



Evaluation of the Sustainable Aspects In Housing Sector To Overcome Housing Stress In Northern Iraq

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ABSTRACT

Northern Iraq as part of Iraq, has been witnessed a great population increment last few decades. However, housing stress in Northern Iraq has risen due to that. Environmental, economic and social sustainability became crucial in the movement towards a more effective built environment and community nowadays. This research seeks to evaluate the presence of sustainability aspects (environmental, economic, and social) in housing sector, which makes them acquired and affordable for low income earners in Northern Iraq. Housing projects as case studies were investigated in Erbil, the capital of Northern Iraq. The research examined, the presence of sustainability aspects. Field observations checklist have been prepared based on the theoretical analysis through literature review and applied to collect data on the case studies. The results demonstrated that applying the aspects of sustainability for the buildings is weak and not clearly familiar in Northern Iraq. The study concluded that, the housing projects focusing on the case studies not sustainable. The findings show that the application of sustainable principles in the housing projects at Northern Iraq is very weak. It is highly recommended to achieve sustainability, because it is the significant way to produce acquired and affordable housing and overcome the housing problems, socially, environmentally and economically. The recommendations have been suggested to formulate new ways for implementing sustainable principles in the housing sector to overcome housing stress in Northern Iraq.

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1. Introduction

The building of house can be seen as the most significant investment one can make for his family. Hence, the house has many considerations for a human being in the different levels of his life, such as economic level, social level, and even on psychological and safety levels. The housing sector of every country is a very important part of the country's economy this is true because bloomed and developed housing sector is an indicator of a strong program of a countries investment and it is a milestone for future economic growth and social cultural development (Joseph, 2006).

Nowadays, the world is getting aware of climate changes, global warming and natural resources depletion on the earth. They try hard to achieve sustainable development (Chiu, 2004). The sustainability in term of design and construction solutions could be applied to support the low-income people, and solve the housing demand problems, as well as promote social, economic and environmental aspects of

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living in Northern Iraq.

Northern Iraq has experienced significant social and economic growth in the last decade along with a strong contrast between poverty and wealth. The populated city in this region, and Erbil city, as a capital of the region has also witnessed this phenomenon. The disparity in the living environment demonstrates the gap between rich and poor. The lack of housing policy by the region government increased the housing problems (Faraj, 2014). In Northern Iraq There are a significant number of households with no houses, and the current rate of housing occupancy is relatively high (1.37 household per each housing unit and 2.23 person/room) (Ministry of Planning, 2011). That indicates a large housing deficit (about 250,000 housing units are needed in 2016) according to Ministry of construction and Housing-KRG-Iraq estimates (Ministry of Planning, 2012a). In another hand, the modern houses are neither sustainable nor affordable in meeting the financial and environmental needs of the occupants. Missing of government regulations on affordable and sustainable housing creates an obstacle to the application of sustainable methods.

2. Literature Review

2.1 Housing

Housing considers as, one of the fundamental needs of human and it is the most important for his survival after the needs for food (Muhy Al-Din, 2017). Housing, both in units or multiple forms is one of the important parts of community structure, which provide the important need for the human being who is the most important part of the society. The development of the people related to the type and condition of the housing, which consequently develops the countries. It is also an indicator of people level of living and their position in the society (Olayiwola, et al., 2005). The housing can be seen as a big issue mostly for the urban populace and the less privileged areas of the society. The housing problem is agreed as being a complex. This problem seems difficult to solve and it is worldwide. Hence, it is very difficult for any country in the world to meet its housing requirements (Abiodun, 1985). According to Maslow's hierarchy of needs based on Maslow's theory, shelter, sleep etc coming in the second main needs after biological and physiological needs. If these needs are not met, the human body cannot continue to function (Maslow, 1943).

Housing is also one of the basic rights of the human. The Universal Declaration of Human Rights (1948), article 25 states; "Everyone has the right to a standard of living adequate for

the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services".

When a large number of people living in the city became more competitive, the demand for housing will increase then the gap between housing demand and supply will enlarge if the construction speed is lower than housing demand. The young households and low-income households have the lower competition power and maybe they will become homeless because it is difficult for them to enter the housing market.

2.2 Sustainability and Housing

Because of the desires to overcome the environmental problems, which the world facing it in twenty first century, the efforts towards sustainability are now the important subject globally. Quick growth of urbanization will continue rising demand for housing. Housing formulation has developed in remarkable way over the years. The desire for the welfare of future generations is also important. To achieve these desires there is an urgent need to balance urban planning, design and construction. Therefore, sustainability became a necessity and the application of sustainable principles in design and construction is crucial for the survival of natural resources for next generations. United Nations World Commission on Environment and Development (UNWCED), defined Sustainability was defined as that which "meets the needs of the present without compromising the ability of future generations to meet their own needs" (1987), (Al Surf, 2014). Sustainable development and housing are directly affect one another, as Section 7.67 of the United Nations' Agenda 21 states: "The activities of the construction sector are vital to the achievement of the national socio-economic development goals of providing shelter, infrastructure and employment. However, they can be a major source of environmental damage through depletion of the natural resource base, degradation of fragile eco-zones, chemical pollution and the use of building materials harmful to human health"(UN -Agenda 21, 2004).

