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DEVELOPING ASSESSMENT TOOL FOR NEW AND RETROFIT RESIDENTIAL BUILDING IN WEST BANK, PALESTINE

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Master's Thesis in Civil Engineering
International Master Programme in Sustainable Built Environment

This work was carried out under the supervision of
Professor Ricardo Mateus

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"No research without action, no action without research" Kurt Lewin.

RESUMO

Países em desenvolvimento introduzem a sustentabilidade na indústria da construção, especialmente em obras residenciais em prol de resolver as suas questões de acordo com a Agenda 21 de 2002 para a construção sustentável nos países em desenvolvimento. West Bank, na Palestina, é parte de um país em desenvolvimento e um caso especial; tem sido ocupado desde 1967 e necessita com urgência de uma aplicação de construção sustentável. Assim, o objetivo dessa dissertação é contribuir para um melhor entendimento sobre o conceito de sustentabilidade social em edificios residenciais, pois este é o componente mais importante de uma habitação sustentável. Para alcançar esse objetivo, uma estrutura de avaliação do performance social das obras residenciais de West Bank é proposta. A avaliação da sustentabilidade em edificios está em constante evolução e difere de localidade para localidade. Por causa disto, a estrutura apresentada nessa dissertação baseia se sobretudo, nos indicadores de sustentabilidade dos métodos internacionais de avaliação da sustentabilidade (Code for Homes, LEED for Homes e SBTool) e suas aplicabilidades no contexto palestiniono. Em seguida, essa lista preliminar de indicadores foi validada através de entrevistas com profissionais da área. O passo seguinte foi classificar cada indicador de sustentabilidade social de acordo com sua importância no contexto palestiniono, considerando um painel composto por especialistas e usuários de edificios residenciais. Para tanto, foram realizados dois levantamentos para avaliar a opinião dos especialistas em construção civil e moradores quanto à importância dos indicadores de sustentabilidade social. Então, a importância de cada indicador foi definida usando o método AHP. Desse modo, essa pesquisa propôs uma estrutura de avaliação do fator social de sustentabilidade de prédios em Cisjordânia, na Palestina, que é composta por vinte e um indicadores distribuídos em seis categorias de sustentabilidade.

Palavras-chave: Construindo métodos de avaliação de sustentabilidade, Sustentabilidade social, Construção residencial, Sistema de classificação, Países em desenvolvimento, West Babk, Palestina.

ABSTRACT

Developing countries have to introduce sustainability in the construction industry, especially in the residential buildings to solve their issues according to the Agenda 21 for Sustainable Construction in Developing Countries (2002). West Bank, Palestine, is a part of a developing country and a special case, suffering from occupation since 1967, and is in need for an urgent sustainable construction application. Therefore, the goal of this master thesis is to contribute to a better understanding about the concept of social sustainability in the residential building because it is the most important component of the sustainable housing. In order to pursue this goal, a framework to assess the societal performance of West Bank's residential building is proposed. Assessing the sustainability in buildings is constantly evolving and differ from place to place. Because of that, the framework presented in this master thesis is above all, based on the sustainability indicators of international sustainability assessment methods (Code for Homes, LEED for Homes and SB Tool) and their applicability in the Palestinian context. As a next step this preliminary list of indicators was validated through interviews with professionals in the field. The next step was to rank each societal sustainability indicator according to their importance in the Palestinian context, by considering the opinion of a panel composed by experts and building occupants. For this purpose, two surveys to assess the opinion of the building construction experts and residents regarding the importance of the social sustainability indicators were conducted. Then, the importance of each indicator was defined using the AHP method. As a result, this research proposes a framework to assess the societal sustainability of West Bank, Palestine, buildings that is composed by twenty-one indicators distributed among six sustainability categories.

Key words: Building sustainability assessment methods, Social sustainability, Residential buildings, Rating system, Developing countries, West Bank, Palestine.

