard before he arranges spatial organization. However, there can be no form of formal courtyard in a very small piece of land [39].

Majority the house contains two floors only. Basement beneath the courtyard is located at a distance 1 to 1.5 meters and can be accessed on a five steps away or little more from the yard. The lower floors usually have vaulted ceilings based on the thick brick sidewalks. Usually, ceilings on about 2.5-3 meters distance and be light and high and get the air out of several windows are facing the courtyard. Some rooms cannot access them only by the central distance or central room, but the rooms in general can be accessed directly through “Tarma”.



Figure 50 The Central Courtyard which has Lower Windows and Upper Windows to Let More Day Light [111]

This floor has a great importance and gives a great interest in terms of architectural paints and trims and roof panels, and is usually a flat surface. Medium houses have a balcony or patio with arcade arches or columns or “Tarma” overlooking the courtyard until the rooms on the upper floor. You can access to the balcony through the patio just a few steps and directly. The rooms main are located in the house behind the columns or lanes that are placed on the face or both sides of the courtyard. The direct access to these rooms through the balcony and are often planned with the longitudinal axis perpendicular to the balcony. In the case of the surrounding homes they have also windows overlooking the town below. Featuring most of the large and

medium-sized houses its proximity to the two floors, one being partially underground, and the other high ground in a few. The first floor is the main floor where contains the main rooms such as the living room, while the basement shall be to take a nap and store stuff. Internal section features many of the shelves and ports and adorn models often colorful and offers a smaller service such as bathrooms and kitchens, stores and toilets. Often placed on one aspect of the yard in order to be accessed directly. Thickness of the wall is often used for the expansion of these rooms whenever possible [49].



Figure 51 The Upper Floor Rooms with Wooden Columns (Colonnade, Tarma) and Surrounding the Lower Floor with Arcade [115]

4.4.3 Building Materials in Erbil Region

According to the necessity of environmental and cultural aspects design evolved accurate techniques have been developed to protect the population of temperatures and bad climatic factors. The homes courtyards have been opened were built using bricks. They used the joints of the timber for the purpose of roofing, as well as brick spire for the purpose of roofing sub-basements. Often the roof platform erected by wooden paneling and floral patterns, and paint using bright colors. In simple rooms and houses ceilings were left to expose tree trunks and matting.



Figure 52 Wooden Column with “Muqurnass”[123]

Corridors were built using piles of the stone and pillar stone and usually divided into three lanes or more. Corridors on the other hand, usually hail from wooden poles and ends elaborate “Muqarnased”. The walls of the sections in addition to the exterior walls are built using stones, as a result of the irregular shape of the stones, the linkage technique were not perfect. Sometimes it is disposed of different layers of stone without mortar, and to strengthen the structure was used lime or small pieces of stones. The wall thickness of about 50-70CM (1.6-2.29ft) and was dictated by the dimensions of the stone. Depends on the cutting technique and the type of stone that was used. The foundations of the outer wall are houses that have been built on the periphery of the hill to meet the challenges. So were employed retaining walls pointed to about 1.7 to 1.2 meters, but some of the houses belonging to families of the prominent social class had pillars flashing dull or semi-circular and were using the stands as well [41].



Figure 53 Brick Column with “Muqurnass” [71]

The wooden archways have been built using stone which was brought from Mosul and was sometimes covered with gray marble. On the other hand, had the corridors of the stands, columns were sometimes culminate in putting off the "Muqarnased" capitals do not differ from the rest of Baghdad or other parts of Iraq.

4.5 The Sustainability Measures Development in Vernacular City Planning of Iraq

The vernacular housing was integral part of the urban fabric of the Arab city, and there was not alone or a distinct stand tall, the rich and the poor housing where Contiguity within the unit neighbourhood without distinction a class or social in both determine how the housing unit or its processors, but the external difference was lying in inside which achieves the most important features of vernacular architecture, a unified appearance and differences Substance. Distinction between the rich and the poor housing achieved through different housing sizes and the number of spaces and courtyards, thus affecting the spatial diversity of the organization, which added some positives in environmental performance within the overall design of the urban fabric through the formation of different places in the pressure and dislocations air which helped Occurrence of natural air movement between parts of the urban fabric and within the housing between the multiple dwelling spaces. Equality between members of the community is one of the goals of social sustainability, which seeks to achieve

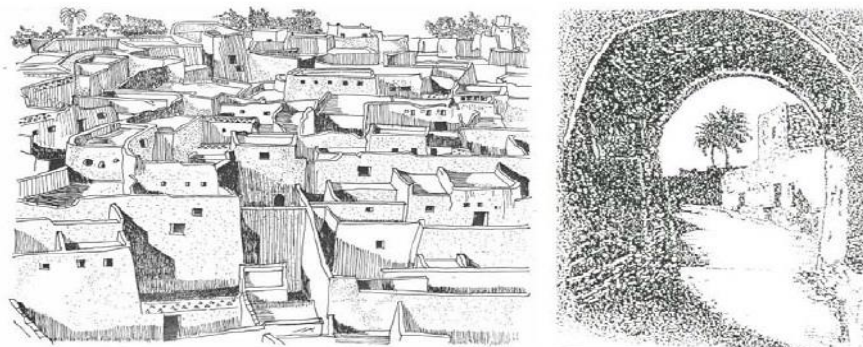


Figure 54 City Planning [4]

Justice and empowerment and social communication between members of society. Also, it is considered the concept of the neighborhood unit of the most important concepts that are based on the layout of the city and it was named after the Arab neighbor and the importance of the need for charity [4-32].

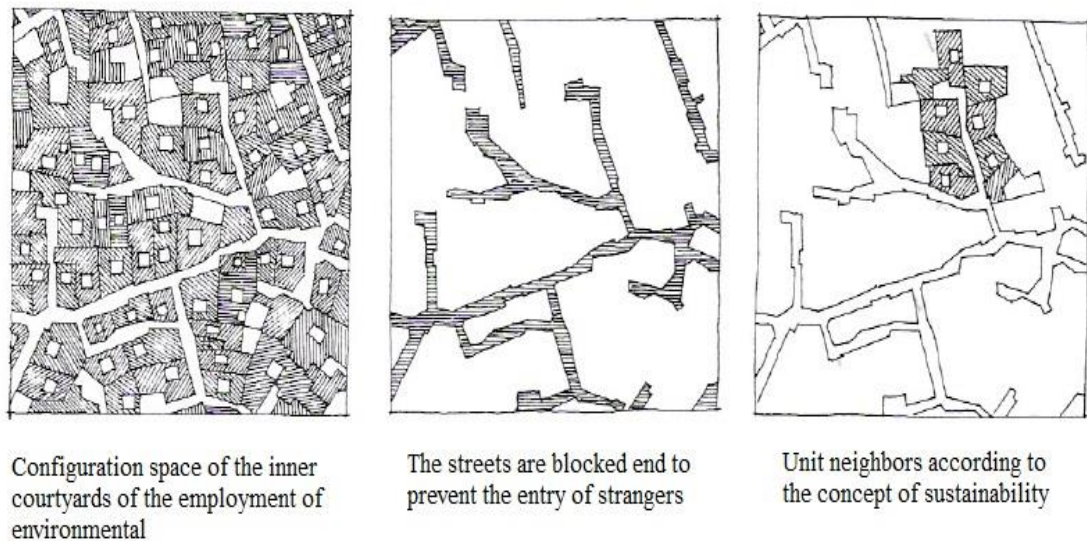


Figure 55 City Planning & Unit Neighbours [4]

4.6 Strategies of Vernacular Architecture for Challenging the Climate in Iraq by Depending On HCECR and Others

Compatibility with vernacular housing environment, with all the positives and its negatives, has been achieved according to two strategies: the protection and adaptation. Protection had been achieved by reducing the impact of cruel conditions of the natural environment, such as climate and few a warm relative humidity in some areas and rising in other regions and the intensity of solar radiation. The adaptation was exploiting the latent potential of these extreme conditions and deal with them In order to achieve thermal comfort of the occupants and the exploitation of natural energy sources like the sun and wind.

There are several basic principles that were based upon vernacular housing included the concept of sustainability, and which can be found with some modification and transgene and development indicators to be a function of the design of contemporary sustainable housing [47-58].

4.6.1 Planning and Dealing With the Site

Vernacular architecture has dealt with the site being a part of the urban fabric of the city as a whole, the urban fabric the city is compact organic building blocks of shops and residential which correlate with each other on the streets and trails Gradual movement in length and width depending on the importance and the region that lead to it and whether the degree of specificity Public places or residential units, adapt to the surrounding environment begins at the level of city planning and dependent degree of adaptation depending on the degree of privacy and the nature of the site and construction, adopted the vernacular architecture of housing to provide self-shade and through the juxtaposition of residential units, reducing the width of Motion paths, especially in residential shops and shadowed by protrusions or even build space or room extends above the alley or the path of movement of the first floor, either the middle courtyard was shadows provides on parts of it whether high walls or plants and trees that were grown in it [32-49].

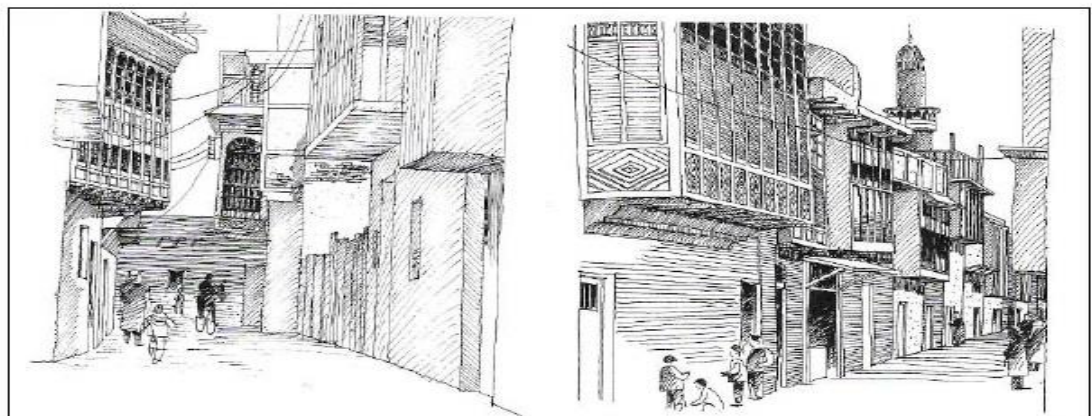


Figure 56 Planning and Dealing with Site of Baghdad [49]

In the nineteenth century, large areas of garden existed within the walls; this led to expansion of the walls, shrinkage of the city and the established traditions in favor of high density housing were all partly accountable for preserving these high densities. Urban houses in Baghdad were always built with two or more floors. Except for the large mansion, the majority were built on small uneven plots in an area ranged between 50-150 square m (538-1614 square ft.) [2-3].



Figure 57 Aerial Photograph of a Residential Area of Baghdad City [58]

4.6.2 The Form and Mass of Building

Building form affects the arrival of solar and wind energy as well as the value of heat gain and heat loss through the external casing. So the built-in building acquires less temperature through the day hours and heat loss in the night, the design of vernacular houses in Baghdad and Erbil as a central courtyard and all rooms open and overlooking it on it, with a square-shaped in the standard house mostly, For the purposes of welfare, or that a large number of family members so some houses had two central courtyard with interior corridors.

For housing facing each other across the yard and two long Ursi and windows facing the courtyard between them. Close the home from outside, most of the houses with high walls from the outside, the perimeter a strong high walls with the rooms and

spaces inside overlooking into the courtyard which access to sunlight on daylight hours and natural ventilation so we felt eye contact, as well as physical communications, while The mass Construction represented in the exterior walls, which made of mud or stone which Played an important role of insulating the building against the heat in the day hours and stored it in night and cold morning[4].

