

THE INHERENT SUSTAINABILITY OF TRADITIONAL ARCHITECTURE IN THE CITADEL OF ERBIL: WITH REFERENCE TO RESIDENTIAL BUILDINGS IN ERBIL CITY

Roza Saber Maarof

Department of Architecture, College of Engineering, Salahaddin
University

Erbil 44002, IRAQ

e-mail: roza.maarof@su.edu.krd

Abstract

This paper is supported to analyse sustainability inherent in traditional architecture in the Citadel of Erbil through developing Sustainability Assessment Method (SAM) suitable to the natural environment and social values in the region. The Problem of this research is the need to form a set of guidelines for planning policies and design decisions for contemporary architecture, especially residential buildings with regard to the potential of sustainability evident in traditional architecture in the Citadel of Erbil. This paper aims to evaluate the sustainability inherent of traditional architecture in the Citadel of Erbil city, with particular reference to residential buildings in Erbil city. To achieve the aim, this paper is related in developing Sustainability Environmental Assessment Method (SEAM) and Sustainability Social Assessment Method (SSAM) suitable for Erbil city through analysing existing sustainability assessment methods. The methodology that used in this paper is the Comparative Analysis (CA) for six houses, three traditional and three contemporary, in Erbil city using descriptive, qualitative and spatial analysis for these case studies. Two of these case studies were chosen, one each from the traditional and contemporary categories, to be tested in the experimental part of this study. The two chosen case studies were assessed using the proposed SEAM and SSAM to investigate environmental and social sustainability performance of traditional and contemporary houses and to test suitability of the prospective SEAM and SSAM. This paper are divided into three parts.

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Key Words and Phrases: Traditional architecture, sustainability, SEAM, SSAM, Erbil Citadel, comparative analysis

1. Introduction

Environmental awareness and contemplation have grown in importance worldwide. Most nations in the world, including Iraqi Kurdistan, have experienced rapid economic growth in recent decades,

which has coincided with a noticeable rise in population. This has caused the existing urban center to grow and expand, as well as the emergence of new complexes and urban centers. Along with the hybrid samples that resulted from the use of some traditional architectural forms, Erbil City, like any other city in the world, experienced a noticeable urban growth that was embodied in the large increase of residential programs to provide the growing residential needs. This led to the appearance of new urban areas in the Western samples. Man had to rely on passive energy and natural resources like the sun, wind, and soil in the past when the building envelope was the primary tool used to protect himself from a harsh climate. Using natural energy sources in our buildings for economic, health, and environmental reasons is known as passive energy [1]. The roots of sustainable design are combined with traditional building, which serves as a living example of how well-suited it is to the local environment. Since the family spends the majority of their time in the house, this article aims to discover the sustainability possibilities inherent in one style of traditional design. In Erbil City's hot and dry atmosphere, the family's home served as their green space. Using sustainable methods and natural resources, the house was adapted to this harsh environment.

2. Research Objectives

- To explore and understand the meaning of the term "sustainability".
- To analyse traditional and contemporary housing in terms of plan, form, building materials, construction, environmental performance, and in particular social sustainability.
- To assess the sustainability inherent of traditional and contemporary housing.
- To formulate guidelines found in the above exploration and analysis for use in contemporary housing design for the region.

3. Literature Review

Examining sustainability in both traditional and modern architecture, as well as its significance and worth to upcoming architectural trends, is the aim of the research literature review. The best chance of creating a modern regionalism that is both feasible and consistently of good quality, able to accommodate a wide variety of building forms, both new and old, is through traditional architecture. Over centuries of constant development, the heritage's inherent richness diversified the potential diversity. (Abel, 2000. P. 171) [2]. Frank Lloyd Wright who described traditional architecture as (Oliver, 2003, P.13): "Folk buildings growing in response to actual needs, fitted into environment by people who knew no better than to fit them to it with native feeling. Wright expressed the opinion that traditional architecture was superior to self-conscious academic attempts to use a historical style in generating architecture". Le Corbusier considered traditional

architecture ideal in compromising social and physical needs by describing traditional architecture: “having attained perfection in serving human needs and harmonizing with the environment”[3]. The traditional architecture contains many values of how people lived in this area and translates their requirements in a unique character. Therefore, these lessons should be studied, handled, preserved, and enhanced in modern planning policies and building practice(Bukhash, 2001, P.35)[4]. Accordingly, to Khalid Asfour (1998A, P. 60) [5] an architect and academic, believes that we may learn a lot from the past where the natural world was the guiding design principle in the Arabian Peninsula. Examples survive of comfortable living environments answering human, social, cultural and climatic needs. In many ways traditional societies have been the true leaders of sustainable development over time. Klinker (2004, P.6, 7) [6] emphasis that traditional architecture has the essence of sustainability to be the link to more environment-respected buildings: ” in seeking sustainable solutions to growth that ensure our society’s continued survival, we must respect the natural laws of environmental balance. A reconsideration of traditional architecture can provide a vital link to the future development of viable ecological building solutions to fit a range of urban and rural needs. Accessing the current knowledge of traditional builders is a key component in that link”. Eman Assad (2006) [7] identified seven aspects as sustainability principals in traditional architecture: respect of site and local environment, respect the inhabitant’s way of living, local building materials, building materials with less embodied energy, energy conservation, creation of long-life buildings, recycling, and desert plantation. Erbil City's modern architecture is typically disregarded in research and analysis because it lacks mental credibility and is only understood in terms of its negative aspects, such as image copying, a lack of attention, excited movement, and little thought. Beyond accelerating steps of modernity versus traditional architecture lies what, Khalid Asfour (1998A, P.52)[5], called 'the dark side of the equation', attacking the way in which 'cutting and pasting' has been used in the UAE as well as in the Arab world - imposing Western building types without considering their impact on the local culture and environment. He also believed that 'direct copying of the past is as absurd as copying from the West'. Relying on imported building styles in the Erbil city and the Arab World may be referred to lack of trust in the traditional methods as they are symbols of poverty and retardation.

4. The Concept of Sustainability

Although the term "sustainable" has evolved over time, some of its most recent connotations are influenced by the current political, economic, social, and psychological landscape, which makes it especially susceptible to date (Steele, 1997, P.ix)[8]. A consensus

definition of sustainability does not exist. (Beatley, 1995, P.339) [9]. As a result, sustainability is defined according to the specific applications. Although there are different definitions of sustainability, they all agree on one important point: no matter how we utilize the environment and its resources, we should protect the ability of future generations to do the same. (Harrison, Wheeler & Whitehead, 2004, P.1) [10]. In any case, the idea of sustainability was developed to integrate ongoing expansion and human development with concern for the planet's welfare. However, as a conceptual framework, sustainable development entails figuring out how to integrate social, economic, and environmental objectives. All facets of society—government, business, communities, and individuals—will need to take action. (Best Practice Energy Efficiency, 2005, P.6) [11]. Sustainability incorporates a number of human life-related challenges (see Fig. 1).



Fig.1: Concept diagram of sustainable development source <http://institute.truman.edu/ses/>

The term "sustainability" is more general and encompasses development's social, economic, and environmental aspects. Resource efficiency, energy efficiency, site conservation, environment conservation, indoor air quality, water treatment, and waste management are some areas that can be used to frame environmental sustainability dimensions. Maintaining a stable environment that consistently and reliably supplies resources while carefully balancing human development activities is necessary to achieve environmental sustainability. (Melnick; McNeely; Navarro; Schmidt-Traub, & Sears, 2005, P.1) [12]. Although the social dimensions of sustainability are mostly associated with people, the "quality of Life" that maintains the society's "Cultural Identity" while meeting the bodily and mental demands of its members [1]. Growth, development, productivity, and a reduction in the input of resources (materials and energy) are more closely associated with economic sustainability.

Population growth and industrialization pose threats to social and economic sustainability. Quantifying intangibles and common property resources (air, waterways, oceans, etc.) requires a shift in economics. It is necessary to internalize environmental and social costs through new legislation and methods of appraisal. [13].

5. Sustainability and Architecture

Sustainable "architecture" is inherent. In order to accomplish this, the design problems ought to be linked to the resources of the ambient environment. In more detail, the underlying impact of social, political, and economic issues—including the cultural and spiritual context in which the goal of sustainability itself represents such a profound shift in values—must be addressed. Concern for the environment and nature have grown in importance globally in recent years. Creating the best possible relationships between people and their surroundings is the primary objective of sustainable architecture. It seeks to identify architectural solutions that provide human well-being and harmonious coexistence with the built environment and the natural environment. (Kim & Rigdon, 1998A, P.8) [14].

6. Sustainability in Traditional Architecture

Traditional communities and lifestyles demonstrated sustainability. Since the ambient environment was the source of life, they mostly lived by the principle of "sustainability" in their daily lives rather than adopting it as a way of life. They constructed, farmed, ate, and lived sustainably. Their survival on Earth included interacting with the local environment and making use of natural resources. According to Hassan Fethy, the Sheikh of Arab architects, architecture is a natural byproduct of the society in which it was created. He says, "Traditional architecture is engaged with extinction due to the connotation that it is part of the old way of life" (Fethy, 1973, P.35) [15]. Accordingly, society that lives sustainably, builds sustainably. Site, location, terrain, and climate influenced Arab traditional architecture, as did religion, traditions, conventions, and cultural background. In his sustainable course, architecture professor Hotten (2003) [16] suggests six historical concepts for sustainable homes. Siting, design, shade, ventilation, earth shelter, thermal inertia, and air lock entrances. He appreciates traditional, vernacular, and cultural values and believes sustainable design can limit building scale.

7. Principles of Traditional Architecture

The following characteristics of traditional architecture are based on the sustainability notion and are realistic.

7.1. Compact Urban Planning

In order to minimize the thermal load on the building envelopes, particularly the houses (see Fig. 2,3), and to protect against extreme temperatures and sand storms, the urban fabric of traditional Erbil is compact, with buildings integrated into a single complex structure that makes it difficult to distinguish individual houses. The cellular layout of a group of courtyard homes indicates that humans are coexisting peacefully with the natural world. (Macintosh, 1973, P. 7) [17].