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ABBRATION LISTE

AHP	Analytic Hierarchy Process
BEES	Building for Environmental and Economic Sustainability
BREEM	Research Establishment’s Environmental Assessment Method
BRE-Global	Building Research Establishment - Global
C	Celsius Degree
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
cm	Centimeter
cm^2	Square centimeters
CI	Consistency Index
CO_2	Carbon dioxide
DGNB	Deutsche Gesellschaft für Nachhaltiges Bauen
GDP	Gross Domestic Product
GSA	The Geological Society of America
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
IBP, Inc.	Iowa Beef Processors, Inc.
kg	Kilogram
Km^2	Square Kilometer
kwh	Kilowatt/ hour
L	Liter
LCA	Life Cycle assessment
LEED	Leadership in Energy and Environmental Design Building

m	Meter
mm	Millimetre
m^2	Square meter
OPT	Occupied Palestinian Territories
NIS	New Shekel
NOx	The total concentration of NO and NO_2
PCBS	Palestinian Central Bureau of Statistics - State of Palestine
RI	Random Index
RII	Relative Importance Index
SBAT	State-Building Assessment Tool
SB Tool	Sustainable Building Tool
SB Tool PT-H	Portuguese Sustainable Housing Assessment Tool
U.S	United States
UK	United Kingdom
UNEP	United nations environment programme
UNDP	United Nations Development Programme
$/KW	Dollar /kilowatt
€	Euro

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INTRODUCTION

1.1 BACK GROUND

Degradation of Mother Nature is no more an illusion. Environmental issues become global and complex. Natural resources will be depleted because of the threat of over consumption and expanding human population (Ding and Rong, 2012). Greenhouse emissions are projected to increase around 50% in 2030 (Hong, Chiang, Shapiro and Clifford, 2007), continued emissions will cause further global warming and increase in climate change (PCBS, 2010). Pollution in air water and soil is harming more than 100 million worldwide (McDaniel, Sprout, Boudreau and Turgeon, 2011) and it is predicted by 2050, 3.6 million could die yearly from exposure to polluted particulate matter (Harvey & Fiona, 2012); in additional to the desertification, food shortage, poverty, earthquakes, and volcanic (Ding & Rong, 2012).

During the last few years, environmental awareness has increased due to the urgent call to pay attention to our ecosystem (Saleh, 2016).This awareness has translated into sustainable development and the green movement in all sectors. Sustainable development can be identified as a process meets the human needs of the present without compromising the ability of future generations to meet their own needs (Isaac, 2010). Sustainability is a concept towards balancing the three headlines, environment, society and economy (Power, 2004).

The building and construction industry have a key part to play in supporting sustainable development. This industry plays a vital role in resource consumption and environmental pollution (Hong, Chiang, Shapiro and Clifford, 2007), according to the United Nations Environment Program (UNEP, 2012) building and construction industry is one of the biggest energy consumers, accounting for 25-40 % of its use; represents 24% of global raw materials extraction, contributes to 20 percent of water consumption; emits 30-40 percent of solid waste; and 30-40 percent of harmful greenhouse emissions (Ju, Ning and Pan, 2016). Moreover, it plays a significant role in addressing basic human needs and developing the economy (Hong, Chiang, Shapiro and Clifford, 2007).

A number of groups have been exploring ways and approaches to achieve sustainability in buildings. These approaches are reflected in the various ranges of building assessment rating tools and guides as BREEAM in the U.K. and LEED in the U.S, GB Tool in Canada (Kang, 2015), and Life-cycle assessment (LCA) as ATHENA (Canada) and LCA House (Finland) have been developed (Chen and Ng, 2015). These methods and system aim to minimize the impacts on building and the natural environmental and maximize the social and economic impacts without ignoring the importance of the harmony between nature and human (Gibberd, 2002). It provides an indicative guide to the performance of the building for the purpose of pre-design, design, construction, operation, maintenance and end of life through numbers of indicators (Burdova and Vilcekova, 2015) that typically include energy, site, water, material usage, and indoor and outdoor environment (Hong, Chiang, Shapiro and Clifford, 2007).

Sustainable building shows an effective way to reduce the impact of building and construction on the natural environment. It helps in reducing emissions, protecting the ecosystem, using energy, water, and other resources efficiently, it helps also in reducing the operation costs, increasing occupant productivity, and creating a sustainable community (Ali & Nsairat, 2009).