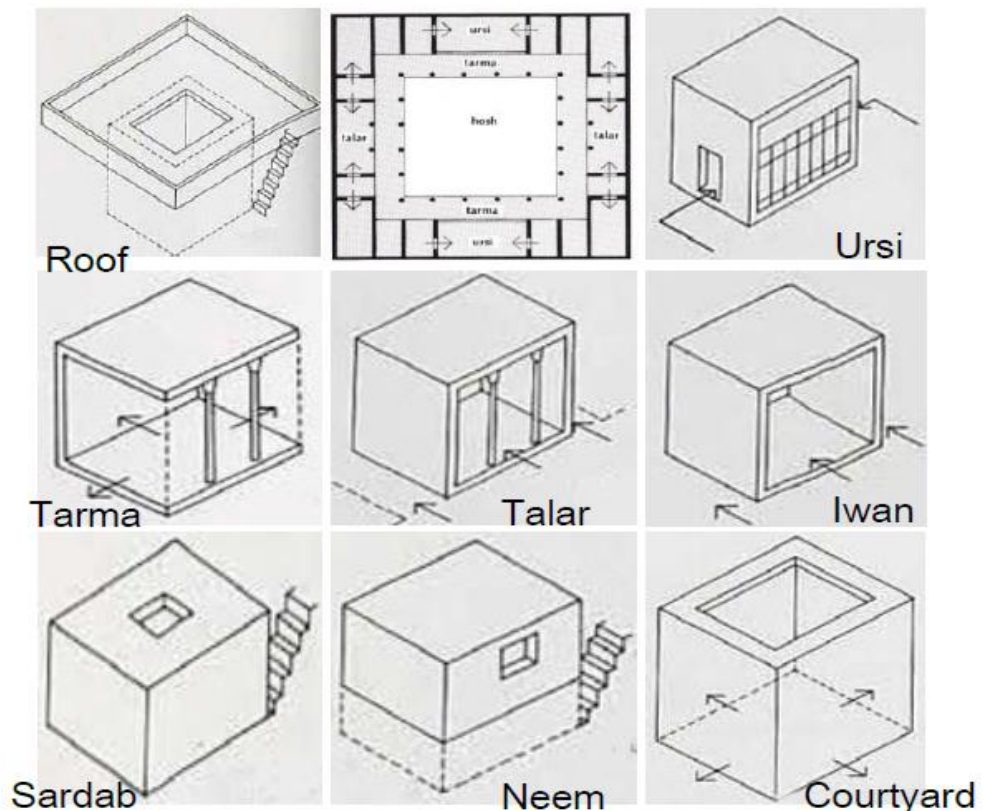


Figure 58 Typical Form of A Courtyard House [58]

4.6.3 The Orientation and the Direction

Orientation is a logical response to the climate, and is considered the sun is the main source as well as the wind plays an active role in shaping the climate map, and is considered the old layout of the city of Baghdad and the city of Erbil, a great example of the flexibility of orientation and accuracy of planning organic city and the distribution network of the housing and opening and closing and the gradient in Street View and axes directed movement toward home and use bows and South

interfaces to increase the comfort of occupants, especially in the summer and all the windows of winter rooms directed on Northern direction[2].

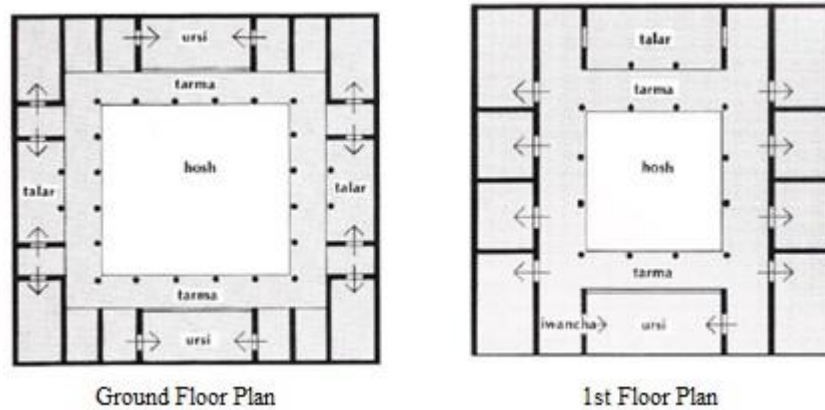


Figure 59 The Orientation Toward Inside the House [58]

4.6.4 Environmental Design and Energy Conservation (Passive Design)

It has been associated with the concept of environmental design exploiting energy or negative self-Passive Energy and reduce dependence on energy sources known for economic reasons and environmental and health and resorting to new energy sources and renewable. This is achieved through the exploitation of the components of the natural environment and geographical to get the necessary energy and provide a comfortable environment for the occupants with protection of the environment and preserve the natural characteristics. Vernacular Housing is an example of the environmental design In terms of Principle design and construction materials and treatments that have adopted environmental basis on the exploitation of natural energy sources and reach to provide a comfortable indoor environment, vernacular housing has responded with the surrounding environment, according to the concept of sustainability, achieved through a balanced interaction with natural resources like the sun, the wind, the topography of the site, building materials, aligned with the social values and habits and traditions community [38].

According to AL-Zubaidi [4]. Passive Design involves designing the form and fabric of buildings so that daylight and solar heat gains through windows / natural wind, which reduce the need for electric lighting, space heating and mechanical ventilation

and cooling. Passive solar buildings aim to maintain interior thermal comfort throughout the sun's daily and annual cycles whilst reducing the requirement for active heating and cooling systems. Specific attention is directed to the site and the location of the dwelling, the prevailing climate, design and construction, solar orientation, placement of glazing-and-shading elements, and incorporation of thermal mass.

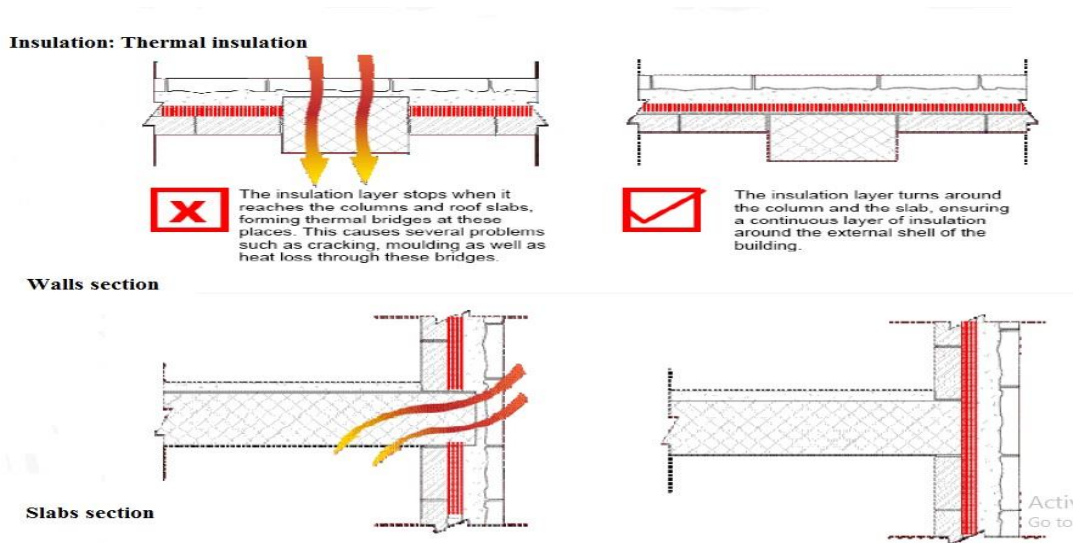


Figure 60 Passive Design [4]

4.6.5 Shading

There are elements affecting the amount of shading, such as the difference of sun angles between summer and winter, as it gets a high value on north or south of the equator, so shading is required against direct sun, especially from April to October while the best rooms which directed on south in November to March, we know all rooms opened and overlooked on courtyard so the shading is placed inside the house around the courtyard, the colonnade and arcade around the courtyard provides shading for the room windows around the courtyard[25-40].



Figure 61 Street Shading [109]

4.6.6 Water Bodies

The air temperature of the microclimate design influenced by water to cool a space via Moisture Thermal Transfer, while to warm a space, the dry air passes an old small droplet of water, get rid heat from the air and that led the air be cold, so we can see all the vernacular houses of Baghdad and Erbil had have fountains to moderate the air temperature in the courtyard and the surrounding space. The air cooling process gets through the heat absorbed by the water by evaporation [32].

4.6.7 Natural Ventilation in Vernacular Systems

Represent the most important natural ventilation strategies for vernacular housing to reduce the burden and thermal to get rid of heat stored in the crust of the building to provide a comfortable environment for the occupants, despite its small windows or lack of it on the ground floor at the front of the home overlooking the street or alley, vernacular architecture has developed innovative methods to get the natural ventilation, courtyard the middle is the lung and the main the breathing space for the house and who works as an organizer thermal benefiting from the high volatility of

temperatures between night and day, The Mlaagaf air (Al Badkir) is the most important means for catching the wind and entered the shelter spaces and configures the pressure area varying between Inside and outside air enters after purification and moisturizing and then take it out through the other openings, usually higher or through Mlaagaf pneumatic drawer in the center of courtyards, where at other times the opposite process, especially in hours of the night where the air moves through these openings and spaces through the shelter towards high Badkir - The provision of natural ventilation, either through openings or Mlaagaf air and to get rid of excess heat and provide fresh air in order to preserve the health of the inhabitants of the most important principles of sustainable vernacular housing. Epitomized the

The importance of the functions of natural ventilation for humans and the most important cooling the human body, because it increased the speed of the air rises the rate of heat transfer from the body to the surrounding environment, as well as increase the capacity of the evaporation of the air, and then increases the cooling influence caused by evaporation of sweat on the skin. Natural ventilation also helps to get rid of the moisture and cool the building, as it mixes with outside air inside the internal air it passes to the difference between the temperature of the environment of each heat between them in accordance with internal and external [5-16].

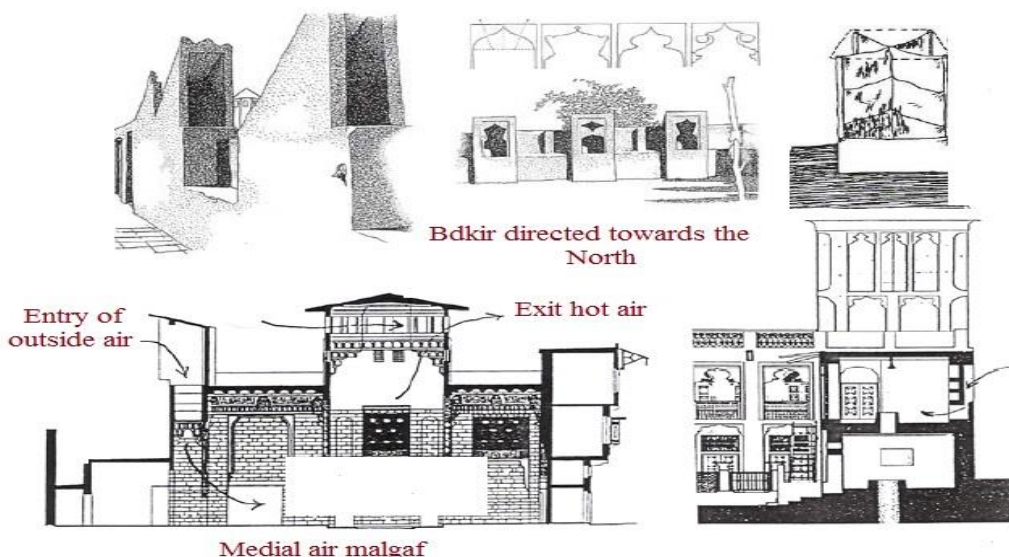


Figure 62 Natural Ventilation [102]

4.6.8 Daylight

Light: is this radiation that affects the eye and cause vision, the daylight is considered essential it the lightning of the vernacular housing Because of its good effects on the health and psychological aspects of the occupants compared to industrial lighting as well as the economic aspects. The courtyard is a major source of daylight in a vernacular house because of all rooms with their large windows overlooking on it, and these windows played to introduce the daylight and nice, refresh the air and aesthetic aspects [3-15].