Fig. 2: Erbil City& Its Citadel Aerial View [18]

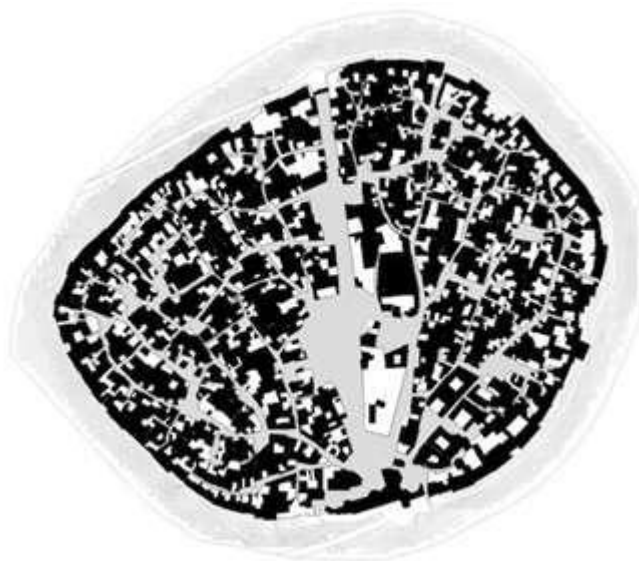
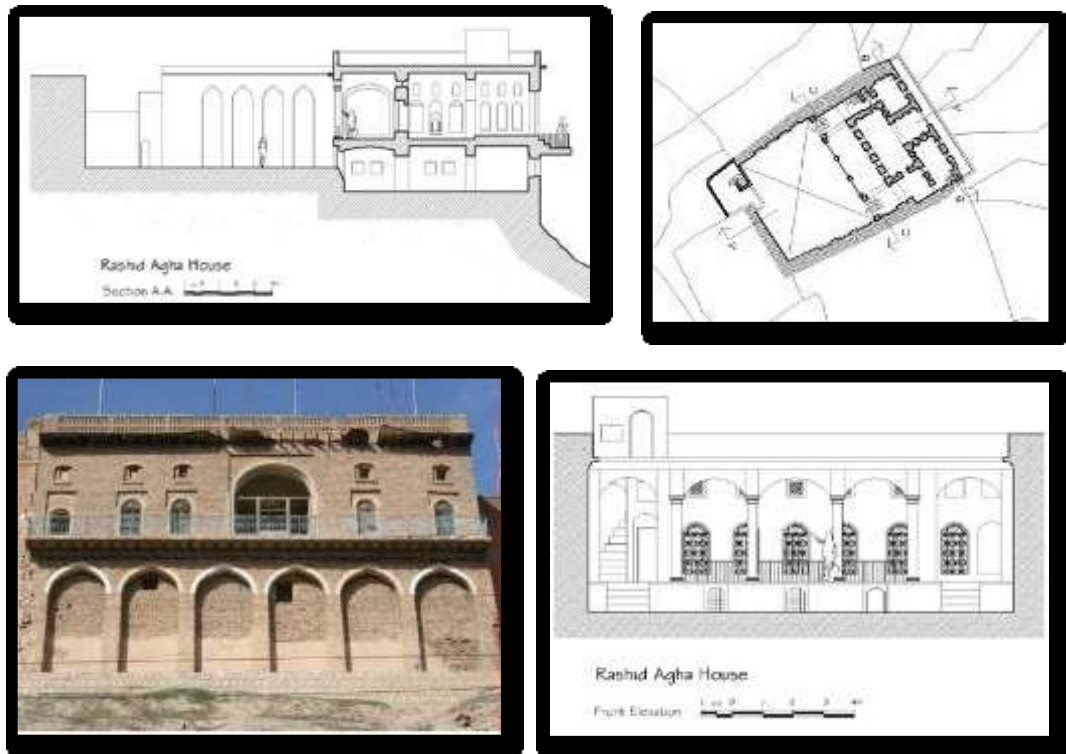


Fig.3: Compact urban fabric in a traditional city in Erbil citadel source [18].

7.2. Site Planning

Minimizing the interior daytime temperature and creating covered outdoor living space are the main goals when choosing a building orientation for a hot and dry environment like Erbil, which is home to the majority of Arab nations. In order to protect themselves from the dust carried by the wind, the building and their continuous outdoor living areas are angled defensively. The majority of the plots were irregular in traditional cities because the urban fabric was organic (see Fig.4).

Figure 4: Documentation of Rashid Agha House inside Erbil Citadel



Source: Conservation Master Plan-Erbil City, 2009 [19].

7.3. Design Conception

Traditional house design concept is according to attaining two strategies: privacy and protection. The architectural elements, spatial relationships, and house arrangement were all impacted by these two tactics. All of the apartments opened into a central internal courtyard that was only available to family members. The courtyard offered privacy and shade in an open area, as well as a suitable climatic and social solution. (Bagnid, 1989, P. 45) [20]. Most of daily facilities were located at the courtyard. The courtyard represents a constant feature of domestic architecture in most of the Islamic World: it was however, developed in different ways as influenced by existing local traditions, construction materials and environmental factors (Sibley, 2006, P.49) [21]. According to environmental regulations, courtyards should be maintained modest and shaded by towering walls, broad eaves, and vegetation in order to prevent exposure to the sun (Macintosh, 1973, P.8) [17].

In the afternoon, the shadows cast by nearby buildings provide further protection for the street, courtyard, and building. The ambient temperature drops quickly when the sun sets in hot, dry regions because the courtyard starts to radiate quickly into the clear night sky.

The cycle is completed when cool air starts to drop into the courtyard (Moore, 1993, P.51) [22]; see Fig. 5.

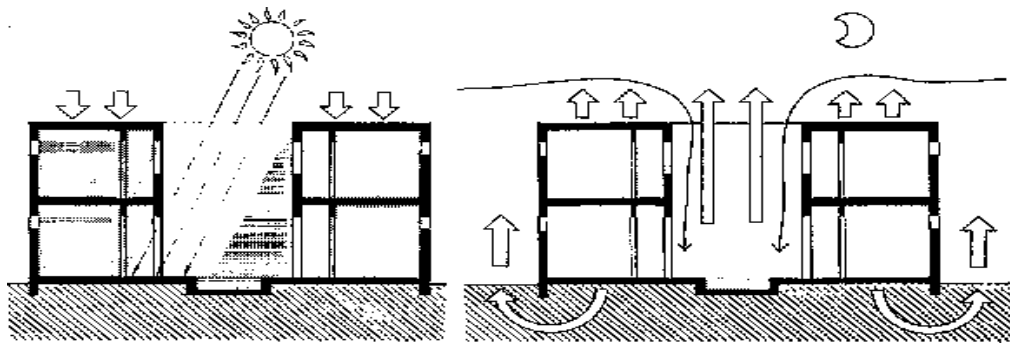


Fig.5: Thermal performance of the courtyard in a traditional house source [23]

7.4. Building Envelope and Materials

A typical home's construction envelope effectively protects it from the harshest weather conditions. In order to provide cool conditions inside and counterbalance excessive solar gain, the home envelope's primary purpose is to prevent heat transfer, reflect as much of the sun's rays as possible, and reduce heat and solar gain (Giovani, 1998, P.120) [24]. Because they are typically natural, traditional building materials including wood, brick, stone, and palm trunks have minimal levels of toxicity and embodied energy (Kim & Rigdon, 1998b, P. 13) [14]. Brick and stone, two traditional building materials, were enormous. When employed as thick walls with few external openings, they performed well as thermal insulators.

7.5. Natural Ventilation

One of the passive cooling techniques used in traditional construction to achieve a comfortable indoor climate through evaporative cooling was natural ventilation. Conventional homes are orientated to face the direction of the predominant wind. Blank facades are designed to provide enough winter sunshine into the living areas while protecting the outside living areas from the hot winds. The primary natural ventilation elements in the home are wind towers, also known as badgers, Mashrabiya, and Rowshna. A supplementary natural ventilation system is created for the house by the courtyard and air pullers (see Fig. 6).





7.6. Thermal Mass Effect

is one of the sustainable passive energy techniques that have long been employed in Arab nations, particularly at the Citadel of Erbil, to adapt to the hard environment. Thermal mass-effect cooling means utilizing mass thermal storage of earth to absorb heat during the warmest part of a periodic temperature cycle and release it later during a cooler part (Golany, 1983, P.53)[25]. It can be accomplished by: dampening out interior daily temperature swings, delaying daily temperature extremes, ventilating "flushing" the building at night and earth contact to achieve seasonal storage (Moore, 1993, P.209) [22] see Fig.7.

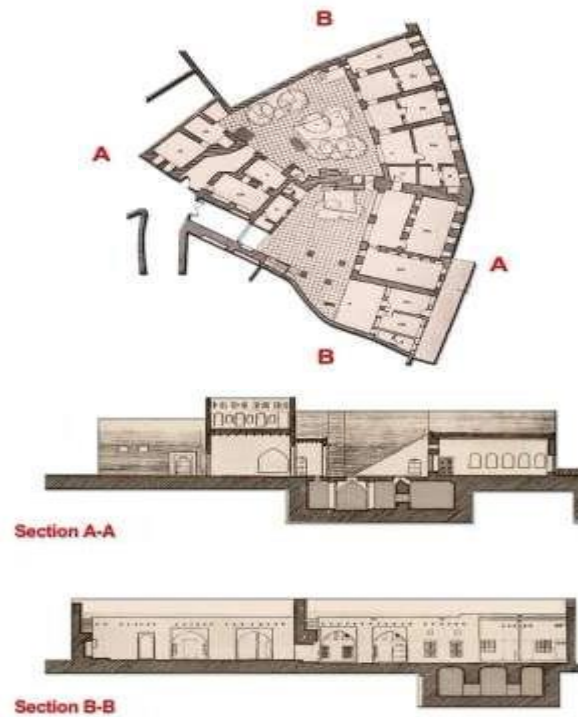


Fig.7: (right) A cellar under a courtyard,(left)

A cellar under a courtyard Plan and section for a cellar which has a complex shape

The Sirdab had to be ventilated efficiently by using wind catchers “badger or malqaf”, which is a vertical shaft, opens high above the roof level towards the favourable prevailing winds, with another opening at the basement close to the lowest level of the building (Al-Zubaidi, 2002 September, P.9) [26]. In Baghdad (Iraq), besides Sirdab, rooms around the courtyard are dropped down by (1.00- 1, 20) m and have high windows, they are called (neem-sirdab), which means (half-basement) (Ragette, 2003, P.64) [27] see Fig.8.

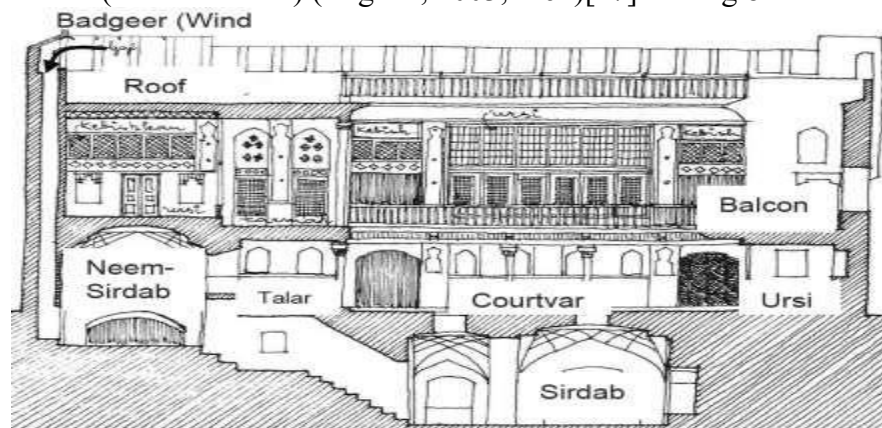


Fig.9: Basement as thermal mass effect cooling strategy- traditional house in Baghdad (Source: Ragette, 2003,) [27]

8: The history of the Citadel

The Citadel Town of Erbil, or Qala't Erbil, is a striking highland community that has been inhabited for thousands of years. Despite the fact that its precise origins cannot be determined, there are compelling archeological clues and discoveries that suggest it dates back approximately 6000 years. The actual fortified town must have

existed approximately 3,000 years ago, during the Assyrian Period (1365–612 BC).