The core of sustainability consists of three main pillars, interlocking circles creates the sustainability. Sustainable development could be elucidating in terms of environmental protection, economic growth, and social development (Adams, 2006). These aspects should be considered in order to implement a desired level of sustainable development. See figure '1'.

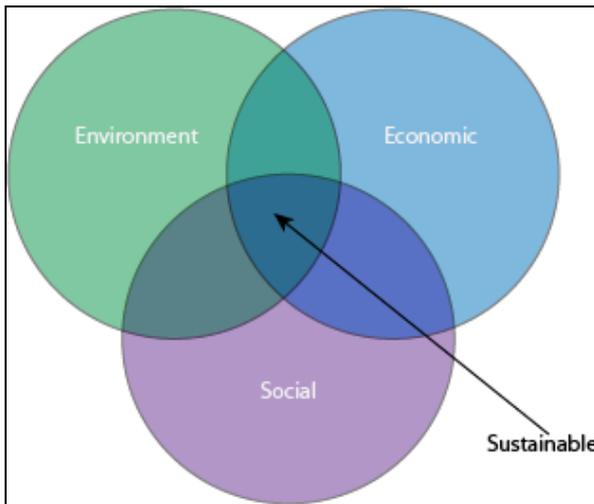


Figure 1. Three main aspects of sustainability.(URL1)

Housing development can be considered one of the crucial issues for sustainable development, because of its long life-span and its direct and indirect impact on human's life. Despite that housing is one of the significant ways to reach the goals of sustainability; however, the researches demonstrate that it is one of the more neglected aspects of sustainability (Winston & Eastaway, 2008). Therefore it is important to find methods to ensure that new housing projects are sustainable.

2.3 Sustainable Factors and Housing System

A sustainable house characterized by cost-efficient over time period, also, comfortable, and eco-friendly. In the same context, sustainable housing could be defined as housing, which looking for integral quality, including social, economic, and environmental performance (Adebayo, 2013). In the social dimension Sustainable housing offers a better environment which encourages residents to stay at home longer among friends and families and neighbor in the social context (Abidin, and Jaapar, 2008). One of the important factors to conduct sustainability in any community is providing decent and affordable housing (Maliene, et al., 2008). Generally, housing can achieve sustainability through the three main dimensions of sustainability: Environmental sustainability, economic sustainability and Socio-political sustainability (McConville, 2006). Table '1', demonstrates the main elements to achieve sustainable housing considering the three dimension of sustainability.

Table 1. The elements to achieve the three dimension of sustainability (McConville, 2006).

Economic Sustainability		Implies that sufficient local resources and capacity exist to continue the project in the absence of outside resources.
Environmental Sustainability		Implies that non-renewable and other natural resources are not depleted nor destroyed for short-term improvements.
Social Sustainability	Socio-Cultural Respect	A socially acceptable project is built on an understanding of local traditions and core values.
	Community Participation	A process which fosters empowerment and ownership in community members through direct participation in development decision-making affecting the community.
Political Cohesion		Involves increasing the alignment of development projects with host country priorities and coordinating aid efforts at all levels (local, national, and international) to increase ownership and efficient delivery of services.

2.4 Sustainable House design principles

Constructions and housing as part of it, involves into socio-economic development deeply and makes significant use of the resources in Nature and affects the generation of greenhouse gasses through buildings (Asif et al., 2005). Sustainable housing main principles are to provide the safety and comfort to occupants as well as the surrounding environment and society. The principles ensure healthy living quality, and in harmony with nature (Abidin and Jaapar, 2008). This principle needs care for future generations without compromising the demands of the present generation. There are several principles of sustainable housing applied around the world. In environmental dimension, are:

1. Apply energy efficiency in the buildings through the optimum orientation, optimum sun incidence into the buildings, introducing ventilation, natural lighting into the building, and use renewable energy technologies in building services (Muhy Al-Din, et al., 2017).
2. Ensure good indoor air quality with achieving thermal, visual, as well as acoustic comfort into the building. This will include low volatile organic compounds usage, inner air filtration, and proper humidity.
3. Selecting a proper site with the accessibility to public transport, services, and open space.
4. Choosing materials that have low impact on the environment and human (Minke, 2006; Koenigsberger, et al., 2010)
5. Rainwater harvesting, recycling the water and water system equipment.

In other dimensions such as social and economic dimensions, assuring social equity and affordability in the housing are the main points to achieve sustainable design principles in housing (Sani and Chi munaaim, 2012).

2.5 Characteristics of Sustainable Housing

Based on the literature review the characteristic of sustainable housing could be including;

- 1) A house which meets the government financial obligation and individual ability without policy change.
- 2) An acceptable building within the people in the society, through understanding traditional and core value.
- 3) A building that does not increase social exclusion or segregation.
- 4) A building that is located on a site with minimum impact on nature biodiversity.
- 5). A building that is located on a site with maximum low-energy consumption.
- 6). A building that encompasses the following environmental features; applies efficient materials, passive solar design, water conservation, appropriate waste management during the construction (Pullen *et al.*, 2010). Whole above points characterize the sustainability based on the literature review, whereas points '1 and 2' concerning economic sustainability. In the same context, the points '2, 3 and 5' related to social sustainability, and the points '4, 5 & 6' are related to environmental sustainability (Pullen *et al.*, 2010). See table '2'.