Figure 63 Day Lighting Rooms which Overlooking the Courtyard Center [15].

4.6.9 Exploit the Potential of the Soil

It is one of the principles upon which sustainable design takes advantage of natural resources. The idea of construction under earth to minimize or determine the effect of external climatic conditions on interior spaces, and by advantage of the

possibilities for the storage of thermal mass of the soil, which is called HVAC (heating or cooling) the impact of the mass, the Construction underground entirely

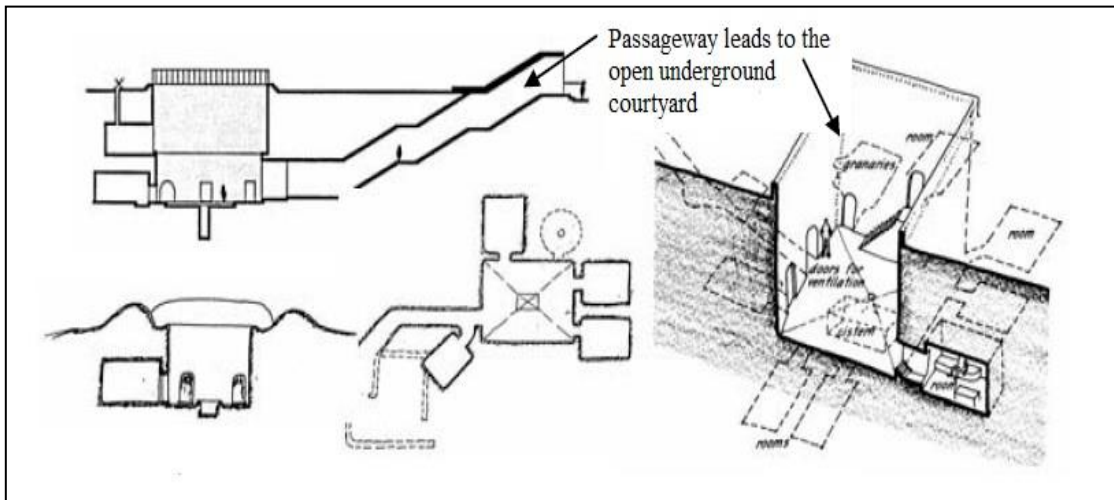


Figure 64 Exploit the Potential Of The Soil [45]

Depend on the quality of the soil and the water table on it, therefore, the use of vernacular basements spread in areas of high average for the General attributable. In areas where the water table is high in the soil reduces the use of basements such as the southern regions of Iraq, the advantage of the properties of the underground to reach the thermal comfort and cooling the interior spaces depending on the natural energies materialize in the space of the basement in the vernacular architecture, especially residential buildings in Iraq, and who have an entire floor or more underground with the survival of the rest of the spaces above the ground where construction is partially underground, the basement can also be more than the level of the beneath the surface of the earth depending on the climatic conditions and functional performance, and in which we find an example of him in vernacular housing in Iraq boasts the so-called "Neem Sardab" and is a half-crypt is located at a depth of (1.2 -1) m provider by vents which overlooks the middle courtyard from the above it becomes clear the efficiency of the thermal performance of the Sardab, especially in the afternoon hours where external air temperatures reaches to the ultimate limits by Ragette [45].

CHAPTER 5

ANALYSIS of ERBIL CITY

One of reasons to choose Erbil are, as well as to the beauty of it is nature and the nice climate, the history and the legacy of buildings of Erbil are dating back to the 6000 B.C, that means it is really a historical wealth is still standing until now.



Figure 65 Erbil Citadel [81]

The architecture in the old Erbil city passed through fast adaptations during its rating periods. These adaptations occurred because of political economic and cultural influences.

5.1 The History of Erbil City

Throughout the 6,000 years of civilization, cities, the architectural tradition of Erbil city has been classified by an architectural feature of building with nature.

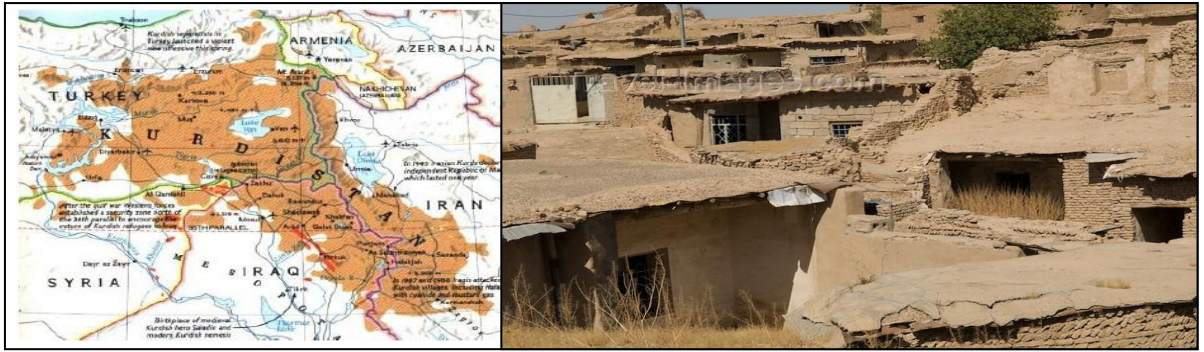


Figure 66 North of Iraq [96]

5.2 The Northern Iraq Vernacular Architecture

It contains of three categories, towns share, and village -gunned and nomadic depending on their location. Citadel of Erbil is an example of an old and unique architectural heritage of Northern Iraq Ancient Erbil city is located in the south of Kurdistan, 360 km at north of Baghdad- Iraq.



Figure 67 Erbil Citadel in1950 & in Present [78].

The Citadel Town of Erbil represents one of the oldest inhabited cities in the world. The Citadel played a big role in Erbil city history, it was the city for many centuries. The historical documents referred that the Citadel passed through three spatial changes, namely:

1- The citadel = the city.

2- The citadel = a large sector- of a city.

3- The citadel = a part of the city

Erbil city in the 12th century as strong and a large city had been built on top of a the hill, which contains houses, markets, and many mosques.

This area were divided into three residential buildings:

- The Saray in the east
- Top Khanah in the south
- Takiyyah in the north.

The rich people forming a ring and lived around the edge of the city while in the interior of this settlement the middle and poor social class quarter were lived there.



Figure 68 Erbil City Satellite Image [83]

5.3 Form of the City

A large complex of buildings with narrow streets, enclosed by the town walls.

All houses were contained of 1- 2 floors. And divided into:

- Small, medium and few large houses of the rich families.
- The streets were narrow (0.7-3 m) and irregular.
- The main streets were branched out of one major gate in the south.
- These streets again branched to smaller streets and dead-end streets as a tree form.



Figure 69 Erbil City Satellite Image [84]

The Different historical sources that refer to the period of time when the citadel was the city, but it is possible that it returns to the Ottomans authority since 1638. In addition to, the influence of the Ottoman civilization, The Erbil which is ballooned shape, according to historical sources, one of the oldest inhabited cities in the world

castle since continued to live there since built thousands of years ago (6000 BC), and passed a historic several stages, including the Sumerian, Akkadian, Babylonian, Assyrian, Median, Persian, Romanian and Sassanid, Ottoman and Islamic, in different periods.

We can see some of building and the houses which returned to these civilizations until now a day. The citadel was the fundamental heart of the city. The city structure, especially the ring road networks and cause of continued survival of the Erbil City.

Based on UNESCO's shortlist of possible new world heritage sites, the Erbil Citadel is "one of the most dramatic and visually exciting cultural sites not only in the Middle East but also in the world.

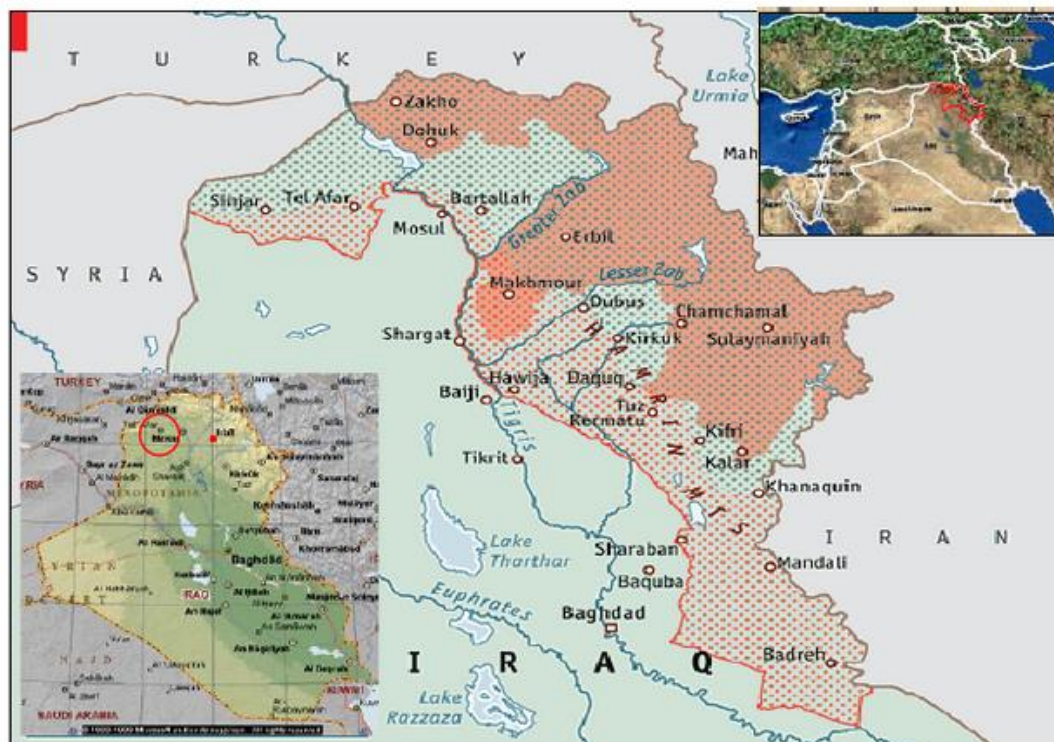


Figure 70 Maps of Erbil City, Iraq [99]

5.4 Erbil City Zones

Erbil City Divide in Four Zones by Depending On Hcecr as Follow:

First Zone: includes the area within 30 meter (from the Erbil citadel) width ring road in Erbil City.

Due to the planning patterns, of residential buildings in a social of homogenous environment.

Second Zone: includes the area between 60 meter (from the Erbil citadel) width ring road and the 60 meter width ring road.

The urban pattern of these districts is mostly a football pattern, which reflects the ideas of modernity in architecture.

Most of the housing units in these areas are affected by the colonization, which is done by the West, especially the UK and US, reflects a direct intervention of western powers in this zone.

Third zone: includes the area between the 60metersr (from the Erbil citadel) width ring road and the Pesh-Qazi ring road. The urban context of these districts contains typical housing blocks, which were constructed after 1980.

Forth zone: includes the areas constructed outside the Pesh-Qazi ring road. The new districts that were established after the process of Iraqi war in 2003.

Note:

In this thesis chapter, so I will concentrate on the first and second zones only because these two zones had the vernacular architecture of Erbil city.