According to some archaeologists, the location has been inhabited since the Neolithic to Mid Bronze Age (6000–1500 BC) (see Fig. 10).



Fig. 10: the Citadel of Erbil

8.1 The Citadel: Location and Geography

In the center of the Greater City of Erbil is the fortress town of Erbil. It is situated between the latitudinal lines (37.20 N, 36.25 N) and the longitudinal lines (45.05 E, 43.4 E). Although it is now completely engulfed by the huge expanse of the modern city it still lies at the heart of the busy central commercial district see Fig.11.



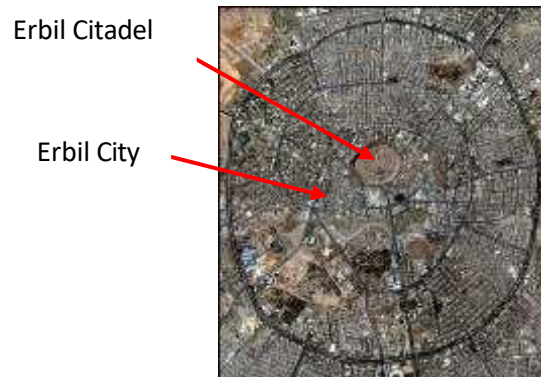


Fig.11: Iraq map: Location & Geography, Erbil Citadel& Erbil city.(Source: the author based on <http://whc.unesco.org>).



8.2: The Climate of Erbil city

The city experiences four distinct seasons and a semi-arid continental climate. With mean highs of 39–43 degrees Celsius and no precipitation, the summers are hot and dry. Winter temperatures are moderately cold, averaging 56 mm and 7 degrees Celsius. of precipitation. In Kurdistan, spring is a really pleasant time of year. Nonetheless, the citadel has a noticeably cooler microclimate during the sweltering summer months. This is due to the nice winds and constant shade that its winding alleyways give. Additional benefits come from the thickness of brick walls and other passive cooling strategies like window screens and semi-basements.

8.3: Urban Context

With a long diameter of roughly 430 meters and a short diameter of

roughly 340 meters, the citadel town of Erbil is situated in an oval shape. Slightly over 10 hectares (102,000 square meters) make up its whole area. Any attacker would find it extremely difficult to mount the steep earthen mound that encircles it on all sides. Additionally, the mound is roughly thirty meters above the city's natural ground level. Due to its height, it dominates the city skyline, even though ancient courtyard residences that are accessible through a maze of tiny lanes now make up the majority of the town.

: Socio-cultural Changes on Architecture in Erbil city

An overview of the social structure of the Erbil city at the time is necessary in order to trace the origins of modern architecture there. Depending on their economy, geography, local identity, and the policies and vision of their rulers, the Erbilian people experienced varying degrees of modernity as they were divided. As seen in Fig. 12, the early phases of contemporary architecture in Erbil started after 1930. In the 1940s, not many new structures were constructed. Expectations of oil production in the 1950s and 1960s drew western corporations to the area as a potential source of energy in the future and as a place with previously unheard-of prospects and investments, which expedited the modernization process.

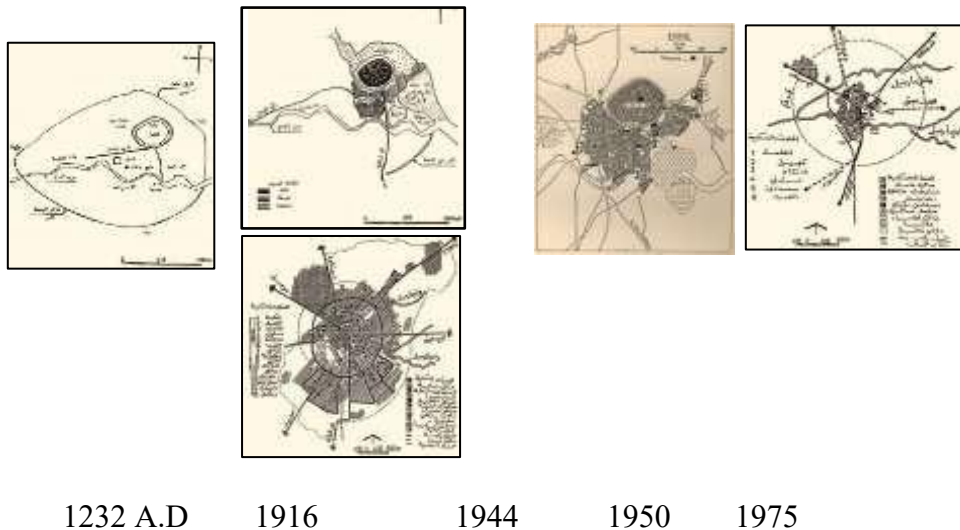


Fig.12: Erbil map from 1232 A.D More old Middle East city maps available from the University of Texas' Perry –Castaneda Library Map Collection to 1975. [28]

The Erbilian rulers' expansive outlook on the future and their determination to maintain the same level of modernity that the neighboring countries were starting to experience at the time served to raise these expectations. After 1970, Erbil city had a sea change in every way; the nation underwent significant social and economic transformations that greatly impacted the architectural boom that the nation saw and changed the lives of its citizens ever since (see Fig.13).

Empire city in Erbil



Fig.13: Erbil city know. <http://dar.dargroup.com/Projects/Erbil-City-Center>

The organic, traditional compact urban fabric was replaced by new, contemporary planning designs. The adoption of contemporary building techniques and materials was promoted by the economic prosperity brought about by the discovery of oil in the 1960s and the economic boom in the 1970s. Both local and foreign architects contributed to the introduction of new architectural styles in the area. All buildings now have air conditioners, which have replaced the conventional wind-catchers. The construction business introduced modern building materials including steel, glass, concrete, and others. Erbil's metropolitan landscape has been permanently altered by gleaming glass buildings that reflect the blazing sun (see Fig. 14).

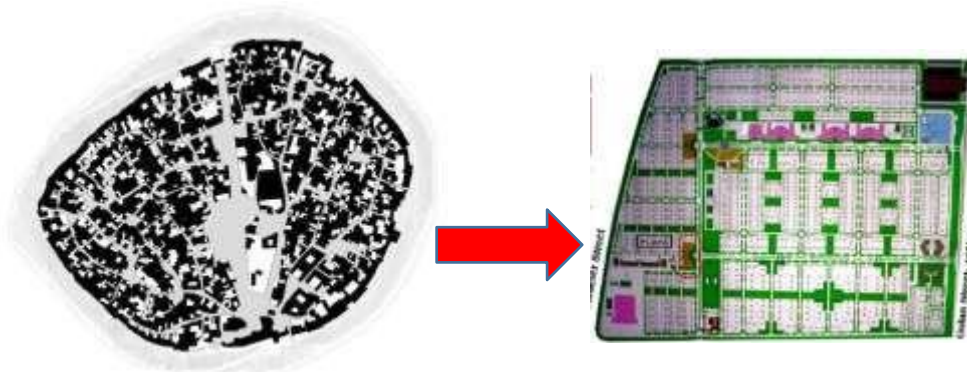


Fig.14: Traditional urban fabric transformed to modern grid iron in Erbil city.

9: The Need for Sustainability Assessment Method

to look into the potential for sustainability in both conventional and modern construction. The main goal of developing the evaluation method is to establish a framework for the comparative analysis that will be carried out to assess the sustainability potentiality of traditional and contemporary architecture.

9.1 : Definition of Sustainability Assessment Method

L. Graham Smith (1993) [29] defines Impact assessment as, “A process for resource management and environmental planning that provides for the achievement of the goal of sustainability”.

The process of sustainability assessment helps policymakers make decisions on plans, projects, policies, and programs that are in line with sustainable principles.

9.2: Analysis of Environmental Assessment Methods (EAM)

Environmental assessment is an essential process in sustainable design to assess the design goals. As defined by Raymond J Cole (2000, P. iii) [30], is “a way to evaluate the environmental performance of a building against an explicit set of criteria”. Three possible methods or systems were investigated and analysed in order to develop of the research SEAM. These assessment systems are[34]:

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

There is a ranking system specific to each environmental assessment approach. Evaluation scores are either based on points (Green Globes and LEED) or credits (Eco Homes). There are variations in the overall number of credits or points. The evaluation area, rating systems, and criteria are depicted and examined to provide a foundation for

creating the SEAM sustainability environmental evaluation approach, which will be utilized to evaluate the research case study (see Table 1).

Table 1: Areas of assessment score for the investigated environmental assessment methods.

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

9.3: The Proposed SEAM Rating System

The assessment areas rating for the selected ones is shown in Table 1 based on the quantitative analysis. The final scores are adjusted to be utilized correctly for assessing the sustainable environmental performance of the selected case studies and the conditions of the region. The results were obtained using environmental assessment methodologies. The common environmental criteria that have been present in all three of the EAMs under investigation—energy, location, resources, indoor environment, water, and waste—will be modified. Criteria including "Transport" in Eco Homes, "Project management" in Green Globes, and "Innovation" and "Homeowner awareness" in LEED were overlooked in one of the environmental assessment methodologies (see Table 2).

Table 2: Proposed SEAM area of assessment score

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

A variety of rating systems were used in the examined environmental assessment methodologies, including 100 LEED credits, 1000 Green Globe points, and 89 Eco Homes credits. Based on the significance of each criterion and assessment goal, these credits or points were separated into assessment areas and sub-areas.

The suggested rating system for this study would include 100 credits, split up by the priority of each criterion (see Table 3).

Table 3: The proposed environmental assessment method criteria and rating system

SEEDA's Sustainability Checklist recommended performance or standard ranges. They vary from "best practice" to "good practice." As a result, the checklist occasionally uses a strategy known as the 80/20

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

rule. levels of certainty based on each figure. As shown in Table 4, this range will be adjusted during the assessment procedure.

Table 4: Sustainability Checklist certainty range(Source: the author based on SEEDA, 2005)[31]

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

This study recommends utilizing a (1–10) evaluation range in place of the (0–1) certainty range modified by the SEEDA Sustainability Checklist, depending on how relevant the evaluated criterion is in relation to a particular standard. The final credit for this section will be calculated by multiplying this score by the assessment credit sub-area. The total credits of the evaluated criteria will then be obtained by

adding the evaluation credits from each sub-area.

$$\begin{aligned} \text{Sub-area of assessment credit} &= \text{Score (range 1-10)} \times \text{criteria credit} / 1 \\ \text{Total area of assessment credit} &= \text{Sub-area1 credit} + \text{Sub-area2 credit} + \dots + \text{Sub-arean credit} \end{aligned}$$

A standard form for evaluating environmental sustainability standards for both traditional and modern homes is displayed in Table 5. This form will be used to examine if the suggested SEAM is appropriate for evaluating the environmental sustainability performance of both historic and modern case study homes.