Table 2. The characteristic of sustainable housing according to literature review. (Pullen *et al.*, 2010)

Sustainability	Economic	1) Meets the government financial obligation and individual ability; 2) Acceptable building within the people in the society; 3) Has low-energy consumption
	Social	1) Acceptable building within the people in the society through understanding traditional and core value; 2) Does not increase social exclusion or segregation
	Environmental	1) Has a minimum impact on nature biodiversity; 2) Has low-energy consumption; 3) Applies efficient materials, passive solar design, water conservation, appropriate waste management during the construction.

Sustainable design in buildings and particularly houses, in Northern Iraq, is still not following the sustainability because of the lack of awareness about the payback principle of sustainable design strategies. Therefore, the concept is not present.

2.6 Northern Iraq

Northern Iraq, is located in the North-East of Iraq, and its capital is Erbil, as seen in figure '2'. The area of the region is almost 42,812 Km². The population of this region represents almost 17% of the total population of the Republic of Iraq. Northern Iraq is located between latitudes 34.7°

N and 37.4° N and longitudes 42.4° E, and 46.25° E, (Rashid, 2014).

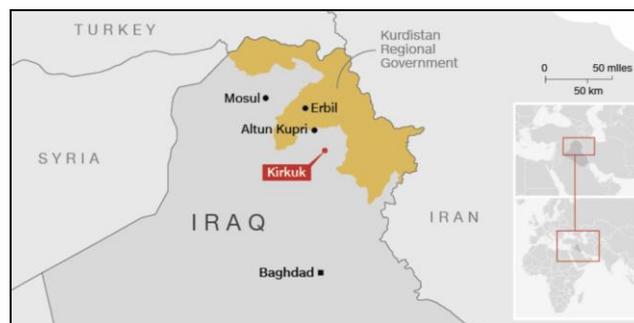


Figure 2. Northern Iraq (Kurdistan region of Iraq). URL 2

The following data will give some indicators about the region, as seen in table '3';

Table 3. General information about Northern Iraq. (Ministry of Planning, 2011)

Governorate	Erbil (Capital), Sulaimanyah, and Duhok
Language	Kurdish & Arabic
Religion	Muslims, Christians, Yezidi, etc.
Ethnic Groups	Majority: Kurds Minority: Turkmen, Arabs, Assyrians, Chaldeans, , Armenians, etc.
Currency	Iraqi Dinar (IQD)
Rate of Exchange front of US Dollar	1 USD = 1200 Iraqi Dinar (IQD) (as average)
Annual average income per Capita in (IQD), 2003-2011	976,794 - 7,693,200 *

*1: 1 US Dollar = 1250 IQD, Source: (Ministry of Planning, 2011)

2.6.1 Housing Stress in Northern Iraq

Based on several studies, economic and social surveys conducted recently in the region, for assessments of the existing housing condition, all of these demonstrated a shortage of housing. The demands are to secure at least 250,000 housing units between 2012-2016 according to Ministry of Construction and Housing in the region (Ministry of Planning, 2011).

In other report for Ministry of Planning in the region (2012) assert that, the population in the region has been estimated at 5,432,000 people or 1,131,700 households in 2012, and the growing rate is at around 2.7% a year. Based on this, information and the annual housing requirement to accommodate the people based on the annual growth rate in the region are 30,390 units including all income levels, assuming separate houses for each householder. The government in the region Housing strategy 2012 estimates that almost 25% of existing households require improved housing or new one in order to change inadequate

housing (Shawkat, *et al.*, 2018). This means other 283,000 houses for all income levels. To overcome the problem within 10 years, 28,300 new or improved houses are required. Thus, according to the previous data, the annual housing demand is 58,690 (30,390 + 28,300) housing units (Ministry of Planning, 2012b). In general view, the most of the existing housings are usually built by private small builders working separately for different customers who have their independent finance and design to run the process. There are no enough data or researches on the size of the housing in the region and relying on old data of the housing statistics carried on several years ago, which does not reflect clear picture. The houses number made by the Ministry of Construction and Housing until the end of 2009 was 25,331 units (45.5% in Erbil, 5.3% in Duhok and 49.2% in Sulaimanyah). Whereas, the apartments number were made by the Ministry in the same period was 4,456 apartments distributed by 77.6%, 22.4% in Erbil and Sulaimanyah, respectively. On the same line, the number of houses which implemented by the investment projects system were estimated by 11,240 units included; 24.5% of the houses in Erbil, 67.5% in Sulaymaniyah and 8% in Duhok, (Ministry of Planning, 2011). Recently, there is a great demand on housings that should be considered as one of the serious challenges in the Northern Iraq.