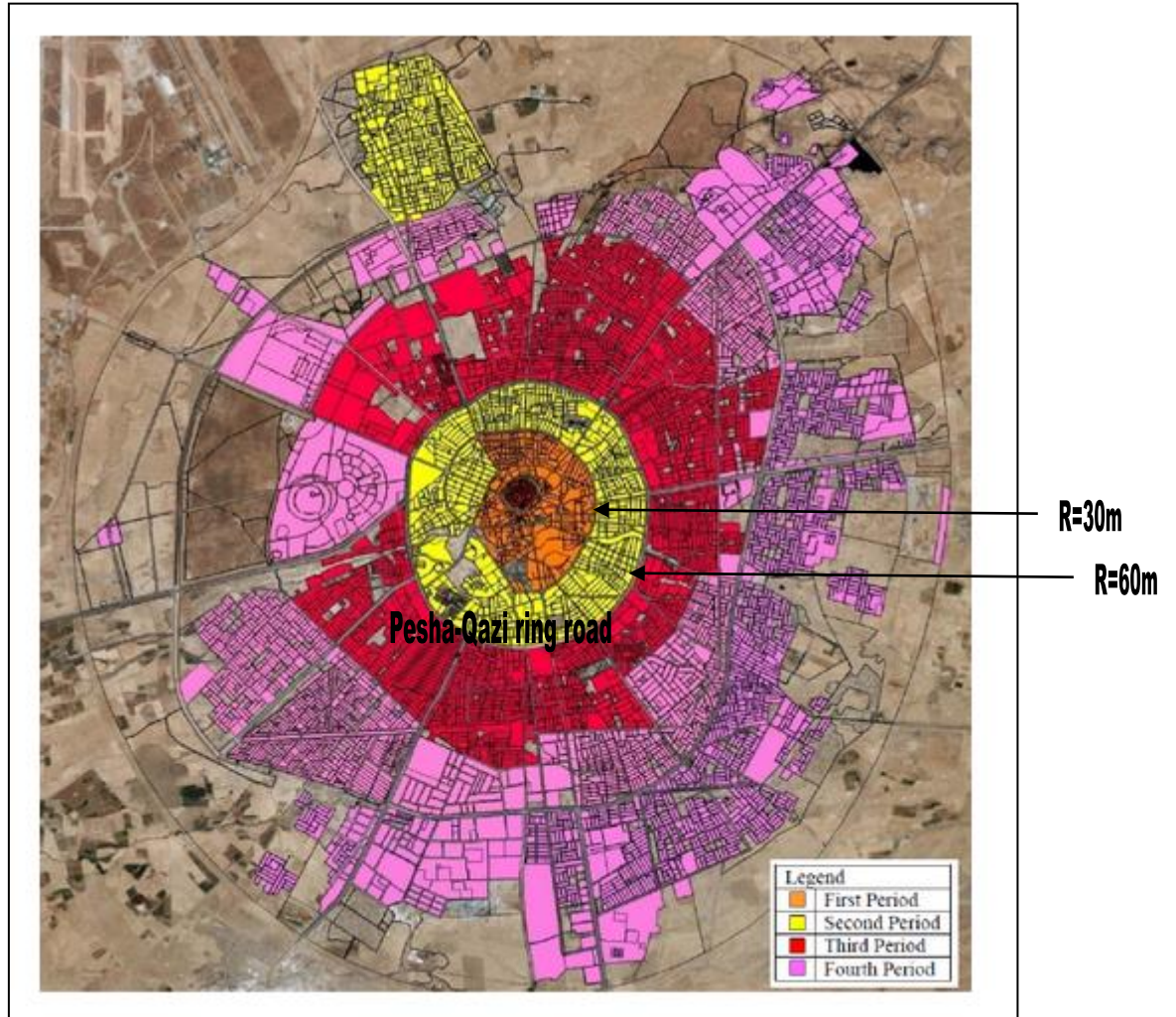


Figure 71 Evolution Periods of the Erbil City [85]

5.5 The Architectural Identity of Erbil City

The Erbil house façades is one of the remarkable changes in the visual scene.

Erbil city had been experienced through different periods by the influence of the political, economic and cultural changes. So that effect on the urban planning and architectural buildings and housing designs which led to form of city in the past and until now a day.



Figure 72 Erbil Citadel – Exterior Wall [77]



Figure 73 Street toward Erbil Citadel [110]



Figure 74 The New Gate of Erbil Citadel Build in 1980 After Demolishing the Old Gate [112]

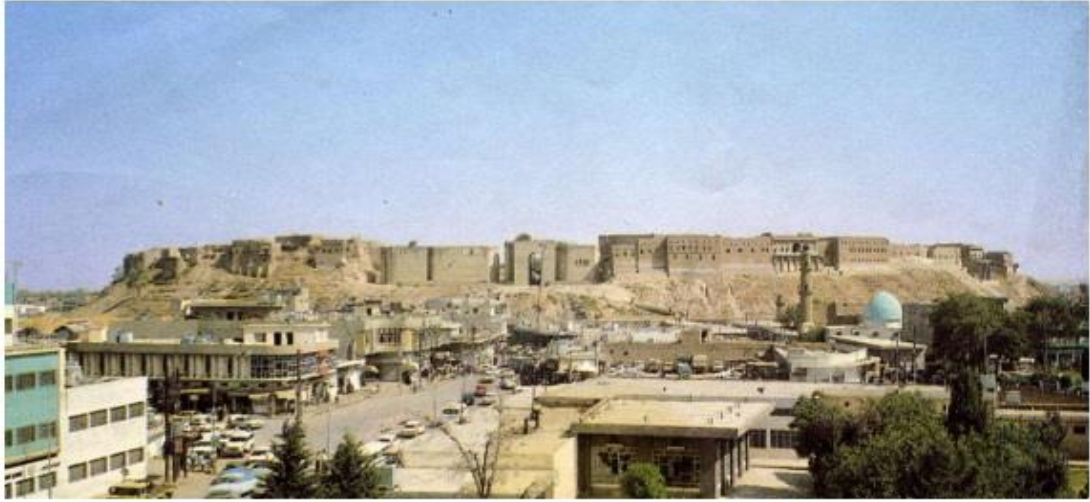


Figure 75 Commercial Area beside the Bazar During 1980's [73]



Figure 76 The Public Bath of Erbil Citadel (Hamam) [113]



Figure 77 External Erbil Citadel Wall with Windows and Balcony [86]

The external wall made by mud brick with a small windows and balcony.

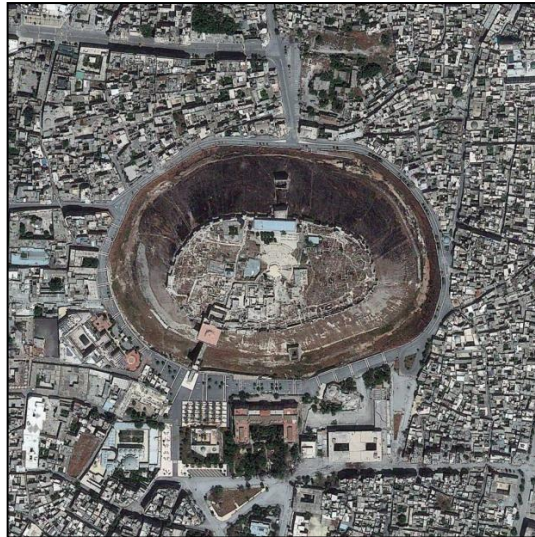


Figure 78 Erbil Citadel- Satellite Image [84]

The trends toward modernity and sharing of foreign architects' in Erbil city reconstruction programs are additional factors in its architectural style on the other hand as follows:

- A- Traditional Period before 1930
- B- Modification Period (Colonial Period) (1930-1980)
- C- Transitional Period (1980-2003)
- D- Advanced Modernity Period (after 2003)

The last two periods (C & D) are represented the modern Erbil city style, not an old one so we mentioned it only without describing any details about their buildings and cultures.

5.5.1 Traditional Period Before 1930:

Traditional ancient city of Erbil is one of the oldest continuously inhabited urban settlements in the world (From 6th BC – before 1930).



Figure 79 Erbil Citadel [81]

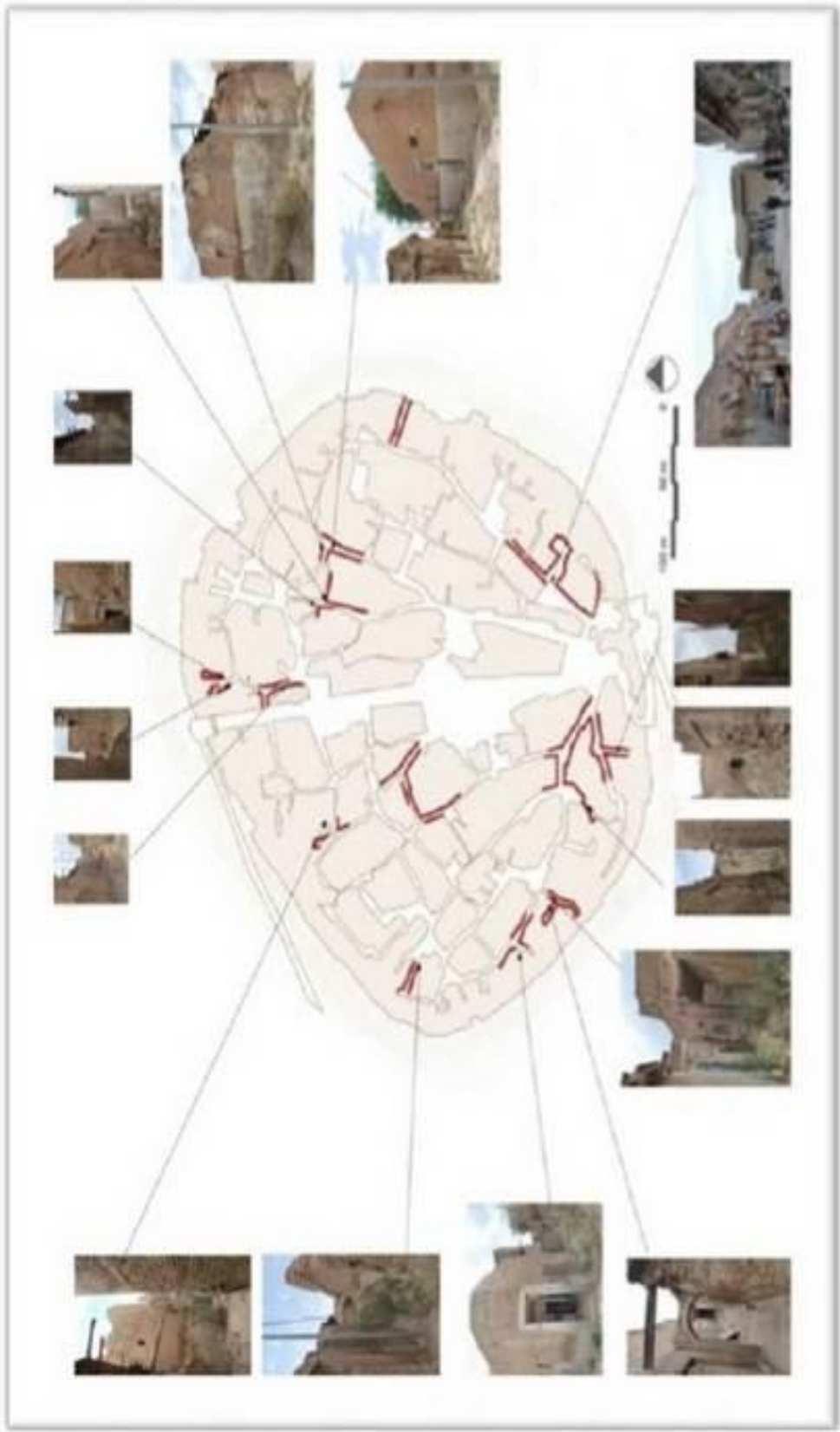


Figure 80 House Façades In Urban Fabric Alleyways [91]