Table 5: Typical form for assessing environmental sustainability criteria for the chosen case studies

Area of Assessment	Sub-areas of Assessment															Total Credit										
	Crds.					Sub-area of Assessment					Crds.						Sub-area of Assessment									
Traditional House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	6	7	8	9	10	
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	Credit=score X credit/10					Credit=score X credit/10					
	Credit=score X credit/10					Credit=score X credit/10					Credit=score X credit/10															
Contemporary House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	6	7	8	9	10	
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	Credit=score X credit/10					Credit=score X credit/10					
	Credit=score X credit/10					Credit=score X credit/10					Credit=score X credit/10															

9.4: Analysis of Sustainability Social Assessment Methods (SSAM)

When assessing an activity for sustainability, the most important consideration is whether it can be conducted or sustained over time without negatively impacting the environment and the social conditions of people [32]. Yasser Mahgoub (1997)[33] lists several ideas as components of social sustainability in traditional architecture in his examination of psychological, social, and cultural sustainability.

These principles are privacy, Social relationships, Neighbourhood, family, and Identity & Social status.

9.5: The Proposed SSAM Rating System

Not every aspect is regarded as equally significant during the review process; some are given more weight than others. In order to arrive at a weighed conclusion based on a variety of attributes, each of which is given the weight it deserves, it can be helpful to assign weights to various aspects (Voordt & Wegan, 2005, P.160). Weightings can be based on several criteria:

Relative weightings of criteria can be based on sound scientific evidence as to their equivalent impacts or consequences.

Implicit in all assessment methods are the social values of the society

or groups the have produced them.

Table 6 illustrates the proposed SSAM area of assessment criteria, sub-area of assessment and the assessed architectural features for each criterion, and each criterion rating system.

Table 6: The proposed social assessment method criteria and rating system

Areas of Assessment	Credits (100)	%	Sub-area of Assessment	Credits	%	Architectural Criteria
Privacy	25	25%	Urban planning and design concept	13	52%	Site organization Design philosophy Building form Outside-inside relation Spaces organization
			External facades	7	28%	Elevation treatment House entrance Openings
			Acoustical privacy	5	20%	Building envelope Spatial zones
Social relations	20	20%	Hospitality	10	50%	Spatial organization Guest room (Majlis) Entry levels
			Guest honouring	10	50%	Guest room (Majlis) size Interior design
Neighbourhood	20	20%	Strong neighbourhood relationships	8	40%	Organic compact planning Attached dwellings Public spaces within neighbourhood
			Preservation of neighbours' rights	12	60%	Main entrance Roof parapet Walls height
Family	25	25%	Strong family ties	15	60%	Spatial organization Flexibility in space use
			Extended family	10	40%	House area No. and size of rooms Interior spaces design
Identity & Social Status	10	10%	Humility & self-advocacy	5	50%	House size Elevation treatments
			Revealing social status	5	50%	Building materials Architectural details

Since the majority of social values are equally important, they were weighted fairly, with "Privacy" and "Family" receiving 25% each, followed by "Social relations" and "Neighbourhood" receiving 20% each, and "Identity and Social Status" receiving 10% due to its relative importance in relation to social and family issues.

10: Case Study Analysis

The case study is one of several ways of doing scientific researches (Yin, 2002). He suggests that, “case study should be defined as a research strategy, an empirical inquiry that investigates a phenomenon within its real- life context”. In order to assess the chosen case studies with SAM, certain data are required. A descriptive analysis is held to obtain the required analysis is divides into the following categories:

- 1. General Information:** includes location, house type, and construction date.
- 2. Site Planning:** includes plot area, built-up area, plot coverage, built-up to open ration, and total built-up area.

3. **Internal spaces:** includes internal spaces zoning and areas, spatial relations, zoning percentage, and structure and circulation percentage. The zones were divided into three categories according to their level of privacy:

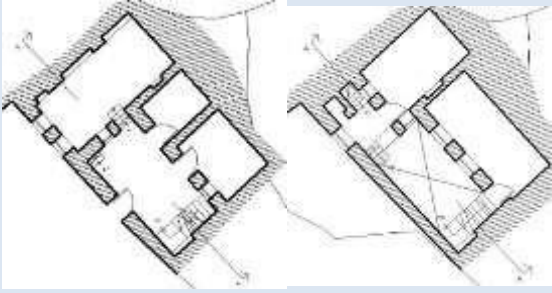
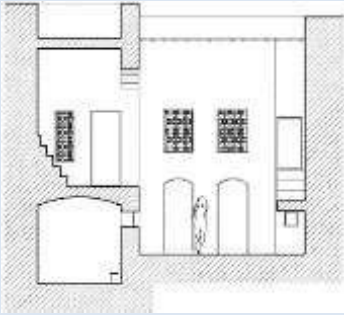

4. **Public zone:** indicates the spaces that are used for public occasions where men are hosted without intruding into family privacy. It includes the main entrance, male Majlis, and services such as the bathroom.

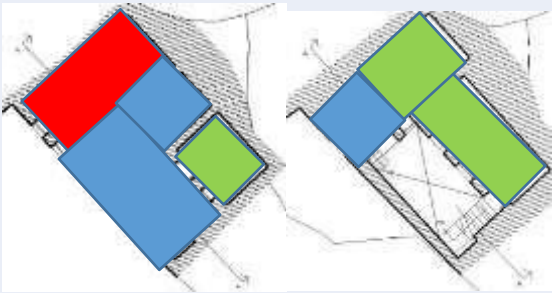
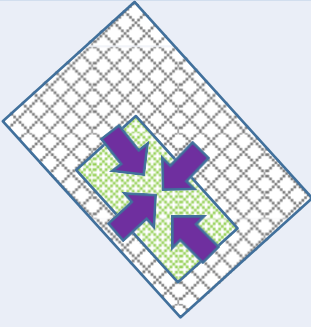
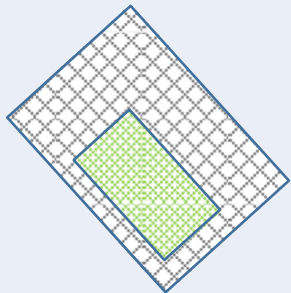
5. **Semi-public zone:** indicates the spaces that are used freely by all family members and others as women guests and servants, except strange men. It includes the women Majlis, circulation areas including the central hall, and services such as kitchen, laundry, bathrooms, and maid's room.

6. **Private zone:** indicates the spaces that are only used by family members such as bedrooms. Private zones, in contemporary houses, may include private family sitting area, pantry, and an office.

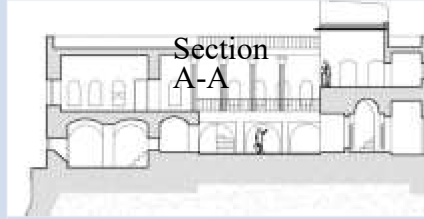
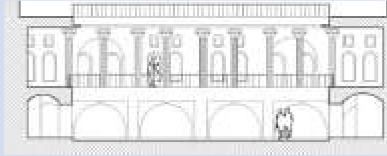
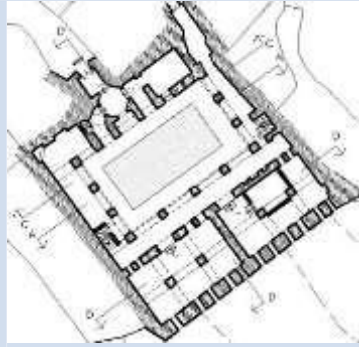
7. **Spatial Analysis:** includes zoning analysis, design concept, built-up to open, and inside- outside relation (introvert or extrovert) .

Six case studies were chosen, three traditional and three contemporary. Traditional houses were constructed within the first quarter of the 20th century; they were built by local builders. The contemporary houses were constructed within the last five years; Arab architects in local and foreign designed them. Design concept, for each type, was comparable representing the most common houses design in the time of construction. The case studies were numbered according to its type (Traditional: Tra.1, Tra.2 ...; and contemporary: Con.1, Con.2...etc). The ten cases studies statistics were organized in tables according to the previous mentioned categories. As show in the following table analysis.

	House No.	Type	Location	House Name	Date of construction
	Tra.1	Tradition	The Citadel of Erbil	21 Saray	
Architectural Drawings	Plan		Sections & Elevations		Image
					

Ground floor + basement First floor plan				Section A-A					
Site Planning	Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area		
	m ²	m	m ²	%	m ²	Ratio	m ²		
	185.5(17.5*10.5)	56.2	161.5	87%	24(3*8)	1.2:1	161.5		
Internal Spaces	Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
	Public	Majlis	30	Semi-Public	Kitchen	17	Private	B. room (2)-1st. floor	48
		store	10		Baths 1st floor	10			
	Total		30 m ²	Total		27	Total		73
			23%			20.7%			56%
	Spaces area= 130 m ² , 80.4% total b		uilt-up area	Structure & circulation= 31.5 m ² , 19.5 % built-up area					
Zoning analysis				Inside-outside relation		Built up/ open			
									

House No.	Type	Location	House Name	Date of construction
Tra. 2	Tradition	The Citadel of Erbil	Jamal Afandi house	
Plan		Sections & Elevations		Image



Ground floor plan +
Basement

Section D-D

Site
Planning

Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
m ²	m	m ²	%	m ²	Ratio	m ²
400 (20*20)	80	304	76%	96(12*8)	1.3:1	304

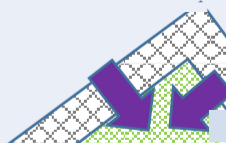
Internal Spaces

Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
Public	Main Ent.	12	Semi-Public	Side Ent.	5	Private	Bed rooms	
	Dahaliz	14		Kitchen	54		Baths (3)-G. floor	49.5
	Majlis	28		services	10		Basement	17
	servic	10		Iwan	33			
Total		64	Total		102	Total		66.5



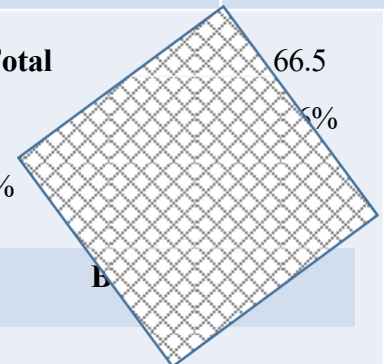
Spaces area= 232.5 m²,
76.5% total built-up area