A variety of sustainability assessment tools are available on the construction market, they are commonly used to certify the buildings (Bragança, Mateus and Koukkari, 2010) and they provide evidences to support the financial and environmental benefits of green buildings (Hong, Chiang, Shapiro and Clifford, 2007). However, these tools meet the needs, problems, and priorities of the countries where they were developed or reflect the national regulations (Bellone, Piccoli and Moro, 2007). Standing upon at that point, several authors realized it was more than important to have certified green buildings to have sustainable building references and supporting strategies in infrastructure (Bellone, Piccoli and Moro, 2007) and this should be done taking into consideration the specific context where the building is built. Some countries have already taken this step on and are starting to adopt green building practices, e.g. Portugal (Sustainable Building Alliance, 2012), Italy (Bellone, Piccoli and Moro, 2007), Abu-Dhabi (Abu Dhabi Urban Planing Center , 2010), and South Africa (Gibberd, 2002).

Palestine is a small geographic region in Western Asia between the Mediterranean Sea and Jordan River (Mark and Joshua, 2010). This small country has a long history as a crossway for religions, culture, commerce, and politics, because of that it remains a focal religious and political point drawing global interest. The boundaries of the region have changed throughout the history. Following the period of 1948-1949, this land was divided into three parts, the state of Israel, the West Bank, and the Gaza Strip (Beinin and Hajjar, 2014) and it was the beginning of the Palestinian-Israeli conflict.

The occupied Palestinian territory (West Bank, Gaza Strip) after 86 years of occupation is subject to many serious challenges and changes (PCBS, 2010). The first and the most important problem is the depletion and destruction of environmental resources, especially water and energy caused by a number of Israeli actions represented in establishing the settlements (Saleh, 2016). The second problem is the high growth of populations, where it is between 3%-3.5 % which is higher than the projected rate of the Middle East and North Africa. The third one is the emission of carbon dioxide and methane from Israeli factories where they accumulate in the atmosphere and cause the risk of climate change. There are other problems such as soil destruction, waste, and destruction of the culture heritage (PCBS, 2010).

The question is where we are going, unfortunately, the impacts of all the previous troubles could be summarized in; development difficulties in a number of key areas, agriculture, public health, and risk nature recourses management; climate hazards formed in a decrease in rainfall and an increase in the temperature (Mtour, 2011); serious economic crises (Isaac, 2010); food security and poverty, pollutions in the water, air and soil (PCBS, 2010).

Palestinian decision makers are under pressure to cooperate with the international community to adapt to the impact of climate change on one hand and to conserve Palestine in another one (Mtour, 2011). As well as, they need to apply new technologies in all dimensions, industry, agriculture, and building construction to successes in protecting the nature, land and the citizens (Power, 2004).

It is the time for all of us to put the blue print for sustainable development comprehensive. For beginning, I believe that sustainable building construction is one of the most important concepts that needs to be taken into account to solve some of the natural, social, economic, political, and military Palestinian issues. In this context, a building sustainability assessment tool that is adapted to the Palestinian context will be presented in this research, to support design teams' decision making towards the development of a more sustainable environment.

1.2 OBJECTIVES

Sustainable and green building design is not a new idea in the Palestinian construction sector. Many architects, engineers and institutions such as Palestine Higher Green Building Council and Iraq Center for Architectural Conservation, work hard to improve the building sector to deal with the sustainability concept. However, most of the solutions in Palestinian market fell on the sustainability trap while they employed strategies that do not fit the regional level which is a critical issue connected with the success of the sustainability race. That means in one way or in another that there is clearly a lack of a framework for promoting sustainable design in Palestine.

The main goal of this study is to adapt sustainable building assessment system for sustainability assessment for Palestinian reality. To fulfill it, the primary objective of the study is to develop a tool for evaluating new and retrofitted residential buildings in West bank, Palestine.

The residential buildings for Palestinians do not just represent the human needs for a shelter, they represent the rights of the Palestinians in their homeland. Indeed, residential buildings take the majority of developed Palestinian land and they are considered the highest consumers for the ecology in the construction sector. Moreover, Palestinian housing problems are more persistent than ever, where the average annual price of apartment increases 10% that has mainly due to the limited land, construction materials, and energy as well.

Today in the light of occupation, policy of demolishing houses, and clearing land, Palestinian people need affordable healthy houses that reflect their family needs, provide an adequate shelter and ensure their human dignity.

Therefore, keeping attention to the housing sector and repairing its infrastructure towards a sustainable lifestyle becomes an essential comprehensive way to create suitable economically, socially and environmentally physical conditions which are an active strategy to improve living standards of the Palestinian people.