The Features of Traditional Period (Before 1930) are:

- A huge complex of buildings and narrow streets enclosed by town walls
- The courtyard houses built of mud brick walls
- Short span, wood logs, roof sand, mud roofing
- The house façades had been Characterized as hardness and solidity
- One floor
- High thickness walls
- Small windows
- Mud bricks with clay mortar
- Flat roof

They offer the largest environment harmony within the street scene



Figure 81 Geometry of Mass- Inside and Outside Erbil Citadel City [88]

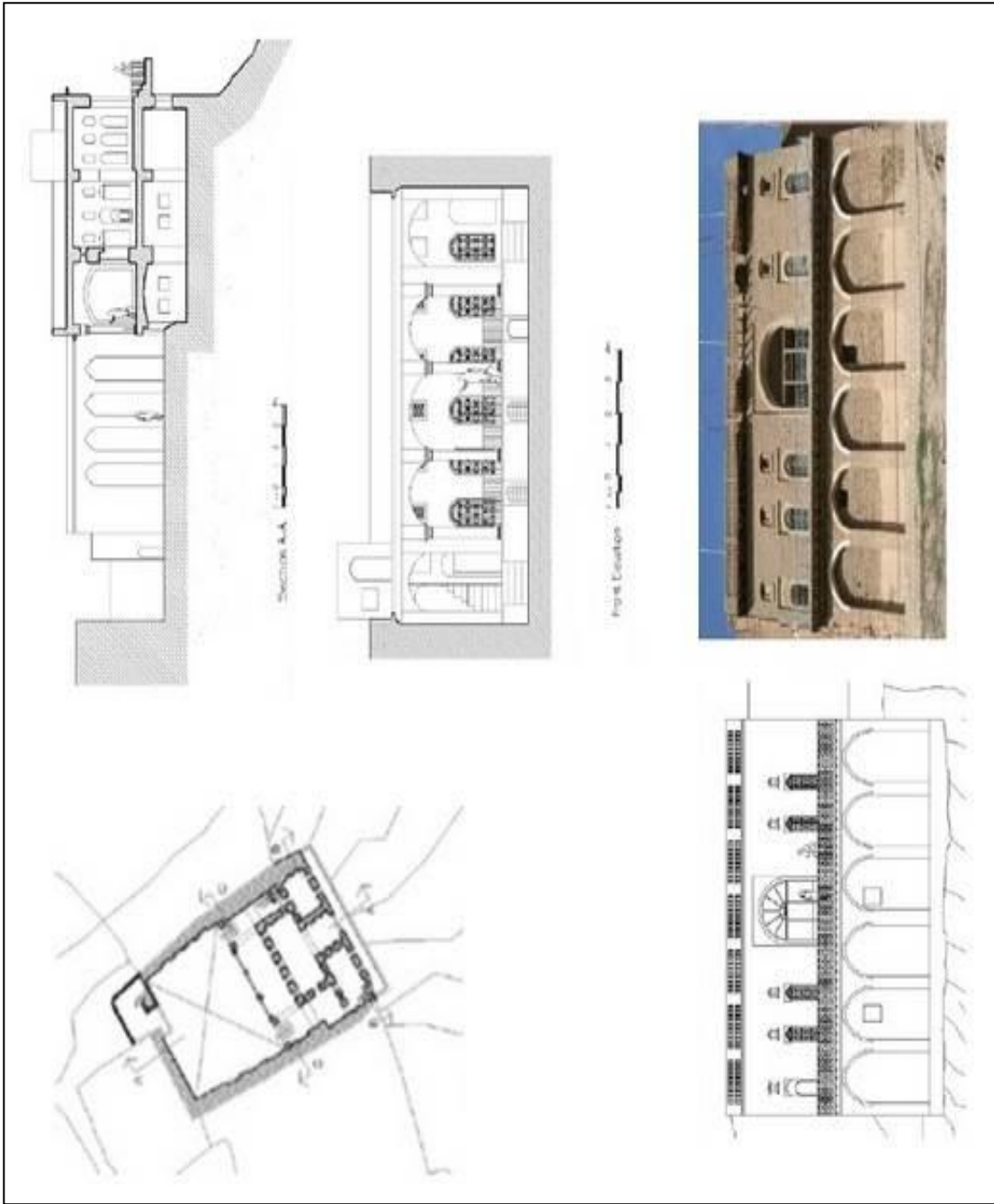


Figure 82 Rashid Agha, the Courtyard House- Plan and Section Inside Erbil Citadel. [104]

It was clear that the Citadel didn't reside by poor families only, or used by squatters. The Citadel had enclosed by houses and estates of the city's rich class, and this picture below seems a private house of a rich family, the house scope a very similar to Urfa houses at Iran from (18th - 19th century), which represents a fashion of a rich family house style at that time.



Figure 83 Rashid Agha. the Courtyard House Inside Erbil Citadel [104]



Figure 84 An Old Courtyard House within the Erbil Citadel

In upper picture, an example of a courtyard poor family houses is a common feature with a high walls represents the inward living of Islamic society.

The population of the citadel was coherent and a strongly conformist and conservative community and this cohesion came from the tribal associations and partly from blood relations and that will Reflect on their residential building and its alleys and streets



Figure 85 Residential Structures within the Citadel [106]

House walls properties

Mud brick walls, as thickness about (75 -90) cm & internal Siding material= mud



Figure 86 Another View of Old Residential Structures within the Erbil Citadel [67]

However, as it's seen, the small water channel is running on the street center (20 - 25) cm, which shows the old system is not working anymore.



Figure 87 Corridor within the Citadel's Maze of Residential Structures

Table 21 Architectural features of Erbil vernacular Houses on Traditional Period (Before 1930).

The Main		The Usage
The Form		Traditional Houses (before1930)
The mass shape		Neat geometrical shape
Building Cladding		Neat simple cladding, No additions
Façade shape		Flat roof with simple form
Orientation		The elevation's house Parallel with street lines
The building's location		The building locates with site lines
The Openings		
Window	Size	Small size ($X \leq 0.5$) m2
	Dimension	Within the mass
	shape	Rectangular shape with square vent slots
	Direction	Vertically of windows
Entran	Location	one side of front elevation
	privacy	Zigzag entrance within mass
External Additions		
Balcony		No
Materials		
Local materials		Mud Brick + wood logs
Roofing Materials		Reed+Mud plaster
Power & Height		
Rigidity		Solid block with small openings
Scale		Human scale

Developed by Ahmed B. Ayyash

5.5.2 Modification Period (Colonial Period) (1930-1980):

After Britain occupations during World War, a modern city was presented as a tool of colonization control:

- The houses are visible within the lower town
- A major departure from the traditional
- The expansions take a circular shape with focusing on the citadel, as a center of a city
- A large strength spans
- No pure brick vaults and arches
- Large external windows
- New paving tiles, doors, and plaster decorations
- Courtyard houses until it was totally disappeared in the 1950s
- New material as concrete block
- Reinforced concrete slabs
- Transparency Windows
- Paintings colors on house façades
- New style of house façades by connecting between modernity and traditions movement
- Simple forms with a large opening, which raised on a clear pedestal.
- Influence of modern movement in architecture



Figure 88 House in Modification Period- Erbil

Table 22 Architectural features of Erbil vernacular Houses on Modernity period (1930 – 1980).

The Main		The Usage
The Form		Modernity Period (1930-1980)
The mass shape		Neat geometrical shape
Building Cladding		Neat simple cladding with Prominent parts
Façade shape		Flat roof with simple form with base
Orientation		The elevation's house low & Parallel with street lines
The building's location		The building locates with site on different sides
The Openings		
Window	Size	Medium ($0.5 < X < 2.0$) m ²
	Dimension	Liner
	Shape	Rectangular shape
	Direction	Horizontal of windows
Entran	Location	In of front elevation
	Privacy	Entrance by Garden
External Additions		
		One in front elevation
Materials		
Local materials		Brick & Stone
Roofing Materials		Traditional arch-and reinforced concrete slab
Power & Height		
Rigidity		Solid block with medium openings
Scale		human scale with large span

Developed by Ahmed B. Ayyash

5.6 Vernacular Architecture and its Form in Erbil city

Vernacular architecture comprises the dwellings and other buildings of the people, Related to their environmental contexts and available resources they are customarily owned- or Community-built, utilizing traditional technologies. All forms of vernacular architecture are built to meet specific needs, accommodating the values, economies and ways of life of the cultures that produce them.”

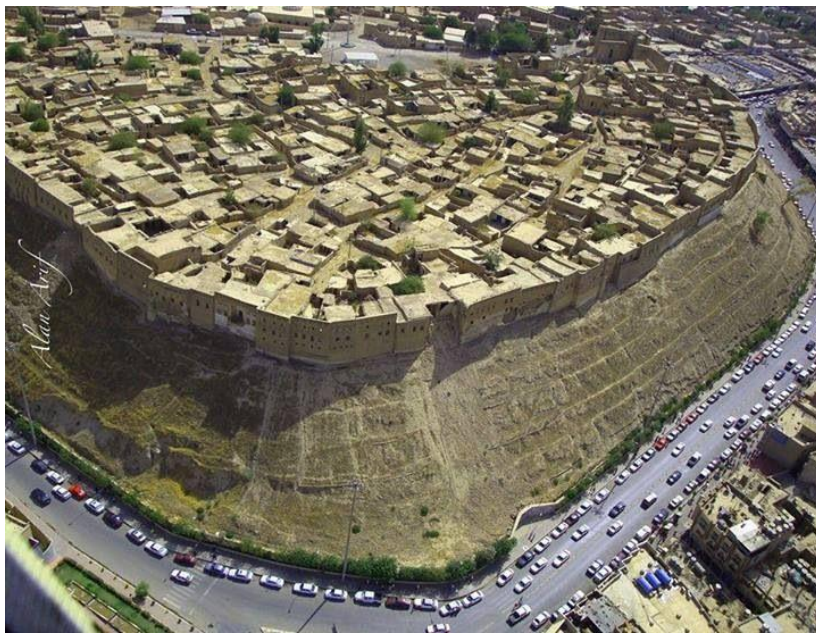


Figure 89 Geometry of Mass- Inside and Outside Erbil Citadel City
[89]

The Subject of Vernacular Architecture:

- The regional forms, materials and technology.
- Forms that reply to specific needs of human.
- Forms that reply to the values, economics, and way of life of a certain culture (people).
- Dwelling buildings as the major representation of vernacular architecture

5.6.1 Elevation Elements of Erbil Houses

In This study we depend on the architectural literature and on designing the house façades. Most of the studies that dealing with the issue of design guidelines for building façades focus that directly influences on a set of attribute the visual appearance.

The basis for both qualitative and quantitative analysis, which intend to be a model for evaluation of the framework

The Features of Erbil House Façades

- Form of the mass
- The Openings
- Shading elements
- Architectural Materials
- Additional characteristics

5.6.1.1 Form of the Mass

Building mass is one of the basic elements which plays as a part of identifying building by collecting all decisions that effect on the architectural form:

- Geometry of mass
- Exterior cladding
- An articulated façade kind (base, body, and roof)
- Orientation of mass
- The relationship of the foundation with the ground line
- Location's mass inside the land

5.6.1.2 The Openings

Openings, windows give a façade its unique, and their arrangements presenting identity to the area.

The Designing of openings elements, glass windows in particular that allow the light to the interior of a dark space and give a clear attribute visual to an elevation of the building and which in turn, helps the building to affecting the characteristics of the place.

The Windows



Figure 90 Types of Window in Erbil City [103]

- The size and the proportions of the windows.
- The shape of windows.
- The direction and orientation of the window.