Zoning analysis



Structure & circulation= 71.5 m², 23.5 %
built-up area

Inside-outside relation



b

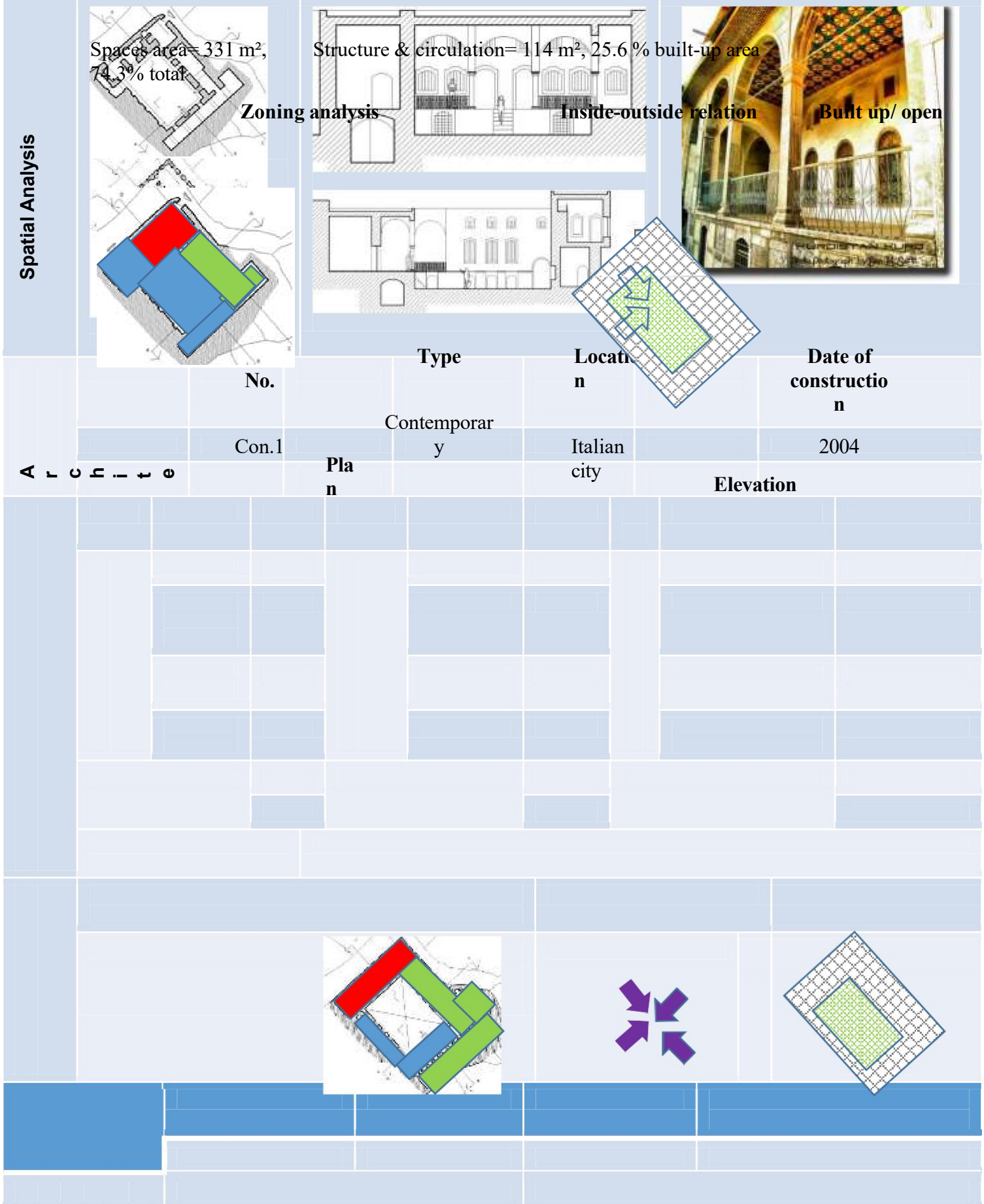
Spatial Analysis

	House No.	Type	Location	House Name	Date of construction
A r c	Tra.3	Tradition	The Citadel of Erbil	Salih Chalabi house	
	Plan		Sections & Elevations		Image

Section A-A

Section B-B

Site Planning	Ground floor + basement First floor plan		Section B-B					Total Built-up area	
	Plot area	Perimeter	Built-up area (Gr.)	Plot Coverage	Open space area	Open/built up ratio			
	m ²	m	m ²	%	m ²	Ratio	m ²		
	500(20*25)	90	370	74%	130(10*13)	1.4:1	445		
Internal Spaces	Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
	Public	Main Ent.	17	Semi-Public	Kitchen Side Ent.	15	Private	Talar	10
		Majlis 1st floor	28		Iwan G. floor	8		Sitting -G. floor	28
		Hall & service	28		Iwan 1st floor	15		Family services	15
		Dining 1st floor	25			24		B. room (5)-1st. floor	118
		Total	98		Total	62		Total	171
		29.6%			18.7%			51.6%	



Site
Planning

Ground floor First floor plan

Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
m ²	m	m ²	%	m ²	Ratio	m ²
800(29*27.6)	113.2	504	63%	296	1.6:1	730

Internal
Spaces

Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
Public	Main Ent.	8	Public	Kitchen	40	Private	Bed rooms G. floor	48
	Reception	45		Store & services	25		Sitting 1st floor	45
	Dining	28		Living	42		B. room (2)-1st. floor	105
	Bath	15		Inside hall	43		Baths 1st floor	25
				bath	18		Dining & service	30
Total		96	Total		168	Total		253
		18.5%			32.4%			48.9%

Spaces area= 517 m²,70.8% total built-up area built-up area

Structure & circulation= 213 m², 29.1 %

Zoning analysis

Inside-outside relation

Built up/ open



Spatial Analysis

House No.	Type	Location	Date of construction
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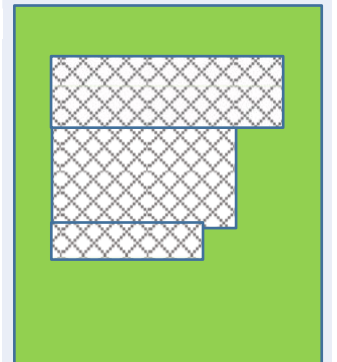
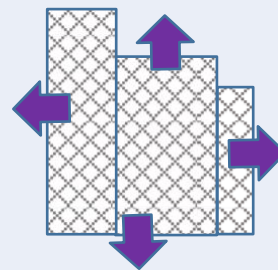
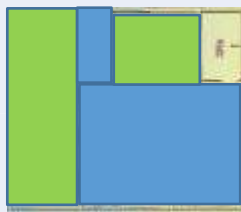
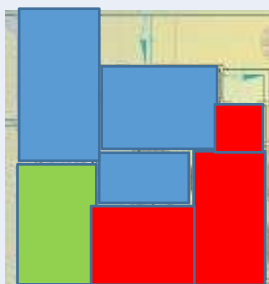
Con.2	Contemporary	Zeren city	2012
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Area

Plan

Elevation

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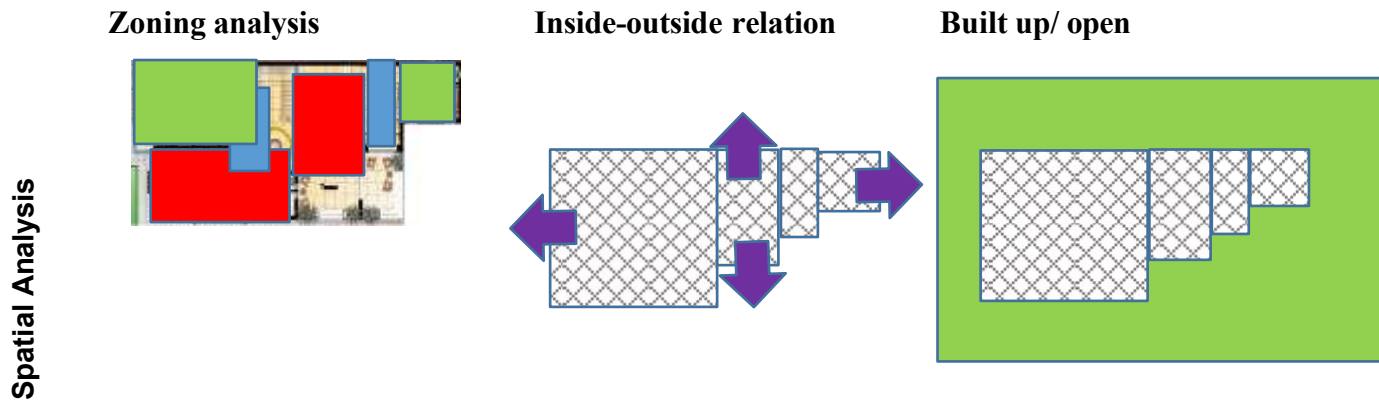


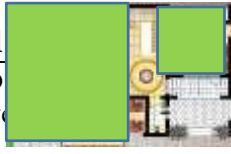


Site Planning	Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
	m ²	m	m ²	%	m ²	2:1:1	m ²
	510(30*17)	94	254	49.8%	256		396

Internal Spaces	Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area	
	Public	Public	Main Ent.	6	Semi Public	Kitchen & store	18	Private	Bed(2) G. floor	46
			Reception & Dining living	40		Inside hall	14		Bath (2) G. floor	20
			Gest baths	10					B. room (4)-1st. floor	68
									Baths (3)- 1st floor	30
Total		76	27.9%	Total		32	11.7%	Total	164	

Spaces area= 272 m², 68.6% total built-up area
 Structure & circulation= 124m², 31.3 % built-up area





	House No.	Type	Location	Date of construction
A r c h i t Plan	Con.3	Contemporary	Dream city Elevation	2014



Ground floor plan



First floor



Site Planning

Plot area	Perimeter	Built-up area (Gr.)	Plot coverage	Open space area	Open/built up ratio	Total Built-up area
m ²	m	m ²	%	m ²	2.3:1	m ²
770(35*22)	114	380	49.3%	390		558

Internal Spaces

Zone	Spaces	Area	Zone	Spaces	Area	Zone	Spaces	Area
Public	Main Ent.	18	Semi-Public	Kitchen & store	30	Private	Bed G. floor	20
	Reception & Dining	48		Hall & Living	35		Baths G. floor	12
	Guest bathrooms	12					B. room (3)-1st. floor	70
							Baths (3)-1st floor	36
Total		78	Total		65	Total		138
		27.7%			23.1%			49.1%

Spaces area= 281 m², 50.3% total built-up area Structure & circulation= 277 m², 49.6 % built-up area

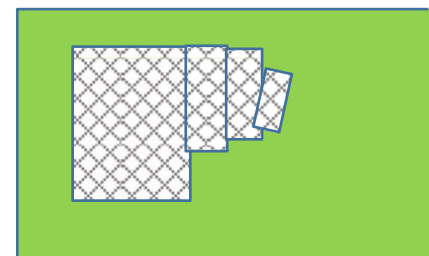
Zoning analysis

Inside-outside relation

Built up/ open

Spatial Analysis

s i





		Traditional Houses	Contemporary Houses	
Internal Spaces	Plot area (m ²)	361.8	Plot area (m ²)	693.3
	Built-up area - Gr. (m ²)	278.5	Built-up area - Gr. (m ²)	379.3
	Plot coverage	79	Plot coverage	54.1
	Open space area (m ²)	83.3	Open space area (m ²)	314
	Open/built up ratio	1.3:1	Open/built up ratio	2:1
	Total Built-up area (m ²)	303.3	Total Built-up area (m ²)	561.3
	Public	25.5	Public	24.7
	Semi-public	27.8	Semi-public	22.4
	Private	45.4	Private	52.7
	Spaces area	77.1	Spaces area	63.3
Cir. & structure	22.9	Cir. & structure	36.6	

Table 7 Average Case studies quantitative analysis

11: Findings of Case Study Analysis

The main findings may be listed as follows:

11.1: Site Planning

Generally, plot areas in traditional houses were smaller than the contemporary. Most of the traditional plots tend to be square while contemporary plots tend to be rectangular. The average of traditional plot size is 361.8m². While contemporary plot areas were 693.3m², This indicates the major difference in land use between the past and the present, which was reflected in site planning and plot coverage that was high in the traditional houses the average of plot coverage is 79%. While plot coverage in the contemporary houses is less than the traditional which is 54.1%. Open spaces in the traditional houses (the courtyard) were less than open spaces in the contemporary houses (the outdoor spaces). In traditional the average of open/built up is 1.3:1. In contemporary houses, the contrary occurs; the open spaces are double the built-up area. The average of open/built up in contemporary is 2:1.