Sustainable assessment building rating methods deal with the three dimensions of sustainability: environment, economic and social. In this work, the method to be developed will be focused only on social aspects because it is difficult to cover all sustainable aspects in this thesis and due to the importance of this dimension on the actual Palestinian reality. Therefore the main objectives of this thesis are:

- Investigating the current situation of the residential building on the West Bank;
- Finding out the resident's satisfaction with their building related to the social aspects;
- Proposing guidelines to assess the societal sustainability of Palestinian residential buildings.

In the conclusion, this study seeks to contribute to the dissemination of sustainable construction in Palestine, help Palestinian people to build sustainable local residential Palestinian architecture in the light of needing more healthy, safe, and affordable homes. To suggest specific modifications to conventional building practices to optimize the delivery of green building projects, increase the awareness and trust of the concept of sustainable building and its benefits to minimize the consumption of natural resources and pollution, develop a tool and guidance applicable to promote green building practices easy to use by all stakeholders.

1.3 METHODOLOGY

The research aims to adapt the social aspects of sustainable assessment tools to the Palestinian reality. In fact, Sustainable Assessment Tools indicators meet the realities of the place where they were developed. Therefore, the methodology of this research is based on the interaction between quantitative and qualitative methods which aim to analyze the sustainable building assessment system and identify the local context of Palestine to determine the indicators that meet the Palestinian reality.

The dissertation is subdivided into five tasks,

- Task 1: A literature survey was conducted in order to define the research problem and gain information about:
    1. Palestinian context considering its physical, environmental, social, and economic conditions such as topography, social culture structure, architecture and building codes, etc.;
    2. Indicators considered in existing sustainable building rating methods and indicators used to assess the social performance of buildings.
- Task 2: Interviews were conducted to a number of Palestinian experts to define the first draft of social sustainability indicators.
- Task 3: Two questionnaires were developed, one for the specialists in the field and another one for residential building occupants to validate and evaluate the list of indicators that was defined in the previous stage.
- Task 4: Analysis of the data that was collected from the field survey from both professional and building occupants.
- Task 5: Define the final list of indicators and their relative weights for residential Palestinian buildings.

1.4 RESEARCH STRUCTURE

The thesis is organized as the following way;

Chapter 1: It provides the general introduction of this study, in which the background, problem statement, aim and objectives of study, scope of the study, significance of the study, conceptual framework, methodology of study, and structure of the research are briefly described.

Chapter 2: It is intended to define the Palestine reality in different branches to give a global idea about the conditions related to the location, environment, economic, and social in one hand and to explore the criteria that affect and shape the identity of residential buildings into another.

Chapter 3: It includes the definition of the sustainable development as a whole, clarifies the definition of the construction sector point of view and how it helps in solving some of the construction problems, then it provides an introduction to the social sustainability of the residential building to cope with the research objectives.

Chapter 4: It examines the approaches for involving sustainability in the construction industry with more concentration in the assessment tools and social sustainability in the residential buildings, presents three case studies for residential building sustainable assessment tools LEED for Home Design, Code for Sustainable Homes and SB Tool PT- H.

Chapter 5: It provides a basic framework for developing and assessment rating methodology for West Bank residential buildings, it reserves for an outline of research methodology. Both surveys and interview methods are explained in this section and analyze the results of survey and interview. Then, it presents the proposed method categories of social dimension and their related indicators and calculates the weights of the indicators and categories.

Chapter 6: Draws a conclusion and summarizes the findings in the thesis, presents recommendations for developing sustainable assessment tool and strategies for implementing sustainability in West Bank residential buildings.

2 DEFINITION OF THE PALESTINE (WEST BANK) REALITY

2.1 BACK GROUND

The second chapter is intended to define the Palestine reality in different branches to give a global idea about the conditions related to the location, environment, economic, and social in one hand and to explore the criteria that affect and shape the identity of residential buildings into another.

Palestine state is subdivided into two parts: West Bank and Gaza Strip. This thesis will be subjected to the West Bank due to the restricted movement between Gaza Strip and West Bank, where it is difficult to the researcher to access to the Gaza Strip.