Figure 91 Types of Window in Erbil Citadel [103]

The Entrances

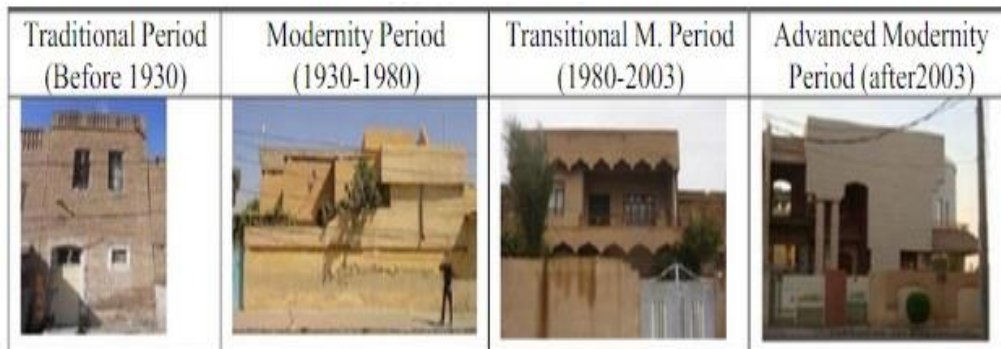


Figure 92 Types of Entrance in Erbil City [103]

- Entrance connect with the street line.
- The Entrance inside the mass.
- Accessible Entrance.

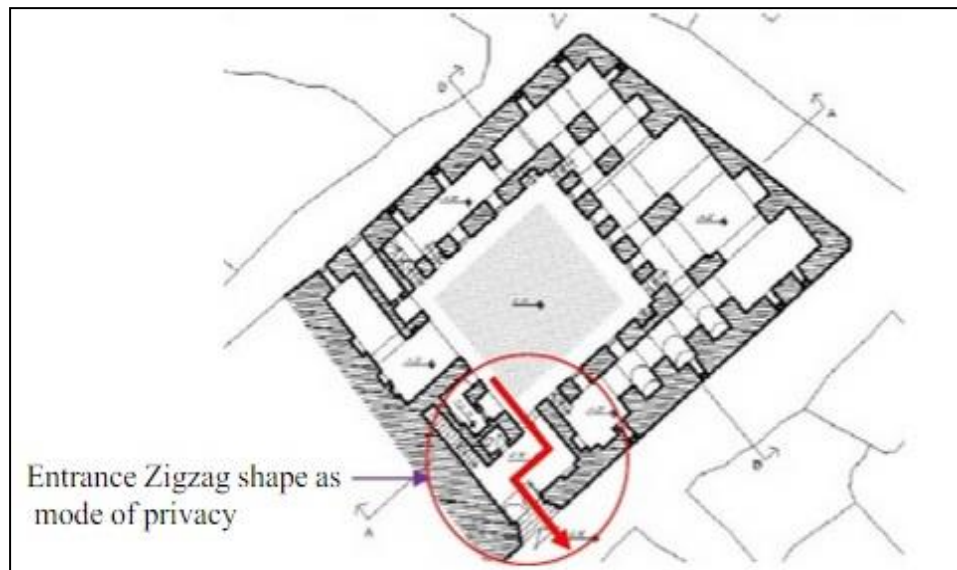


Figure 93 Entrance Indirect in a Traditional House-Inside Erbil Citadel City [45]

5.6.1.3 Shading Elements

Canopy.

Balcony.

Shanasheel (or Erhang).

Parapet (Sitara).

Patterns and ornaments.

Canopy



Figure 94 House Canopy in Erbil

Balcony

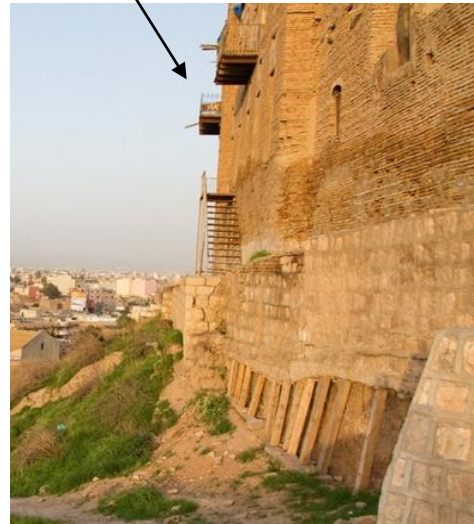


Figure 95 House Balcony in Erbil

Parapet



Figure 96 House Parapet in Erbil

Shanasheel



Figure 97 Shanasheel House in Erbil

5.6.1.4 Architectural Materials

The key visual parameters to realization of architectural façades. Which play a very significant role in identifying the building styles as an effective indicator of its identity:

- Construction Material.
- Cladding materials
- Termination materials



Figure 98 Brick- Basic Building Material in Traditional Period - Erbil City [70]



Figure 99 Traditional Roofing Materials- Erbil City [118]



Figure 100 Roofing at Indoor House- the Erbil Citadel [118]

5.6.1.5 Additional Characteristics

It refers to measure, discuss and related evaluation between the elements and check the rules that arrange the façade components into overall.

- Solidity.
- Complexity.
- Rhythm and Scale.
- Regularity.
- Integration.

Table 23 Comparison between Vernacular Courtyard Houses & Modern Houses of Erbil City - Architectural Elements
 In this table many evaluation points have been chosen depending on the planning and the proposal aspect are:

Attributes	Elements	The Vernacular Courtyard Houses	The Modern Houses	Evaluation	Proposal
Architectural Elements	The Plan	1- Houses in general have a central courtyard overlooking the House rooms, some of them have Shanasheel especially which oriented to alley way.	1- Houses in general have different types of arrangement rooms, no central courtyard and many of them overlooking to the garden at the front of the house or the back of the house.	No courtyard	Courtyard with automatic cover
	The Form	2- Simple geometry form With a cubic yard in middle, the 1st floor equal ground floor area - courtyard area.	2- Different shape and different details, no relationship in areas between the ground floor plan and the 1st floor plan.	Separated Masses of Houses	Configurable correlation
	The Section	3- The standard houses made up 2.5 - 3 floors (Ground floor, 1st floor and Neem Sardab floor). some houses had mezzanine (Takhta-Boosh) in the double height of Neem Sardab.	3- Most of houses consist of 2 floors (Ground and 1st floor) without Neem Sardab and mezzanine.		
	The Elevation	4- The standard houses had 1- external elevation which oriented toward the alleyway while the other 3 sides parts of the neighbors walls, some of houses had 2 external elevation when these locate at the junction of two alleyways.	4- No standard so most houses have 2-4 external elevations in the front and the back with both sides.		
	Arranging House Spaces	First floor Ursi = winter family living room Bed rooms = winter bed rooms Ground Floor Hawsh = Guest and family living room kitchen + Iwan	First floor All rooms - using air conditioning units	Need to air conditional means	solar system

Designed by Ahmed B. Ayyash

Attributes	Elements	The Vernacular Courtyard Houses	The Modern Houses	Evaluation	Proposal
Architectural Elements	Arranging house spaces	<p>Ground Floor Hawsh = Guest and family living room kitchen + Iwan</p> <p>subterranean level Summer rooms Sardab = summer family room Neem-Sardab = storage food room</p> <p>Roof floor Summer rooms Bed rooms using natural air</p>	<p>Ground Floor Hall = family living room Guest room = reception-dining room Bedroom's parents kitchen</p>		
	The Space Average	<p>An Area Of The House Small house = 50 - 70 m² Medium house = 100 - 150 m² Very large 300 - 400 m²</p>	<p>An Area Of The House Small house = 150 - 200 m² Medium house = 300 - 400 m² large 600 - 800 m²</p>	Lost in space	Control of the spaces with the number of people
	Number Of Family Members And Occupancy	<p>Number Of Family Members And Occupancy In general, there are more than one family in one house, small areas with high occupancy rate. Its contain courtyard with fountain and trees inside.</p>	<p>Number Of Family Members And Occupancy In general, there are one family in one house, large areas with low occupancy rate. Most house contain a front Garden with trees inside and some houses have front and back Garden.</p>	successful functional Building	Balance between the number of individuals and area, A family gathering space

Designed by Ahmed B. Ayyash

Table 24 Comparison between Vernacular Courtyard Houses & Modern Houses of Erbil City - Environmental Effect on Buildings

Attributes	Elements	The Vernacular Courtyard Houses	The Modern Houses	Evaluation	Proposal
Environment- AI Effect on Buildings	The Courtyard	1- Due to the courtyard in middle and all house spaces over looked on it with the 100% of coverage ratio, that led to one external elevation with 3 sides as a boundary and partly of neighbors walls, this resulted in the lowest exposure to the external environment and the solar radiation and the largest amount of shade for those homes.	1-Due to the detached houses with at least 2-3 elevation sides and the ratio of coverage reach to 50 -75 % and most of rooms overlooking outside with wide size windows so all this has led to Significant exposure to sunlight small amount of shadows	Loss of space and energy	Increased natural shading and the balance of the building space and ratio of coverage
	Exterior walls	2- Exterior walls especially ground floor's wall were made of thick mud brick (50 -70 cm) and they works as a heat insulation in the daytime and heat transfer delay and stored during the night.	2- Exterior walls although they are (24 cm) thickness and made of supported Bricks but not thermal insulation on a daytime nor retard heat transfer or storage in nighttime.	Environmental insulation problems	Change building technologies & materials
	The Windows	3- The exterior walls on the ground floor, do not contain windows or have windows but a very small size which it located in upper part while the exterior walls at the first floor included a large size windows (Shanasheel) for the living room and overlooking the alley way.	3- Big windows with a high numbers not only in the houses but in their house spaces	Loss of privacy and environmental insulation	Change materials, increase shading ratio

Designed by Ahmed B. Ayyash

Attributes	Elements	The Vernacular Courtyard Houses	The Modern Houses	Evaluation	Proposal
Environmental Effect on Buildings	The Cooling	4- The existence of courtyard led to cool and comfortable the house spaces especially in nighttime and continuously to daytime hours.	4- The garden instead of courtyard but it doesn't physical influence as the courtyard.	Aesthetic non-functional	The introduction of an internal open spaces
	The House Shape	5- Because of the cubic shaped house and hollow from the center(courtyard) makes surface area exposed to the sun is little in summer and winter rains	5. They take different forms and solid, does not have any central cavity therefore the surface areas exposed to climate change in a large proportion	Blocks irresistible time, the accumulation of environmental pressure	changing of Design, Building Technologies & materials
	The Soil	6- Advantage of the characteristics of the soil in the heating and cooling, especially in summer (Sardab and Neem Sardab) and thus these rooms cooled naturally and used as bed rooms after lunch in summer while the bedrooms which located in the first floor were benefit from low angle of sun led to heat the rooms in winter as well as external and internal walls are thick and heat-insulating	6- Reliance on a different types of industrial air-conditioning in summer and winter, not depending on the soil	increase the internal and external pollution & bills	Used as a means of natural cooling, environment-friendly and economical

Designed by Ahmed B. Ayyash

Attributes	Elements	The Vernacular Courtyard Houses	The Modern Houses	Evaluation	Proposal
Environment -Al Effect on Buildings	The Roof	7- Flat roof, as a result of the superposition of buildings with each other like one block, as well as the variation in elevations helped to exploit the roof surface to sleep at summer night.	7- Because the air pollution and separate houses from each other all that led to do not use roof surfaces to sleep.	Environment al pollution and cancer	Reliance on clean natural sources
	The Shade	8- External walls were shaded by the surrounding houses and mashrabiyya often been used inside the houses to isolate vision and to comfort the space add to let spaces more beautiful	8-Most of the walls and windows are not shaded but some designs makes it shaded but not a standard	Decrease age of the building, extra thermal burdens	Change in exterior houses design, use of natural energy sources
The Orientation	The geographical orientation	The first floor rooms oriented to the south direction such as Ursi and Tarma to heat gain of the direct sunlight and use these rooms in winter time, while the ground floor rooms oriented to north and west north direction such as Diwania (guest room) to speed up a cross-ventilation and convective cooling overnight.	There is no relationship between the orientation of windows rooms of all house floors and the geographical orientation so we can see all windows rooms overlooking to garden and outside because it depends on the industrial air conditioning.	Economic burdens as well as spaces uncomfortable throughout the year	Bio climatic houses cool summer and warm in winter naturally