11.2: Internal spaces

Both traditional and modern homes share many similarities in terms of internal spatial relations and space zoning. The following is a list of key findings for the analysis of internal spaces.

11.2.1: Public zone: The average proportion of public areas (25.5%) in conventional homes is visible. On the other hand, public areas in modern homes average 24.7%. As a result, the proportion of public places in traditional vs contemporary settings was higher. This is typical in the traditional homes of the wealthy.

11.2.2: Semi-public zone: indicates spaces that are used freely by all family members and others as women guests and servants. In traditional houses the average percentage of semi-public spaces (27.8%) Appears. While in contemporary houses the average of semi-public spaces are (22.4%).

11.2.3: Private zone: indicates to spaces that are only used by family members such as bedrooms. The private zone average in most traditional were (45.4%) of the houses built-up area, whether in contemporary houses the average were (52.7%). In traditional houses, the bedroom is not specified as a bedroom; it was used for multi-functions especially in extended family houses. Thus, it is indicated as “room” not “bedroom”. In contemporary houses, family bedrooms are so private and almost each member in the family has his own bedroom with its own dressing and bathroom. The private zone took more space in contemporary houses than the traditional because of the exaggeration in spaces, privacy, and luxurious life style.

11.3: Spatial Analysis

All traditional case study houses are designed as introvert where all spaces oriented towards an open central courtyard. Contemporary houses reflected modern life style of society in the Erbil city. All contemporary case study houses are designed as extrovert where all spaces are open to outside.

12: Choosing Case Study Models

According to the findings obtained of the quantitative and spatial analysis and the average figures, the traditional case study house (Tra.2) and contemporary case study house (Con.3) were chosen as the most appropriate paradigmatic case studies to be assessed using SSAM and SEAM.

13: Evaluation Standards

Each sub-area of assessment will be evaluated and given a score ranging (0-10) depending on degree of relevance the assessed criterion to the acceptable standards. This score will be multiplied by the sub-area of assessment credit to obtain the final credit of this part. Then all sub-area of assessment credits will be summed to get the total credits of the assessed criteria. Table 8 shows the rating score and degree of relevancy for the proposed SEAM and SSAM.

Table 8 :The proposed rating score

10	8-9	6-7	5	3-4	1-2	0
Total relevancy	High relevancy	Good relevancy	Medium relevancy	Average relevancy	Low relevancy	Not considered

Sub-area of assessment credit = Score (range 0-10) X criteria credit / 10

Total area of assessment credit = Sub-area1 credit+ Sub-area2 credit+...+ Sub- arean credit

14: Testing the Proposed SEAM

Testing the proposed SEAM process will be held through comparative analysis for the two case studies that have been chosen Fig.14.shows the criteria that will be assessed using sustainability environmental assessment method.

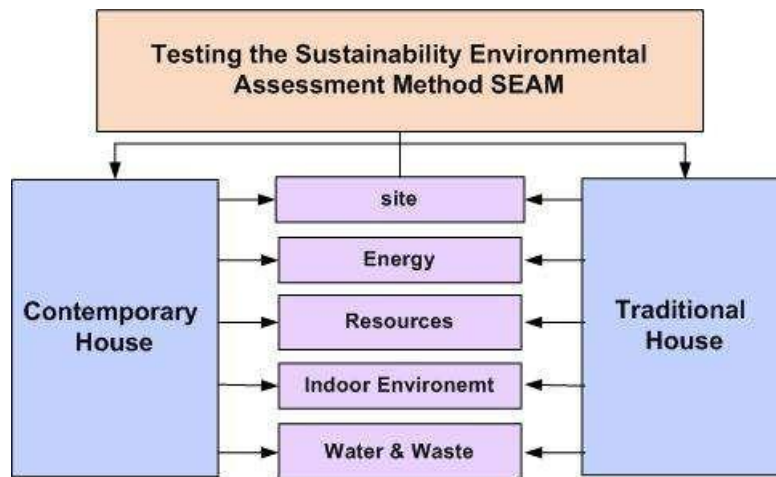


Fig. 14: The criteria of sustainability environmental assessment method

14.1 : Site

According to the proposed SEAM rating system, “Site” was given 15 credits; these credits are divided as follows: site selection (6 credits), site planning (6 credits), and building footprint (3 credits).

14.1.1: Site selection

Site selection for residential buildings had to fulfil the occupants’ requirements environmentally and socially. Selecting sites for traditional houses was based on geographical location, topography and availability of resources, especially water. The traditional case study is located within The Citadel of Erbil in the urban fabric of residential buildings. The contemporary case study is located within the modern residential district in Dream city within the urban fabric of the modern city gridiron planning system. Selecting sites for contemporary houses is based on modern urban planning where urban settlements expanded over available lands. All these residential sites were new and were not used before; it means that all modern sites were virgin lands. According to the previous discussion, it can be concluded that site selecting in both case studies are acceptable, nevertheless the traditional house scored better level in site selection than the contemporary did. Final rate for the two case studies is 8/10 for traditional house, and 6/10 for the contemporary.

14.1.2: Site planning

Front elevation orientation for the traditional house is northeast, where the angle between northeast to northwest is the common orientation for most of the traditional houses to receive the prevailing wind. For the contemporary house, main elevation is oriented towards northeast also, but this is a coincident because attached plot from the back is oriented towards southwest. Moreover, the open spaces around the building allow elevations to have different orientations according to its siting. In traditional house, the inward design allowed all the internal elevations and openings to open into the central courtyard. This solution provided natural lighting and ventilation, yet shaded elevations according to the sun path along the day. The traditional house was built on a plot area 400m² where the plot coverage is 76% while the contemporary plot area is 770 m² where the plot coverage is 49.3%. This gives an advantage to the traditional house in plot size, plot coverage, and orientation compared to the contemporary. According to the previous discussion, the research concluded that site planning in the traditional house scored better level than the contemporary. Final rate for the two case studies is 10/10 for traditional house, and 6/10 for the contemporary.

14.1.3: Building footprint

To evaluate building footprint (ecological impact), Eco Homes used what called “Footprint ratio”; Eco Homes gives credits when Footprint ratio is greater than

2.5:1. For the traditional house, Footprint ratio is 1.3:1, and for the contemporary house is 2.3:1. Both of the case study ratios did not match with the standards set by Eco Homes, yet the contemporary footprint ratio was higher than the traditional. According to the previous discussion, the research concluded that building footprint in the contemporary house scored better level than the traditional did. Final rate for the two case studies is 7/10 for traditional house and 8/10 for the contemporary. Final assessment for “site” criteria is illustrated in Table 9.

Table 9: Final assessment for environmental sustainability-Site

Area of Assessment	Sub-areas of Assessment														Total Credits																
Site	6					Site Selection					6					Site Planning					3					Building Footprint					15
Traditional House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	12.9										
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10											
	Credit= $8 \times 6/10 = 4.8$					Credit= $10 \times 6/10 = 6$					Credit= $7 \times 3/10 = 2.1$					9.9															
Contemporary House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5											
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10											
	Credit= $6 \times 6 / 10 = 3.6$					Credit= $6 \times 6 / 10 = 3.6$					Credit= $9 \times 3 / 10 = 2.7$																				

14.2: Energy

According to the proposed SEAM rating system, “Energy” was given 30 credits; these credits are divided as follows: carbon dioxide (10 credits), renewable energy resources (10 credits), and building envelope (10 credits).

14.2.1: Carbon dioxide

the Climate Change Levy Negotiated Agreements and the ETS are using an average carbon intensity factor for the estimation of carbon dioxide emissions from the consumption of electricity; this has been fixed at 0.43 kgCO₂/kWh. For renewable energy sources, the CO₂ emission factor is 0.00(www.thecarbontrust.co.uk/foundation/0302GWP.html - Last accessed 15- 07-2006) Using the Carbon Trusts nationally agreed emission factors and the formula presented below, the calculation of an energy sources CO₂ emission responsibility can be seen to be a fair and reliable process:

CO₂ emissions= Energy Consumption (kWh) x Energy Source Emission Factor (kgCO₂/kWh) x 0.001

According to the results of the equation above and based on Eco Homes accredits 10/10 for houses with zero CO₂ emission and 9/10 for houses that release less than 10 kg/m²/year(BRE, 2005, P.3), the final rate for the two case studies is 10/10 for traditional house and 5/10 for the contemporary.

14.2.2: Renewable energy sources

A full credit is given if at least10% of either the heat (space and hot water) demand or the non-heating electrical demand within the development is supplied from local renewable energy sources (BRE, 2005, P.67). Energy resources in the traditional house are renewable depending on sun and natural ventilation (wind). The contemporary house depends totally on non-renewable energy resources. Accordingly, final rate for the two case studies is 10/10 for traditional house and1/10 for the contemporary.

14.2.3: Building envelope

As illustrated in Table 9, R-value of the wall in the traditional house is about 49.3 ft².hr.F°/Btu and the U-value is 0.02 Btu/ft².hr.F°, while R-value of the wall in the contemporary house is about 2.37 ft².hr.F°/Btu and the U-value is 0.42 Btu/ft².hr.F°. This shows that building envelope in the traditional house is more insulative than the contemporary is, thus it has a better thermal performance. Poor thermal performance of the contemporary house compared to traditional, is referred to use of non-sustainable building materials that are not suitable for local climate.

Table 9: Thermal properties of building materials in traditional and contemporary houses (Moore, 1993)

Material	Thickness Inch	Thermal Conductivity (K) Btu.inch/ft.hr.F°	Thermal Conductance (C) Btu/ft ² .hr.F°	Thermal Resistance (R) Ft ² .hr.F°/Btu
Brick	24	0.5	0.021	47.6
Concrete	8	12	1.5	0.67
Gypsum	2	1.2	0.6	1.7

Traditional wall R- value = 47.6 Ft².hr.F°/Btu + 1.7 Ft².hr.F°/Btu = 49.3 Ft².hr.F°/Btu
Traditional wall U-value = 1/ 49.3 = 0.02 Btu /Ft².hr.F°

Contemporary wall R- value = 0.67 Ft².hr.F°/Btu + 1.7 Ft².hr.F°/Btu = 2.37 Ft².hr.F°/Btu
Contemporary wall U-value = 1/ 2.37 = 0.4 Btu /Ft².hr.F°

As previously discussed, study found that the traditional home's building envelope performed better thermally than the modern one. The final scores for the two case studies are 6/10 for the modern home and 9/10 for the traditional one. Table 10 shows the results of the final evaluation for the "Energy" category.

Table 10: Final assessment for environmental sustainability-Energy

Area of Assessment	Sub-areas of Assessment															Total Credits			
Energy	10	Carbon Dioxide					10	Renewable energy resources					10	Building envelope					30
Traditional House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	29			
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10				
	Credit=10 ×10 /10= 10					Credit=10×10/10 = 10					Credit= 9 ×10/10= 9								
Contemporary House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5				
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10				
	Credit= 5 ×10 /10 = 5					Credit=1×10/10 =1					Credit= 6 ×10 /10 = 6					12			

14.3: Resources

"Resources" received 21 credits under the proposed SEAM grading system, which are broken down as follows: building materials (9 points), recycle and reuse (7 credits), and materials lifespan (5 credits).