2.2 GEOGRAPHY

Palestine is a tiny piece of land located in the southern east of Asia at the heart of Middle East, on the eastern coast of the Mediterranean Sea (Mark & Joshua, 2010). To the west, it is bordered by Jordan and Syria, to the north Lebanon, and to the southeast Egypt (Figure 2.1).

Figure 2.1– Palestine Geographical location with respect to the World *(*Haddad, 2010).

The Occupied Palestinian Territories (OPT) has two geographical districts, which is 23% of the total area of historic Palestine, Gaza Strip and West Bank, and they are separated by the state of Israel. West Bank area is 5,655.km^2, and it is divided into eleven governorates, Nablus, Jenin, Tulkarm, Qaliqilya, Salfit and Tubas are the Northern Governorates; Jerusalem, Ramallah, and Jericho are the Middle Governorates; Bethlehem and Hebron are the South Governorates. The total area of Gaza strip is 365 km^2 (PCBS, 2016). It consists into five governorates, North Gaza and Gaza, Deir Al-Balah, Khan Yunus and Rafah.

Moreover, Oslo Accords divide the West Bank into three administrative areas, A, B and C. Areas A are under Palestinian administrative, areas B are controlled by both the Palestinian Authority and Israel, and areas C are under Israel control (Figure 2.2).

West Bank geography consists of four varied regions. The four geographical regions are the central highlands, where most of the population lives, the semi-arid eastern slopes, the arid rift valley and the coastal plains, in the north and west. However, the terrain of Gaza Strip is flat coastal plain (Töpfer, 2002) (Figure 2.3).

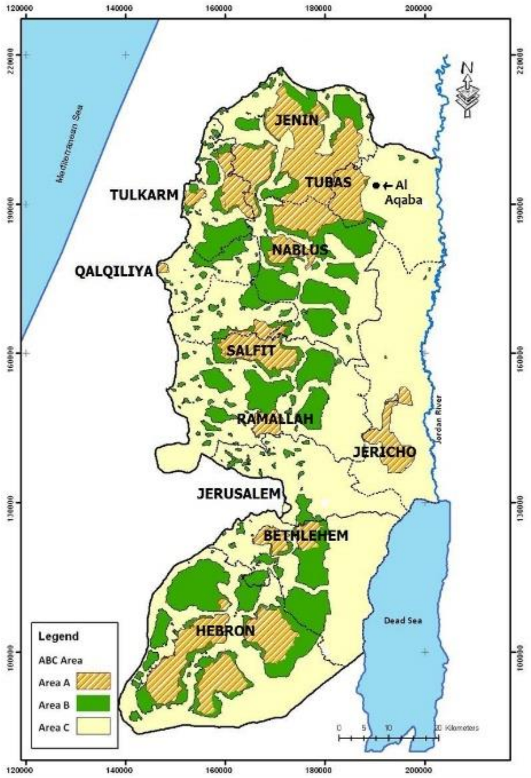


Figure 2.2–West Bank Divisions A, B, and C (Töpfer, 2002).

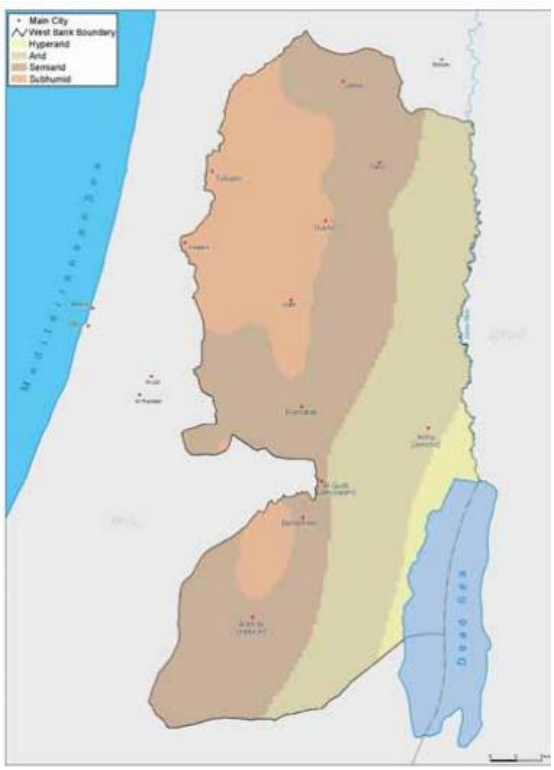


Figure 2.3 –The aridity index map of the West Bank (Töpfer, 2002).