3. Methodology

In order to validate and enhance the credibility of the research, the real-life case study for affordable projects have been selected from Northern Iraq, and then the data collection and analysis will be acquired. Both primary and secondary data sources were used in the study. To reach an adequate understanding about the main ideas and theories related to the topic. The literature review was carried out through different sources, such as documents, government reports, books, previous researches and studies, published and unpublished materials internet and electronic documents, as well as architectural and planning journals. Secondary data collection have been used in this research, where, the analysis of the case studies have been conducted base on assessment of the 'Check List' prepared to be tested through site observation to evaluate the use of sustainable aspects in the projects. The self-observation has been conducted, through the site visit, studying the documentary and plans of the projects. Furthermore, theoretical analysis of the house has been approached, to investigate sustainable principles according to

the three aspects of sustainability, economic, environmental, and social. The assessment of the aspects was implemented as per each dimension concerns, which provided based on previous literature review as seen in Figure '3'.

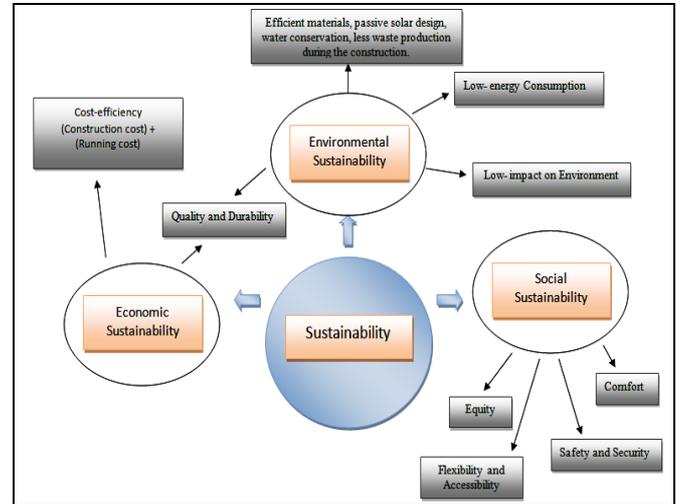


Figure 3. Assessments of sustainability three dimensions based on their factors. (By Auther). Source: (McConville, 2006; Abidin, and Jaapar, 2008; Zainul Abidin and Pasquire, 2005; Muhy Al-Din, et al., 2017; Asif et al., 2005; Sani and Chi munaaim, 2012; Dell'Isola and Stephen, 1981; Minke, 2006; Koenigsberger, et al., 2010; Jin Kim, 1998; American Institute of Architects, 1992; Ilberg, and Rollins, 2007; Pullen et al., 2009)

3.1 Case Studies

Two housing projects have been selected as case studies. The goal behind analyzing any case study is to get a comprehensive intelligibility about the case to learn lessons (Waltz *et al.*, 2010). The case studies were selected based on the several criteria, namely; the case study should be a housing project; the case studies should have relatively the same construction age; the projects should be in the area of Northern Iraq.

3.1.1 First case study 'Goollun City'

The project has been implemented at Erbil City near 'Ankawa' district, and far from Erbil center (Citadel of Erbil) around 5.27 km, as seen in figure '4'.



Figure 4. The location of Goollun City housing project. Source: Google Earth.

The project started in 2008 and ended in last quarter of 2010, which contains 610 houses, and the evaluated price for each house is 55,000 US Dollar, around 68,750,000 IQD (Taken by the author from Municipality of Erbil, January, 2017). The project executed by Investment sector, and all the houses are occupied. The houses are semi-detach houses, and total land area is 200 m², whereas, the building area is 200 m², 110 m² for the ground floor and 90 m² for the first. See figure '5'.



Figure 5. Goollun City housing project. (By Author).

3.1.2 Second case study 'Aarshum project'

The project started in 2009 and completed in 2011, and located at north part of Erbil city, 4 km from Erbil center (Citadel of Erbil), see figure '6'.

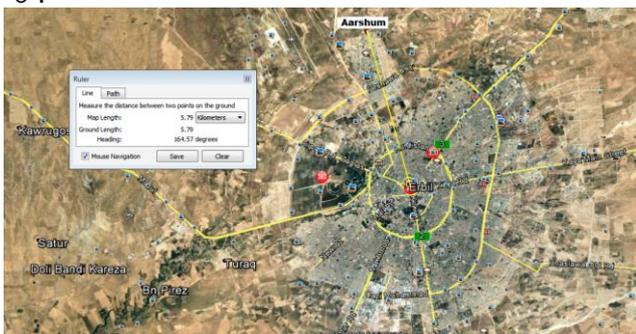


Figure 6. Location of Aarshum Housing Project. Source: (Google Earth, 2017)

The project contains 500 houses, and the evaluated price for each house is 35,000 US Dollar, around 43,750,000 IQD (Taken by the author from Municipality of Erbil, January, 2017). The project executed by government and private sector, and all the houses are occupied. The houses are raw housing system, and total land area is 200 m², whereas, the building area is 147 m², one floor. See figure '7'.



Figure 7. Aarshum Project. (By Author).