Designed by Ahmed B. Ayyash

Attributes	Elements	The Vernacular Courtyard Houses	The Modern Houses
Building Materials	Exterior & Interior Materials	<p>1- Advantage of the characteristics of the soil in the heating and cooling, especially in summer (Sardab and Neem Sardab) and thus these rooms cooled naturally as well as external and internal walls are thick and heat-insulating.</p> <p>2- Exterior walls especially ground floor's wall were made of thick mud brick (50-70cm) and they works as a heat insulation in the daytime and heat transfer delay and stored during the night, while the exterior walls of first floor (Shanasheel) be of little thickness which speed up the heat gain in winter from sunlight.</p> <p>3- The roof terrace was thick and compound in the form of boarded ceiling, in addition to reed mats, timber broad, wooden beams and two earth layers.</p> <p>4- Usage the traditional porous brick (Farshi) to finishing the courtyard floor, this type of brick has features in moisture retention for long periods, therefore In summertime the courtyard floor is washed daily before mid-day and then sprinkled with water at intervals during the afternoon to increase the relative humidity of the air and reduces its high temperature.</p>	<p>1- There are no rooms located below the ground</p> <p>2- Exterior and interior walls for all floors are (24 cm) thickness and made of supported Bricks but not thermal insulation nor retard heat transfer, except the thickness walls (36 cm) of some houses.</p> <p>3- The roof terrace is built by reinforced concrete slab with a layer of asphalt, layer of soil and concrete tiles and this in turn increases the thermal burdens in the summer and winter</p> <p>4- Usage the concrete slabs for finishing the roof terrace which absorb very little water, they reduces very slight amount of the roof surface temperature by evaporating.</p>

Non-local building materials, So expensive, not environmentally and audio isolation, unhealthy indoor environment, large bills and maintenance costs, reduce the age of the building, the loss of historical identity all that led to a sick building.

Solution: is by depending on the strategies of vernacular architecture and their building materials

CHAPTER 6

Conclusive Suggestions for Future Private Houses in Baghdad and Erbil Region

In this thesis, we had found many objectives such as the benefit behind the design of houses depending on the climate is to reduce the uncomfortable weather conditions that have been created by the drought and high temperatures, as well as night and day like there is a need for cooling, there is also a need for negative heating during cold nights in the winter.

The construction of the house requires prevention of various climatic conditions such as a heavy radiation coming from the sun as well as the prevention of other conditions such as sandstorms, dust and insects. In addition, the spread of dust should be prevented and provide proper ventilation, shade and control of buildings and settlements. With the world's economic and population growth crisis continues, the increasing of an energy crisis and environmental problems in a modern building especially the houses.

The technological changes have a significant impact on the urban forms in general and housing in particular. Such as Vehicle entry into the settlements has also drastically altered the vernacular urban pattern of hot arid regions.

The new wide streets reduce the shading possibility. In addition, the great amount of heat discharging air conditioners and large paved surfaces have contributed to changes in the microclimate of urban situations, hence, problems emerged.

So the great challenge of this growing is to balance its rapid residential building programs with The mechanism of protecting its environment and energy conservation by the using of long-term energy-efficient strategies that have a sustainable ethos and all of that represents the vernacular architecture strategies.

In this paper I took the Iraqi vernacular architecture strategies by concentrating on Baghdad city in general and Erbil city in particular, and how the possibility of its application in modern building.

6.1 The Alley and the Street Patterns

The urban forms of a city are not only a result of physical and functional, social and cultural factors and traditions in a region with taking into account solar radiation and wind:

- East to west Axis

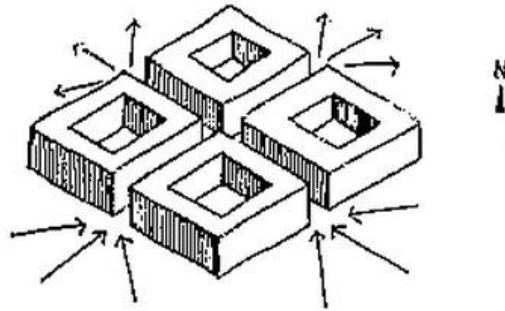


Figure 101 Alley and Street Direction.

- Tortuous and Narrow Alleys

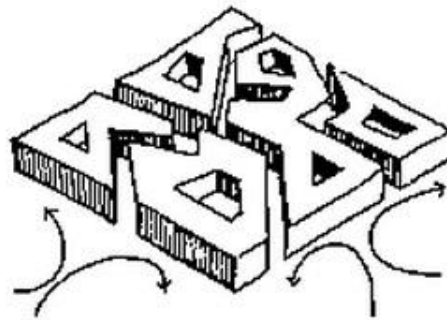


Figure 102 Alley and Street Shape.

Blocked Endings

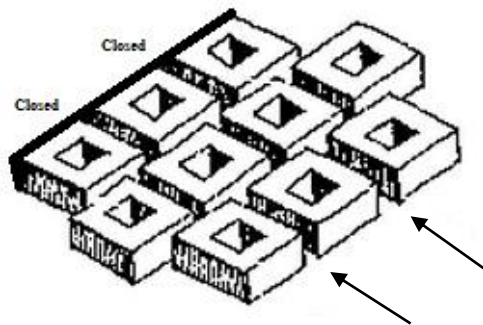


Figure 103 Alley and Street Endings.

6.2 Exterior Spaces

The town structure and the public spaces must resist heat sun and wind with a shaded and dense layout through design of trees.

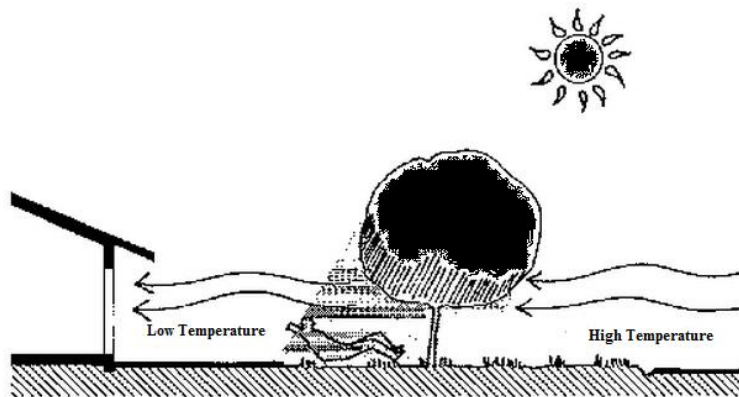


Figure 104 The Effect of Trees on Temperature.

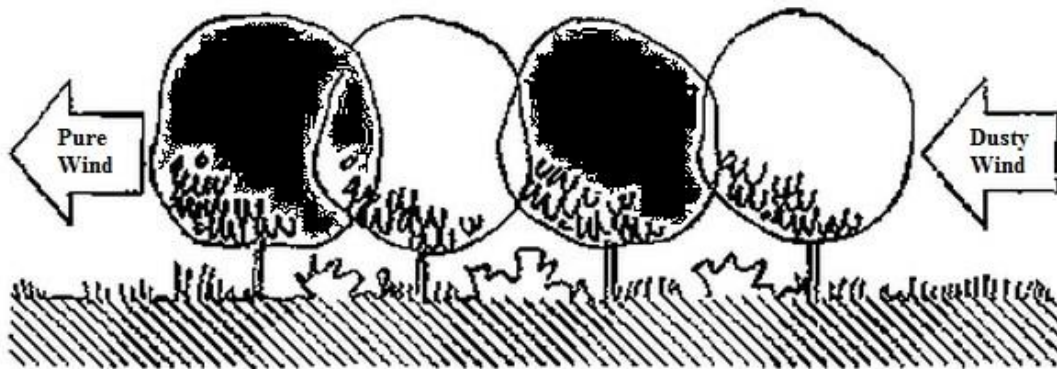


Figure 105 The Effect of Trees on Wind.

6.3 Buildings Orientation

Site and the proper orientation of the building help to protect against the wind and warm sun radiation and controls the air flow.

6.3.1 Sun Orientation: The best orientation of the houses is north-south with 25° south easterly direction. Should pay attention to the emitted heat from the surrounding areas such as slopes, terrain and rocks and the worst direction of the building is to the west because of the high temperature of the air with strong sunlight alone.

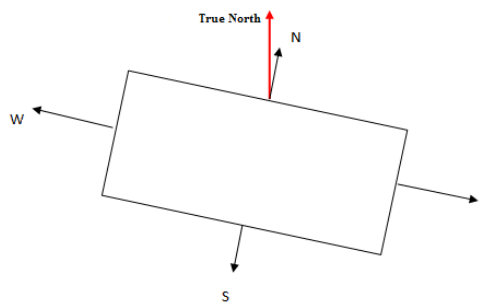


Figure 106 Best Direction.

6.3.2 Wind Orientation: Locations are preferred where the effect of cool airflow can be utilized and controlled. Settlements have to be properly oriented regarding prevailing winds.

6.3.3 Shape and the Volume: The shape and volume of buildings must be compact, which elongated along the east-west axis to provide shading.

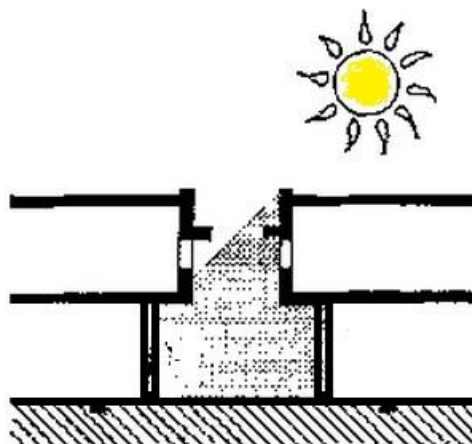


Figure 107 Shading of Buildings.

6.4 The Courtyard

From my point of view, it is difficult to meet all the different function and climatic requirements, but the courtyard had achieved those requirements through time. This minimizes the solar radiation impact on the outside walls and provides a cool area within the building. It also meets other requirements such as safety, defence, privacy, lifestyle etc.

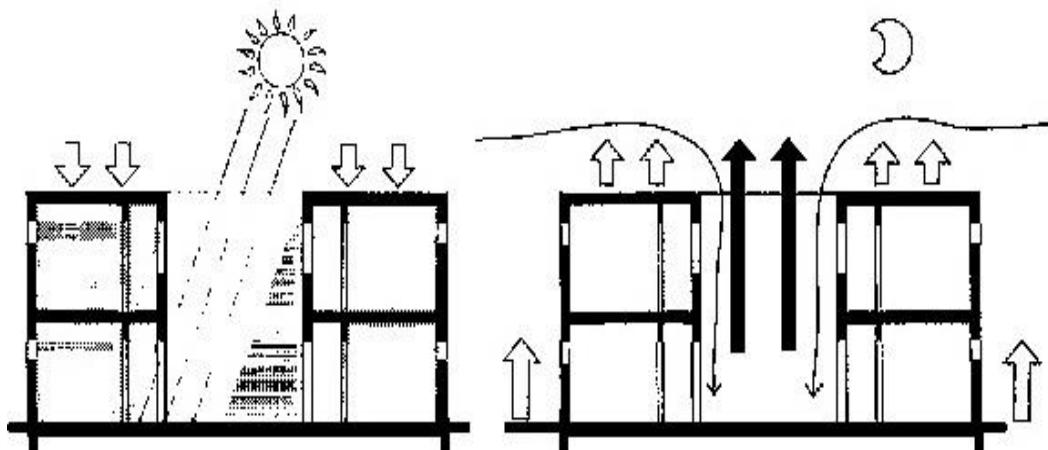


Figure 108 The Effect of The Courtyard.