14.3.1: Building materials

Nevertheless, using locally sustainable building materials, such as coral stone, limestone, and palm trees, in the traditional house promoted conservation of dwindling non-renewable resources. In the contemporary house, using non-renewable imported materials such as concrete, steel, aluminium and glass, is not suitable for the climate of the region and involve continuous costly maintenance According to the previous discussion, the research concluded that building materials consumption in the traditional house is more rational than the contemporary does, thus it was more sustainable. Final rate for the two case studies is 9/10 for traditional house and 6/10 for the contemporary.

14.3.2: Recycling and Reuse

Main building material used in the traditional house, Brick is of recycled content and can be reused. Concrete blocks, used in the contemporary house, can be recycled if crushed for new aggregate According to Table11 that illustrates sustainability characteristics of building materials used in the traditional and contemporary case study houses, it is concluded that building materials used in the traditional house have more sustainability characteristics than building materials used in the contemporary.

Table 11: Sustainability characteristics of building materials used in the traditional and contemporary (Kim & Rigdon, 1998B)

Type of Houses	Building Materials	Manufacturing Process MP					Building operations BO					Waste Management WM			
		P2	RC	EER	NM	WR	EE	WTC	RES	NT	LL	RU	R	B	O
Traditional House	Coral stone		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
	Gypsum			✓	✓		✓			✓			✓		
	Wood	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Contemporary House	Concrete block		✓			✓	✓			✓	✓	✓	✓		✓
	Steel		✓		✓					✓	✓	✓	✓	✓	
	Glass		✓									✓	✓		
	Aluminium		✓								✓	✓	✓		

Symbol	Material Characteristic	Symbol	Material Characteristic
P2	Pollution Prevention	RES	Renewable Energy Systems
RC	Recycled Content	NT	Non-Toxic or Less-Toxic Material
EER	Embodied Energy Reduction	LL	Longer Life
NM	Natural Materials	RU	Reusability
WR	Waste Reduction	R	Recyclability
EE	Energy Efficiency	B	Biodegradability
WTC	Water Treatment/Conservation	O	others

According to the discussion above, the study found that traditional homes are more sustainable since they recycle and reuse building materials more than modern ones. The two case studies' final ratings are 10/10 for the traditional home and 6/10 for the modern one.

14.3.3: Materials lifecycle

A material's life cycle can be organized, as identified by Kim and Rigdon (1998B, P.3), into three phases relate to the flow of materials through the life of the building - **Pre-Building Phase- Building Phase- Post-Building Phase** Durable materials, as brick, stone and steel that require less frequent replacement will require fewer raw materials and will produce less landfill waste. According to the previous discussion, the research concluded that materials lifecycle is more sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 10/10 for traditional house and 6/10 for the contemporary.

Final assessment for "Resources" criteria is illustrated in Table 12.

Table 12: Final assessment for environmental sustainability-Resources

Area of Assessment	Sub-areas of Assessment															Total Credits			
Resources	9	Building materials					7	Recycle & reuse					5	Materials lifecycle					21
Traditional House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	20.1			
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10				
	Credit= $9 \times 9 / 10 = 8.1$					Credit= $10 \times 7 / 10 = 7$					Credit= $10 \times 5 / 10 = 5$								
Contemporary House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5				
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10				
	Credit= $6 \times 9 / 10 = 5.4$					Credit= $6 \times 7 / 10 = 4.2$					Credit= $6 \times 6 / 10 = 3.6$					13.2			

14.4: Indoor environment

"Indoor Environment" received 15 credits under the planned SEAM grading system, which are split as follows: 5 credits for natural ventilation, 5 credits for indoor air quality, and 5 credits for thermal comfort.

14.4.1: Natural Ventilation

The aim of ventilation systems is to provide effective ventilation thereby helping to ensure occupant well-being and comfort (Green Building Initiative, 2005, P.30). The traditional case study house had two barjeels, one opens to the Majlis in the ground floor, the other opens to one of the rooms in the upper floor. With an area 155 m², courtyard along with the barjeels created natural ventilation across the house. In spite of large windows from the four sides in the contemporary case study house, they are not fully opened. Thus, these windows do not provide adequate cross ventilation within internal spaces without any additional natural ventilation systems as wind stacks. According to the previous discussion, the research concluded that natural ventilation is more considered in the traditional house than in the contemporary. Final rate for the two case studies is 9/10 for traditional house and 5/10 for the contemporary

14.4.2: Indoor air quality

Building materials used in the traditional house such as coral stone, wood, and clay mortar are all natural, thus they are not toxic and do not emit pollution or gases that may affect negatively on air. They are environment-friendly and sustainable. While the contemporary house is characterised with total dependency on artificial air-conditioning, manufactured materials, excessive use of chemical products as air perfumes and cleaning products and insufficient natural ventilation. According to the previous discussion, the research concluded that indoor air quality is more sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 8/10 for traditional house and 5/10 for the contemporary.

14.4.3: Thermal comfort

Traditional houses in the Citadel provided maximum comfort in a hot climate of the region. Using available local materials such as limestone, and mud brick provided good insulation, preserving a cool interior environment, utilizing natural ventilation and catching any passing breeze through walls and lattice wooden and gypsum screens. This provides comfort indoor environment without depending on artificial air conditioning equipment. Comfortable indoor environment in Contemporary houses obtained depending on mechanical air-conditioning. This thermal comfort is artificial consuming a great deal of energy with high cost and negative environmental sequences. According to the previous discussion, the research concluded that thermal comfort is more natural and sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 7 /10 for traditional house and 4/10 for the contemporary. Final assessment for “Indoor Environment” criteria is illustrated in Table 13.

Table 13: Final assessment for environmental sustainability indoor Environment

Area of Assessment	Sub-areas of Assessment															Total Credits			
Indoor environment	5	Natural ventilation					5	Indoor air quality					5	Thermal comfort					15
Traditional House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	12			
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10				
	Credit= 9 × 5 /10 = 4.5					Credit= 8 × 5 /10 = 4					Credit= 7 × 5 /10 = 3.5								
Contemporary House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	7			
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10				
	Credit= 5 × 5 /10 = 2.5					Credit= 5 × 5 /10 = 2.5					Credit= 4 × 5 /10 = 2								

14.5 : Water & waste

"Water and Waste" received 19 credits under the proposed SEAM grading system; these credits are split as follows: waste output and recycling (8 credits) and water consumption and recycling (11 credits).

14.5.1 : Water consumption and recycling

According to Eco Homes, assessing water consumption aims to reduce consumption of water in the home (BRE, 2005, P.71). the traditional house had only one or two bathrooms. The contemporary house every bedroom have its bath, and besides the reception, living room have the

public bath According to the previous discussion, the research concluded that water consumption and recycling is more rational and sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 8 /10 for traditional house and 3/10 for the contemporary.

14.5.2: Waste output

Domestic waste produced by the traditional house negligible amount of waste as compared with the contemporary. Erbil city has one of the world's highest levels of domestic waste. There is no recycling or separation process takes place in contemporary house. According to the previous discussion, the research concluded that waste output is more sustainable in the traditional house than in the contemporary. Final rate for the two case studies is 7 /10 for traditional house and 4/10 for the contemporary. Final assessment for “Water & Waste” criteria is illustrated in Table 14.

Table 14: Final assessment for environmental sustainability-Water & Waste

Area of Assessment	Sub-areas of Assessment										Total Credits
Water&waste	11 Water consumption & recycling					8 Waste output & recycling					19
Traditional House	1	2	3	4	5	1	2	3	4	5	14.4
	6	7	8	9	10	6	7	8	9	10	
	Credit= 8 ×11/10 = 8.8					Credit= 7 × 8/10 = 5.6					
Contemporary House	1	2	3	4	5	1	2	3	4	5	6.5
	6	7	8	9	10	6	7	8	9	10	
	Credit= 3 ×11 /10 = 3.3					Credit= 4 ×8 /10 = 3.2					

It is concluded that traditional house is more environmentally sustainable. Final assessment results for environmental sustainability performance are illustrated in Table 15.

Table 15: Final assessment for environmental sustainability of traditional and contemporary houses

SEAM	Areas of Assessment Credits					
Areas of Assessment	Site	Energy	Resources	Indoor Environment	Water & Waste	Total Credits
	15	30	21	13	21	100
Traditional House	12.9	29	20.1	12	14.4	88.4
Contemporary House	9.9	12	13.2	7	6.5	48.3

15: Testing the Proposed SSAM:

The suggested method's impartiality and dependability depend on the SSAM's suitability being tested. The sustainability social assessment method's criteria are displayed in Fig. 15.

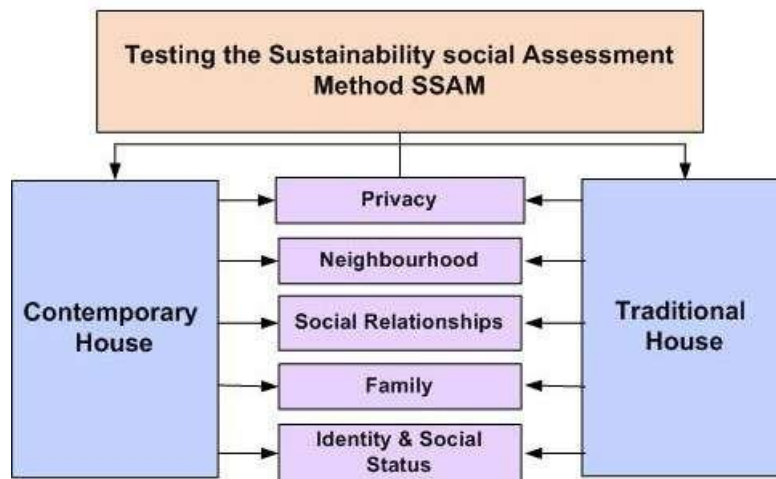


Fig.15: The criteria of sustainability social assessment method : Privacy

15.1 :Privacy

"Privacy" received 25 credits under the planned SSAM rating system, which are split as follows: 13 credits for urban planning and design concept, 7 credits for exterior facades, and 5 credits for acoustical privacy.

: Urban planning and design concept

15.1.1 : Urban planning and design concept

In a typical home, the courtyard serves as a private, inward area where family gatherings and other activities take place. In modern homes, this private outdoor area (courtyard) is used in place of outside spaces

that are encircled by walls. As previously discussed, the study found that the traditional homes reflected the family lifestyle and attained privacy through introverted architecture. The final scores for the two case studies are 8/10 for the modern home and 9/10 for the traditional one.

15.1.2 : External facades

The traditional house reflected privacy by semi-solid external facades with no openings in the ground floor, except the Majlis, and treating the first floor opening with wooden screens. External facades in the contemporary house have little relation to the traditional. They are transparent with big openings and porches that do not provide an adequate level of privacy. To keep privacy openings are covered with heavy curtains. According to the previous discussion, the research concluded that the traditional house achieved privacy through external facades treatment more than the contemporary did. Final rate for the two case studies is 9 /10 for traditional house and 4/10 for the contemporary.