3.2 Field Observation

The observation is one of the commonly used methods, which the information is collected by researcher through direct investigation. In this method personal tendency could be neutralized, information acquires by current events (Kothari, 2004). It had been used to observe sustainable principles in the houses for the selected case studies in Erbil city. Checklist has been prepared by the researcher to assess the sustainable factors in the houses. For sustainability analysis three aspects of sustainability were analyzed, which are (environment, economy, and society). The factors have been formulated based on literature review and depending on several studies and references. Fourteen factors were identified to cover the three dimensions of the sustainability to apply on the case studies in order to get intelligible understanding about the presence of sustainability in the housing in Northern Iraq. Each dimension of sustainability (environmental, economic, and social) was identified by several factors according to their relation and effects to the aspect. See table '4'.

Table 3. The assessment checklist for sustainable factor presence in the housing. (By Author)

No	Aspects of Sustainability. (Adams, 2006); (Adebayo, 2013); (Winston & Eastaway, 2008); (McConville, 2006)	Sustainable factor	References
1	Environmental Sustainability	Passive solar design Cooling/heating strategies (Less use of mechanical cooling)	(Koenigsberger, et al., 2010); (McConville, 2006); (Zainul Abidin and Pasquire, 2005); (Sani and Chi munaaim, 2012); (Muhy Al-Din, et al., 2017).
2		Thermal Insulation	(Koenigsberger, et al., 2010); (Sani and Chi munaaim, 2012)
3		Water Conservation	(Minke, 2006); (Muhy Al-Din, et al., 2017); (Sani and Chi munaaim, 2012); (Ilberg, and Rollins, 2007);
4		Availability of Green Area	(Sani and Chi munaaim, 2012); (Pullen et al., 2009)
5		Site Orientation	(Koenigsberger, et al., 2010); (Pullen et al., 2009); (Muhy Al-Din, et al., 2017); (Sani and Chi munaaim, 2012)
6		Low- impact on Environment (Using local, eco-friendly materials and equipments in the building)	(Minke, 2006); (Asif et al., 2005); (McConville, 2006); (Zainul Abidin and Pasquire, 2005); (Dell'Isola and Stephen, 1981); (Sani and Chi munaaim, 2012); (Jin Kim, 1998); (American Institute of Architects, 1992); (Pullen et al., 2009); (Ilberg, and Rollins, 2007)
7		Low- energy Consumption (Use of Green Energy)	(McConville, 2006); (Minke, 2006); (Koenigsberger, et al., 2010); (American Institute of Architects, 1992)
8		Environmental & Economical Sustainability	Structural Quality, Durability, and Low Maintenance Cost

9	Economical Sustainability	Cost – efficiency (Construction + Running costs)	(Dell'Isola and Stephen, 1981); (McConville, 2006); (American Institute of Architects, 1992); (Pullen et al., 2009); (Ilberg, and Rollins, 2007)
10	Social Sustainability	Flexibility and accessibility (Near all amenities)	(Pullen et al., 2009); (Sani and Chi munaaim, 2012)
11		Safety (Indoor Air Quality, and Physical Health 'Wellbeing')	(Jin Kim, 1998); (Zainul Abidin and Pasquire, 2005); (Pullen et al., 2009)
12		Equity (Suitable for the local social context and cultures)	(McConville, 2006); (Pullen et al., 2009); (American Institute of Architects, 1992)
13		Comfort (proper inner spaces for the users, comfortable services)	(Abidin, and Jaapar, 2008); (Zainul Abidin and Pasquire, 2005); (Koenigsberger, et al., 2010); (Pullen et al., 2009)
14		Security (proper Urban planning for the safety of the occupants and their movement and activities)	(Sani and Chi munaaim, 2012); (Jin Kim, 1998); (Pullen et al., 2009)

The checklist assessment of sustainability with included factors have been evaluated through DST (Descriptive Statistical Tools) as well, and the percentage were considered as a scale to recognize the presence of sustainability in the houses, following the availability of the factors which are fourteen factors and find the percentage based on presence of these factors in the case study houses. The assessment carried out by the researcher based on theoretical analysis.

4. Data analysis & Discussion

Based on the three main dimensions of sustainability, environmental aspect, economical aspect as well as social aspect, there are many factors to implement each of these dimensions in the buildings as per the prepared "Check List".

4.1 'Goollun city' housing field observation data (First case study)

The result were obtained for the field observation according to checklist form, which prepared by the researcher to analyze the sustainability in 'Goollun City' houses. The factors to evaluate the sustainability in the housing sectors were investigated as shown;

The first factor in the checklist was the availability of passive solar design cooling/heating strategies, as part of environmental sustainability was investigated through personal visit. Passive design strategies are important to the climate of Erbil. There are many effective strategies to reduce heating/cooling exchange through inside and outside, such as wall thick mass. Also, examine the window or opening response to sunlight entrance or block into the building, as well as the ventilation which is relatively limited in harsh seasons in Erbil. The result was negative because the designer didn't take into consideration any of these passive strategies during the design of the housing units. Second factor was missing in all the housing units according the existing condition and design documents of the project. Third factor had been missing as well through examine the existence of any ground water storage for rain water harvesting or water re-cycling system in the houses. The front garden or green area were founded in the houses unites, as seen in figure '8'. Factor number five was the orientation of the building according to their response to sun path. The observations demonstrate that the units are oriented in all the directions regardless the relation with the sun or manipulating the building envelope for this purpose.