6.5 Underground Buildings

Underground dwellings have been known for thousands of years. At a depth of about 2.5 m, the temperature of the earth is practically constant and remains close to the average yearly temperature. Which is not affected by hot days and cold nights, such as Sardab and Neem Sardab.

6.6 Building materials

Comfort people rely heavily on the type and building materials of the ceiling inside the house and internal and external walls as well as the thermal characteristics. Depending on the desired qualities of thermal storage as well as on the construction components of buffer such as Mud Brick, Mud plaster, Rees and wood logs.

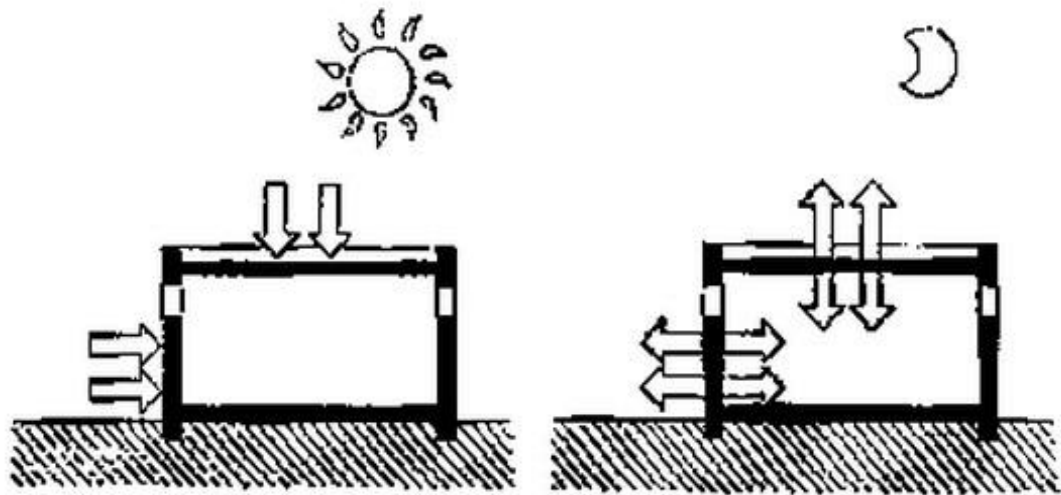


Figure 109 The Effect of Building Materials on Heat Flow.

6.7 Openings And Windows

Openings and windows are necessary for natural lighting and ventilation, Do not favors the openings on the west side. The heat gain in summer should be minimal. During the daytime, hence, larger openings should be closed during the day with insulated shutters and opened at night.

The absence of openings would be desirable, especially on the west side.

Appropriate natural lighting is important. The direct natural lighting can be avoided by the use of internally reflected light.

6.8 Natural Ventilation

The future ideas about the natural ventilations:

- Wind catchers

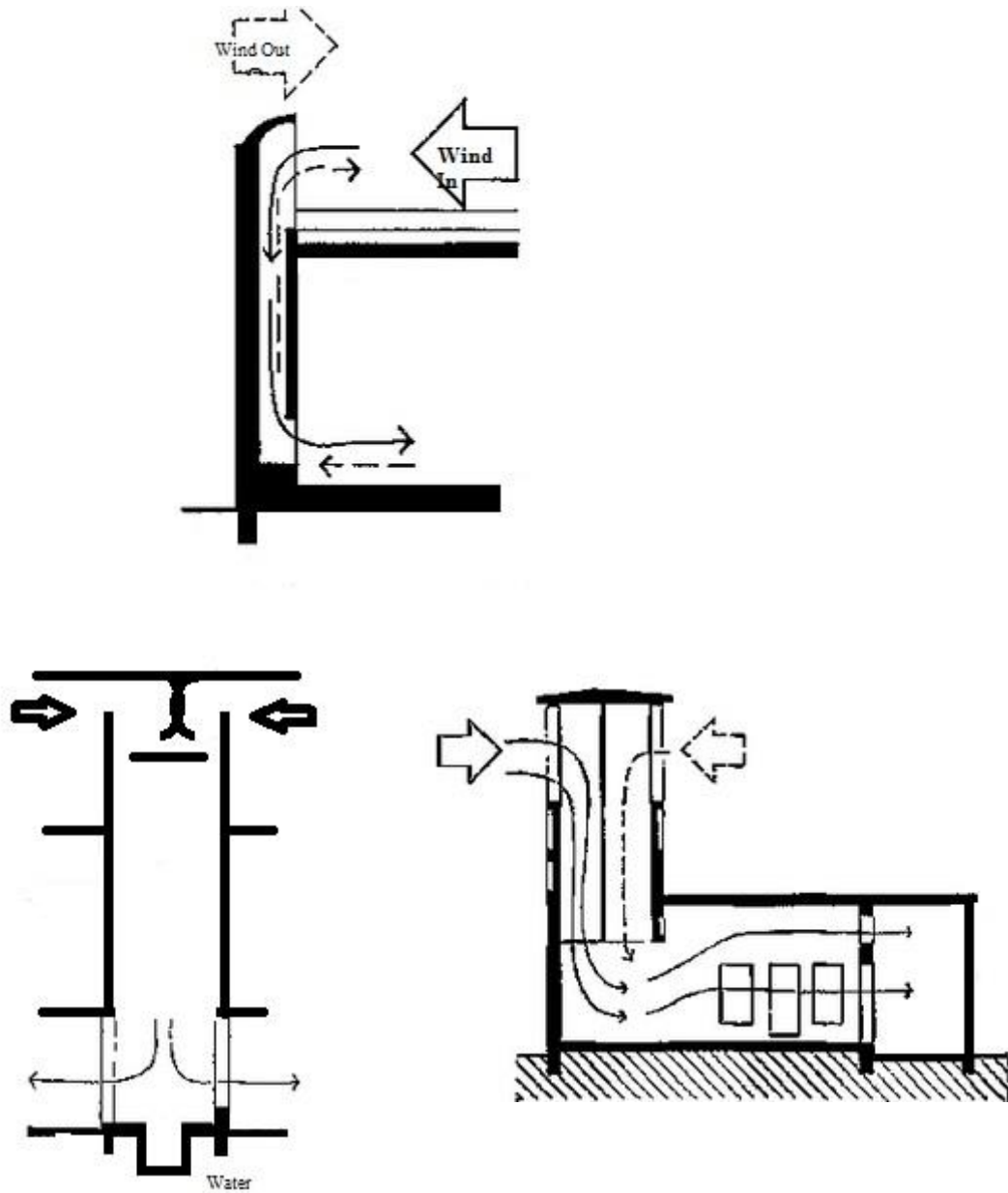


Figure 110 The Windcatchers.

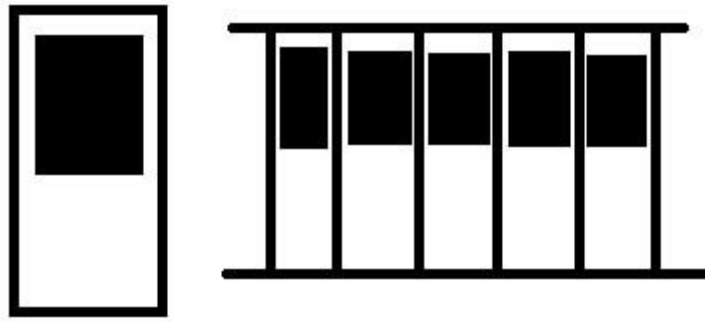


Figure 111 Location Problem of Modern House Block in An Area.

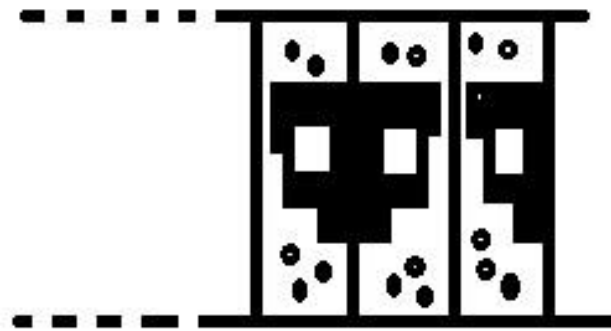


Figure 112 Update Location of House Block in An Area.

All in all, the success of the vernacular houses and the failure of the modern buildings of the economic, health and environmental aspects although with the sustainability and keep the success. In addition, for many years each element in the vernacular houses was presenting a solution for the particular problem depending on the principle of trial and error. While the modern buildings are the full quote from a cold western environment and applied in a hot environment despite to the social traditions and the different culture, which lead to losing the historical identity and the appearing of building problems. So the solution is present by applying the strategies of the vernacular houses in the modern buildings in sophisticated style and practical look.

CHAPTER 7

CONCLUSION

This thesis was a source of inspiration through the ethics of the first nations, supervisions and sustainable philosophies to earth and respect for the land. To understand how these ideologies have formed their architecture, it has expanded out to extract the key strategies from the first nation's architecture and apply them to a current model of contemporary architecture. Through articulating the function and the identity of each element of the building, which represents the key for understanding the vernacular architecture. The most craft characteristics of the vernacular architecture come from the collection of the elements that had been tested by people's traditions and culture. There is no doubt; the outstanding of the architectural quality of the vernacular architecture and the pros effect from their images does not only come from its dependence upon recognized prototypes and intentional plans, but also from their interesting exteriors. These houses keep on the cohesion and the unit between occupied construction, landscape and space. So the aesthetic of the vernacular architecture comes from the Combination of putting the architectural elements all together as well as the juxtaposing between them providing the variety and the visual interest through the change in their size and their range.

Although, the domes, the vaults, the bearing walls, the mashrabiyya, the malqaf and the courtyard all of them together created a recognized language in vernacular architecture and their designs based on finding the solutions for the cultural needs, religious and requirements that people are asking for, such as the arrangements for the spaces that are around the inner courtyard . There is no doubt that the quality of the outstanding of the vernacular architecture was derived not from stylistic elements, but from the superiority of their basic features, their comparative arrangement and their basic ideas. Despite the difficulty of testing between two different levels of data, where the first group is the elements of LEED, BREEAM.. etc. which are specific details by

features modern technology, while the second one is a sustainability in vernacular architecture which represent via a concept and applications the ancient vernacular architecture achieved sustainability through the principle of trial and error and referred to in a large number books, sources and this study has proven that vernacular architecture has dealt with all issues of sustainability in inclusive and hit the ground running and the possibility of their application in modern residential buildings which suffer from economic, environmental and health problems.

Future Work

The objective of this research was to find radical solutions for the problems that the modern buildings had faced in generally and the houses in particularly, from the economic, environmental, and health aspects, which had reflected negatively on the citizen and the livelihood and wellbeing. All these problems had found the solutions for all of them since a long time, according to fact that the vernacular buildings are still standing from thousands of years ago until now, despite the changes of the climate, and passing the years on them, through solid strategies that is based on the principle of trial and right, with the respect for the environment in human scale, and provide a comfortable indoor environment away from the vagaries of climate. Many additional questions has raised that is required to be achieved in the future by inserting strategies of the vernacular architecture (like ventilation and natural cooling system) as an essential requirement in residential buildings and modern houses. Thus, we get naturally air-conditioned in buildings without any need for industrial cooling; this will reduced heating bills and cooling from 30-50% to reduce 100 % in the future. Do additional researches in the sustainability and vernacular buildings field, that is providing for the interior decoration engineers more knowledge, which might be helpful for them for finding more solutions to the energy and the environment problems to design modern buildings that is energy-consuming and environmental friendly.

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APPENDICES A

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