15.1.3 : Acoustical privacy

Acoustical privacy is well reserved in the traditional and contemporary houses, either by thick walls and introvert design (in the traditional) or by big open spaces around the house and the wide streets (in the contemporary). According to the previous discussion, the research concluded that both the traditional and contemporary houses achieved acoustical privacy in design. Final rate for the two case studies is 8 /10 for traditional house and 8/10 for the contemporary. Final assessment for “Privacy” criteria is illustrated in Table 16.

Table 16: Final assessment for social sustainability-Privacy

Area of Assessment	Sub-areas of Assessment															Total Credits
Privacy	13 Urban planning and design concept					7 External facades					5 Acoustical privacy					25
Traditional House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	22
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	
	Credit= $9 \times 13 / 10 = 11.7$					Credit= $9 \times 7 / 10 = 6.3$					Credit= $8 \times 5 / 10 = 4$					
Contemporary House	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10	
	Credit= $8 \times 13 / 10 = 10.4$					Credit= $4 \times 7 / 10 = 2.8$					Credit= $8 \times 5 / 10 = 4$					17.2

15.2 : Social Relations

"Social Relations" received 20 points under the proposed SSAM rating system, which are split into two categories: guest honoring (10 points) and hospitality (10 points).

15.2.1: Hospitality

It is found that both the traditional and contemporary houses design had to retain a private section or zone for guests; men Majlis with the

Area of Assessment	Sub-areas of Assessment			Total Credits	
Social	10	Hospitality	10	Guest honouring	20

required services. According to the previous discussion, the research

concluded that both traditional and contemporary houses took hospitality as an essential factor in house design to sustain social values. Yet, the traditional Majlis was open even for strangers, while the contemporary Reception is for family guests and relatives. Final rate for the two case studies is 9 /10 for traditional house and 8/10 for the contemporary.

15.2.2 : Guest honouring

Guest honouring is well preserved in the traditional and contemporary houses. The Majlis, in both houses, is big in size (19.6 m² in the traditional and 70 m² in the contemporary), well decorated, and furnished because it is symbol of the owners' hospitality. According to the previous discussion, the research concluded that both traditional and contemporary houses kept guest honouring in design and decorations. Yet, the contemporary house was more elaborate because of the modern life style and high economic standard. Final rate for the two case studies is 8 /10 for traditional house and 9/10 for the contemporary. Final assessment for "Social Relations" criteria is illustrated in Table 17.

Table 17: Final assessments for social sustainability-Social relation

15.3 : Neighbourhood

According to the proposed SSAM rating system, “Neighbourhood” was given 20 credits; these credits are divided as follows: strong neighbourhood relations (8 credits), and preservation of neighbourhood rights (12 credits).

15.3.1: Strong neighbourhood relations

The traditional house was located within organic urban fabric in

Area of Assessment	Sub-areas of Assessment										Total Credits
Traditional House	1	2	3	4	5	1	2	3	4	5	17
	6	7	8	9	10	6	7	8	9	10	
	Credit= $9 \times 10 / 10 = 9$					Credit= $8 \times 10 / 10 = 8$					
Contemporary House	1	2	3	4	5	1	2	3	4	5	17
	6	7	8	9	10	6	7	8	9	10	
	Credit= $8 \times 10 / 10 = 8$					Credit= $9 \times 10 / 10 = 9$					

citadel of Erbil district that kept strong neighbourhood relations. At the contrary, the contemporary house as located in modern residential district surrounded with wide gridiron streets where each family lived within her own property isolated with high walls. According to the previous discussion, the research concluded that the traditional was more successful to keep neighbourhood relations. Final rate for the two case studies is 8 /10 for traditional house and 4/10 for the contemporary

15.3.2 : Preservation of neighbourhood rights

Preserving neighbours’ rights was evident in the traditional house through thick walls, semi-solid elevations, and main entrance door. In spite of modern life style and changes in some social values, neighbours rights are well preserved in the contemporary house where family lives in its private isolated villa surrounded with its own realm in of the plot fences, wide streets, and busy lifestyle According to the previous discussion, the research concluded that both traditional and contemporary houses design has preserved neighbours rights. Final rate for the two case studies is 9 /10 for traditional house and 9/10 for the contemporary. Final assessment for “Neighbourhood” criteria is illustrated in Table 18.

Neighbourhood	8	Strong neighbourhood relations					12	Preservation of neighbourhood rights					20
Traditional House	1	2	3	4	5	1	2	3	4	5	17.2		
	6	7	8	9	10	6	7	8	9	10			
	Credit= $8 \times 8 / 10 = 6.4$					Credit= $9 \times 12 / 10 = 10.8$							

Table18: Final assessment for social sustainability-Neighbourhood

15.4 : Family

According to the proposed SSAM rating system, “Family” was given 25 credits; these credits are divided as follows: strong family ties (15 credits), and extended family (10 credits).

15.4.1: Strong family ties

Relationship between family members is permanent and enduring in Islamic perspective where family is the nuclear seed of society. This factor was evident in the traditional house. The house included several

Contemporary House	1	2	3	4	5	1	2	3	4	5	14
	6	7	8	9	10	6	7	8	9	10	
	Credit= $4 \times 8 / 10 = 3.2$					Credit= $9 \times 12 / 10 = 10.8$					

Area of Assessment	Sub-areas of Assessment										Total Credits
Family	15 Strong family ties					10 Extended family					25
Traditional House	1	2	3	4	5	1	2	3	4	5	17.2

rooms that fit for the grandfather and the grandmother and married sons and daughters. All spaces were opened to the central courtyard creating a common space for the family members to share their everyday life activities. This enhanced family relation ties. The contemporary house reflected the new life style and economic prosperity that allowed each member in the family to have his private room. The contemporary house had three bedrooms in the ground floor and five bedrooms in the first floor; each room is provided with separate bathroom. This type of design affected family ties where each member had his life and interest. According to the previous discussion, the research concluded that the traditional house sustained family ties better than the contemporary did. Final rate for the two case studies is 10 /10 for traditional house and 6/10 for the contemporary.

15.4.2 : Extended family

	6	7	8	9	10	6	7	8	9	10	
	Credit= $10 \times 15 / 10 = 15$					Credit= $9 \times 10 / 10 = 9$					
Contemporary House	1	2	3	4	5	1	2	3	4	5	
	6	7	8	9	10	6	7	8	9	10	
	Credit= $6 \times 15 / 10 = 9$					Credit= $5 \times 10 / 10 = 5$					14

The traditional house was designed to fit to the extended family members where several families (married sons, their wives, and children) shared the same house. The rooms were flexible; they were designed to be a suite for one nuclear family comprising a living room, bedroom, children room, bathroom & store. Thus, most of the rooms tended to be rectangular to fit to multifunctional design. The contemporary house is designed as a final product not allowing for modifying or changing. According to the previous discussion, the research concluded that the traditional house is more flexible for modification, expansions, and change. Thus, it is more sustainable than the contemporary is, because flexibility is one of sustainable architecture principles. Final rate for the two case studies is 9 /10 for traditional house and 5/10 for the contemporary. Final assessment for “Family” criteria is illustrated in Table 19.

Table 19: Final assessment for social sustainability-Family

15.5 : Identity & social status.

"Identity & Social Status" received 10 points under the proposed SSAM rating system.

These points are split as follows: 5 points for self-advocacy and humility, and 5 points for disclosing social standing.

15.5.1 : Humility & self-advocacy

The traditional house was simple, using local materials with plain simple elevations. In the contemporary house, the values of humility began to weaken and self-advocacy became more popular. Elevations were sophisticated with big windows, high porch, classic columns, and curved corners. According to the previous discussion, the research concluded that the traditional reflected humility and simplicity, thus it was more sustainable than the contemporary was. Final rate for the two case studies is 9 /10 for traditional house and 3/10 for the contemporary.

15.5.2: Revealing social status

For the traditional house, richness of inner spaces via the external ones was the main trend in dealing with spaces in term of decorative issues. External elevations were simple, reflecting equity between the rich and poor. The contemporary house represented the social status

reflecting the owner’s economical level and social status. The house facade was painted in pastel colour picked out with white columns and details. According to the previous discussion, the research concluded

Area of Assessment	Sub-areas of Assessment										Total Credits		
Identity & Social Status	5	Humility & self-advocacy					5	Revealing social status					10
Traditional House	1	2	3	4	5	1	2	3	4	5	7.5		
	6	7	8	9	10	6	7	8	9	10			
Credit = $9 \times 5 / 10 = 4.5$					Credit = $6 \times 5 / 10 = 3$								
Contemporary	1	2	3	4	5	1	2	3	4	5	6		
	6	7	8	9	10	6	7	8	9	10			
Credit = $3 \times 5 / 10 = 1.5$					Credit = $9 \times 5 / 10 = 4.5$								

that contemporary house reflected the owner’s identity and social status, while the traditional house reflected society identity and social values. Final rate for the two case studies is 6/10 for traditional house and 9/10 for the contemporary. Final assessment for “Identity & Social Status” criteria is illustrated in Table 20.

Table 20: Final assessment for social sustainability- Identity & Social Status.

SSAM	Areas of Assessment Credits
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According to discussed issues and assessment process for social sustainability criteria for the chosen case studies, it is concluded that traditional house is more socially sustainable. Final assessment results for social sustainability performance are illustrated in Table 21.

Table 21: Final assessment for social sustainability of traditional and contemporary houses

Areas of Assessment	Privacy	Neighbourhood	Social Relations	Famil y	Identity & Social status	Total Credits
	25	20	20	25	10	100
Traditional House	22	17	17.2	24	7.5	87.7
Contemporary House	17.2	17	14	14	6	68.2

16: Conclusions

Examining sustainability potential in architecture in Erbil City concluded that:

Traditional buildings are more sustainable than contemporary.

Traditional houses were more responsive to natural environment and social values. Contemporary houses neglected natural environment, yet they were responsive to social values in a way to accommodate to modern lifestyle.

The comparison in this research is conducted to obtain general conclusions not merely comparison between two objects or buildings. Thus, the results that were obtained from assessing two types of houses (traditional and contemporary) with CA methodology will be generalized as guidelines for sustainability indicators without taking the assessing figures as final findings.

The maximum difference in environmental sustainability performance of traditional and contemporary houses was in “Energy” criteria.

Final assessment for environmental sustainability of traditional and contemporary houses.

SEAM	Areas of Assessment Credits					
Areas of Assessment	Site	Energy	Resources	Indoor Environment	Water & Waste	Total Credits
	15	30	21	13	21	100
Traditional House	12.9	29	20.1	12	14.4	88.4
Contemporary House	9.9	12	13.2	7	6.5	48.3

- Assessing social sustainability performance for the chosen case studies shows that the traditional house was more sustainable than the contemporary was, yet final credits were closer than in assessing environmental sustainability.
- The maximum difference in social sustainability performance of traditional and contemporary houses was in “Family” criteria.

Final assessment for social sustainability of traditional and contemporary houses

SSAM Areas of Assessment	Areas of Assessment Credits					
	Privacy	Neighbourhood	Social Relations	Family	Identity & Social status	Total Credits
	25	20	20	25	10	100
Traditional House	22	17	17.2	24	7.5	87.7
Contemporary House	17.2	17	14	14	6	68.2

- The proposed SAM was an objective, reliable, and applicable method to assess sustainability potential in buildings in the Arab World.

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