Figure 8. Front Garden of the houses in Goollun City

Low- impact on the environment as the sixth factor in the checklist were assessed through examine the usage of local materials like natural stones as an eco-friendly materials, also examine the type of equipment used at the

houses as electrical sets, cookers, heating and cooling sets, and how much they are eco-friendly. The observations showed that building materials for masonry units are concrete block. It is containing aggregate and cement and that has more impact on environment comparison with bricks, or natural stone which is very good building material in Northern Iraq. The slab and foundation had been achieved by using reinforced concrete, which considers very much impacted on environment. The factor number seven is showed negative because of missing any green energy system application in the building even the solar panels.

Factor number eight in the check list was 'structural quality and durability' were tested through watching the material and construction technique. The houses demonstrate durability in the view of sustainability, as well as Low Maintenance cost. The main material in the building is concrete and steel which provide high durability and low maintenance during the age of the building. The ninth factor was 'Construction cost –efficiency and running costs. The factor showed that the construction cost is not efficient, based on the analysis of construction cost compared with average construction cost in Northern Iraq which it is 300,000 IQD according to Ministry of Construction & Housing, Republic of Iraq (2006). As per the price of the houses which is 68,750,000 IQD and the area of the constructed which is totally 200 square meter for both floors, the cost of the building per square meter will be as shown;

$$\text{One Square meter building} = \frac{\text{Total price of building}}{\text{Total area of building}} \dots\dots\dots (1)$$

After apply the data in the formula '1', the results will be 343,750 IQD, which indicate that the cost of the building price is already higher than average, whereas the price should be even lower than average market price to achieve the efficiency. Take in the consideration that the land is free of charge and subsidized by government to the investors.

In the factor number ten, the 'Flexibility and Accessibility' were analysed and found that the project is located on country-side of the city. Despite of that, the project is relatively far from the city centre, but the accessibility to the place or from the place to the city centre is not difficult, because of the availability of public cars and paved roads.

In the factor number eleven, 'Safety (indoor air quality, and physical health', the evaluation of the building inner spaces division carried out and found. Apertures quality is PVC and low infiltration take place through them, thus, the

quality of inner air could be controlled. Also, the existence of frontage garden will promote the wellbeing, as seen in figure '9'.

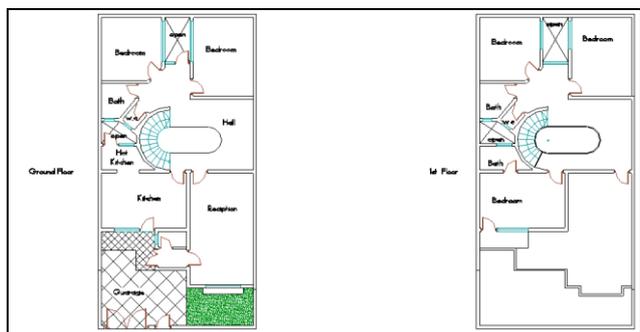


Figure 9. The plan of the both floors in single house in the Goollun city Housing Project. (By Author).

Equity (suitable for the local social context and cultures) is another factor for sustainability (social sustainability), which is very important in the society of Erbil, which it could be consider relatively closed society. Hence, the design analysis found that the specialty has given to family zones and guest zones and some of separation is considered in the design between the occupant's families. Bedrooms and services are well managed as well. See figure '9'.

In the factor number thirteen 'Comfort and proper inner spaces for the users, comfortable services), is includes the comfort of occupants. After the field observation the research came out with; there are weakness in services management of the housing project from the investors (who are responsible for provision of the services like water, electricity, etc.) according to Investment contraction. That affected occupants comfort inside the buildings due to shortage in providing electricity and water.

Last factor of sustainability in the checklist form is proper planning for the safety of the occupants and their movement and security. The field observation showed that the security of the housing project is provided. This was done through entrance, exit check points and also providing the location of school buildings within the 'walkability' distances for the primary and secondary schools without crossing any main street. Super block design concept is applied in the project.

Based on previous explanation the checklist form for the first case study was as shown in table '5'.

Table 4. Sustainability assessment in the houses of First Case study 'Goollun' city, based on prepared Check list form.

	Aspects	Sustainable factor	Criteria for judgment	Presence of the factor	
				Yes	No
1	Environmental Sustainability	Passive solar design Cooling/heating strategies (Less use of mechanical cooling)	Site visit to check the existence of thermal mass walls, successful incidence of sunlight as per requirements, ventilation, etc.		●
2		Thermal Insulation	Personal site visit		●
3		Water Conservation	Existence of rain harvesting system or water conservation sanitation fittings such as sensors taps, etc. Using construction materials, which needs less water consumption		●
4		Availability of Green Area	Site visit and based on the units design	●	
5		Site Orientation	Site visit and examine the sun path in different seasons		●
6		Low- impact on Environment (Using local, eco-friendly materials and equipments in the building)	Site visit to investigate construction materials properties, and investigate the cooling and heating system		●
7		Low- energy Consumption (Use of Green Energy)	Investigate the presence of renewable energy technologies in the building such as photovoltaic or solar panels		●
8		Environmental & Economical	Structural Quality, Durability, and Low Maintenance Cost	Site visit and structural design review	●

9	Economical Sustainability	Cost – efficiency (Construction + Running costs)	Construction cost per square meter, analysis and compare it with the standards.		●
10	Social Sustainability	Flexibility and accessibility (Near all amenities)	Based on Site visit, and location analysis	●	
11		Safety (Indoor Air Quality, and Physical Health 'Wellbeing')	Design analysis; inner space analysis, aperture location analysis, and construction material used.	●	
12		Equity (Suitable for the local social context and cultures)	Personal assessment of the design through achieving private zones and gathering zones inside the building	●	
13		Comfort (proper inner spaces for the users, comfortable services)	Housing project management assessment, after handing over the project to dwellers		●
14		Security (proper Urban planning for the safety of the occupants and their movement and activities)	Site study and assessment.	●	

4.2. 'Aarshum' governmental with private sector participation Project's field observation data (Second case study)

The result for the second case study had been obtained with the same way of the first case study. The observation of the factors in the second case studies demonstrated relatively similar result of the first case study regarding the presence or absence of the sustainable factors in the project, with some difference in the social sustainability dimensions factors, and the checklist form had been implemented as shown in table '6'.

Table 5. Sustainability assessment in the houses of First Case study 'Goollun' city, based on prepared Check list form.

	Aspects	Sustainable factor	Criteria for judgment	Presence of the factor	
				Yes	No
1	Environment I Sustainability	Passive solar design Cooling/ heating strategies (Less use of mechanical cooling)	Site visit to check the existence of thermal mass walls, successful incidence of sunlight as per requirements, ventilation, etc.		●
2		Thermal Insulation	Personal site visit		●
3		Water Conservation	Existence of rain harvesting system or water conservation sanitation fittings such as sensors taps, etc. Using construction materials, which needs less water consumption		●
4		Availability of Green Area	Site visit and based on the units design	●	
5		Site Orientation	Site visit and examine the sun path in different seasons		●
6		Low- impact on Environment (Using local, eco-friendly materials and equipment in the building)	Site visit to investigate construction materials properties, and investigate the cooling and heating system		●
7		Low- energy Consumption (Use of Green Energy)	Investigate the presence of renewable energy technologies in the building such as photovoltaic or solar panels		●
8	Environment I & Economical	Structural Quality, Durability, and Low Maintenance Cost	Site visit and structural design review	●	
9	Economical Sustainability	Cost –efficiency (Construction + Running costs)	Construction cost per square meter, analysis and compare it with the standards.		●
10	Social Sustainability	Flexibility and accessibility (Near all amenities)	Based on Site visit, and location analysis		●
11		Safety (Indoor Air Quality, and Physical Health 'Wellbeing')	Design analysis; inner space analysis, aperture location analysis, and construction material used.	●	

12	Equity (Suitable for the local social context and cultures)	Personal assessment of the design through achieving private zones and gathering zones inside the building	●	
13	Comfort (proper inner spaces for the users, comfortable services)	Housing project management assessment, after handing over the project to dwellers		●
14	Security (proper Urban planning for the safety of the occupants and their movement and activities)	Site study and assessment.	●	

The first factor in the checklist the result was negative because of the same reason in previous case study. The designer didn't take into consideration any of the passive strategies during the design of the housing units, to reduce heating and cooling in different seasons. Second and third factors were missing in all the houses according the building design documents of the project and existing condition based on field observation. The fourth factor was implemented through frontage garden in the houses unites, as seen in figure '10'.



Figure 10. The frontage garden (green area) in the houses at Aarshum project. (By Author)

The field observation about the orientation of the building demonstrates the missing of this factor which is the fifth factor. The sixth factor in the checklist were assessed through examine as in the first case study. The field observations showed that building materials is the same materials that used in the first case study. The factor number seven is missing because of the absence of green energy system application in the building. Eighth factor in the houses demonstrate durability in the view of sustainability, as well as Low Maintenance cost, because it holds the similar character of the first case study.

The factor number nine showed that the construction cost is not efficient, based on the same analysis, which have been carried out for the first case study. As per the price of the houses which is 47,500,000 IQD and the net building area of the houses is 147 m². According to the formula '1', the cost of building per square meter equal to 327,381 IQD, which is also higher than market average cost. Despite of the price in the second case study is relatively cheaper in one square meter of construction if compare it with the first case study, but it is still not efficient. In this project also the land is free of charge and provided by government itself to the project. Factor number ten, the 'Flexibility and Accessibility' in the second case study were analysed. The project is located on country-side of the city, and farther than first case study by 500 meter which is partially unpaved road. This makes the accessibility more difficult than which is in the first case study. Hence, in this case study the field observation found that the accessibility is difficult especially in rainy seasons if the road stayed un-paved. Therefore the factor number is missing in this project in time; it was available in the first case study. For the factor number eleven of the checklist, the field observation found it available according to the same analysis for the first case study, see figure '11';

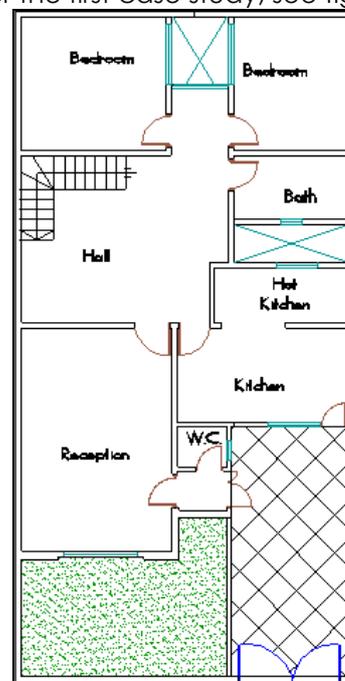


Figure 11. The plan of the house in the Aarshum Housing Project. (By Author)

Factor number Twelve, found available through design analysis based on the similar observation for the first case study. See figure '11'. In the factor number thirteen and after the field observation the researcher found the comfort is missing mainly because of the number of

occupants in each residence unit. There is also shortage in electricity provision, and that is general problem in Erbil and Northern Iraq, which increases the uncomfortable situation especially in cold and hot seasons. For the last factor, based on the same analysis had been done for the first case study, the security of the housing project is available.

4.3 Summary of the sustainability in both case studies

Through the analysis of the sustainability in the houses for both case studies, the results can be summarized. Table '7', demonstrate the ratio of sustainability in the houses of both case studies for three dimensions; environmental sustainability, economic sustainability, and social sustainability), as per the checklist factors.

Table 6. The percentage of sustainability in the case study houses as per prepared factors in the checklist. (By Author)

No.	Sustainability dimension (aspect)	1 st Case study (Goollun)	2 nd Case Study (Aarshum)
1	Environmental Sustainability	25%	25%
2	Economical Sustainability	50%	50%
3	Social Sustainability	80%	60%

According to table 7, the results shows that both case studies have remarkable deficiency in implementing sustainability, especially in the environmental dimension which affect directly the running cost of the building. Economic dimension in both case studies could be improved. The social sustainability has the highest percentage and the first case study registered higher than the second one, because the first case study is more expensive with more facilities compared with the second one.

5. Conclusion

The significant social and economic growth in Northern Iraq creates a strong contrast between poverty and wealth in the last decade. That projected on the cost of the residential units in the region. Provision of the residential units for each family is aim of the most governmental bodies, including the government of Northern Iraq. Low earners in Northern Iraq are facing difficulties in maintaining their life because of the cost of housing provision. To overcome this challenges housing stress in Northern Iraq, requires a deliberate and embracing strategy among the participators to reach successful results in overcoming housing problems. Sustainability in

the housing sectors is the significant factor in order to achieve that. Three dimension of sustainability should be considered by the authorities during the implementation of housing projects. Sustainability is crucial to be implemented not only to overcome the housing problem, but in order to don't compromise the rights of next generations for better life.

The research found that the sustainability is applied in very weak level in the housing projects in Northern Iraq. The reason behind that is the absence of the legislation and the awareness about sustainability (especially environmental sustainability which is significant for controlling running cost of the building.). The observations showed that the buildings were neglecting many fields as renewable energy and water conservation, etc., even the passive design strategies were absent in general for those buildings. Hence, almost one quarter of environmental sustainability had implemented according to the prepared checklist for field observation in this research. The economic sustainability was achieved in the building durability and long life term only, that based on the questionnaire and field observation. In the same time the application of local materials or re-cycled one was missing according to field observation in both case studies. The economic sustainability achieved 50% of the requirement as per the checklist of this research. Social sustainability was examined through field observation and found that the social sustainability has been scored more than other dimensions and has been implemented in 'Goollun City' project with higher score than 'Aarshum' project. The reason is because of the first project is more expensive with more facilities compared with the second one. Thus the social sustainability achieved based on the increment in the building cost which is indicates that the strategies was not perfect in achieving social sustainability when it conflict with cost. The extra initial costs of sustainable materials and strategies have discouraged people to apply sustainable housing concept in the region. It is still difficult to apply a sustainable housing concept in Northern Iraq, which consider very new developing society.

5.1 Recommendations

According to, the obtained results in this research that has been carried out, the following recommendation have been made, to be taken into the consideration for the future, and in order to overcome the problems of housing stress;

- 1) The participators in the housing projects processes should evaluate highly the sustainable strategies and techniques in their projects. Hence, it is recommended to add new legislations about sustainable standards in construction specification and codes.
- 2) The designers and contractors should follow these codes and specification under surveillance of technical sectors in the government authorities. The owners and house holders should be aware about the payback of any extra cost could be spent in order to achieve sustainability at the beginning.
- 3) Designing of houses according to climate response should be encouraged to achieve environmental sustainability and obtain healthy environment for the people, and local building materials such as natural stones, should be studied and improved to produce cost-effective and durable houses.
- 4) Energy saving systems such should be encouraged and supported by government to enhance the sustainable culture among the people.
- 5) Establishment of sustainable construction material manufacturing in Northern Iraq in order to reduce the initial cost of these materials when they are imported from abroad.
- 6) Applying new technologies and methods in the construction that cost less than traditional ways or the existing ones, in order to reduce the cost of the construction. Also apply new cheaper materials in the construction process in order to reduce the cost without affecting the quality of the construction.

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Conflict of interests

The author declares no conflict of interest.

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