Palestine's geographical location supports a tremendous diversity of biodiversity. As part of the Fertile Crescent, Palestine hosts 51,000 living species, it is also known that Palestine covers around 3.0% of the worldwide biodiversity despite its small area. The olive and orange trees, oak, tamarisk, iris, and lily plant (Shaer, Harhash, Omer, Albaradeiya and Mahassneh, 2015) are de most common vegetable species.

2.3 CLIMATE

The Occupied Palestinian Territories belongs to the Mediterranean climate, which is a CSA climate according to the Koppen-Geiger classification (Kottek, Grieser, Beck, Rudolf and Rubel, 2006), as seen in Figure 2.4. Therefore, Palestine has a temperate climate with long hot and dry summer, and cool rainy winter. The summer temperatures reach 35ºC and the temperature may drop to zero during the winter.

Rainfall in Palestine is limited to the winter and spring months, between November to May. The annual rainfall is ranging from 100 to 600 mm, depending on the location (PCBS, 2016).

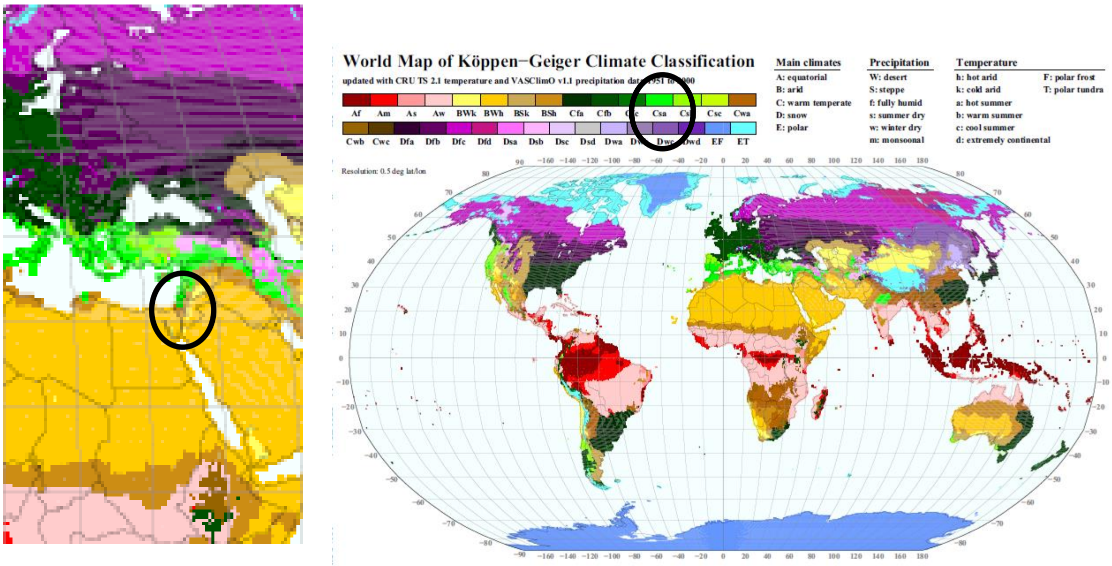


Figure2.4 – Koppen-Geiger Climate Classification world map (Kottek, Grieser, Beck, Rudolf and Rubel, 2006).

The main annual relative humidity average is 60% and reaches its highest rates during the months of December, January, and February. In May, however, humidity levels are at their lowest. This value increases gradually at night (ARIJ, 2003).

2.4 Population

The Palestinian Central Bureau of Statistics (PCBS) estimated that, during the mid-year of 2016, the Palestine’s population was around 4,816,503 people. Where, 2.935 million are in West Bank, and 1.881 million are in Gaza Strip. The population growth rate according to 2016 is 2.8%, which is relatively high comparing with the world population rate (PCBS, 2016).

2.5 Culture and social structure

The culture of Palestine is closely related to the culture of the rest of the Levantine with a long political sense. Hard work, collaborator, friendly and hospitable are the main features of the Palestinian community despite the hard life there under occupation, and the high rates of poverty and unemployment (Haddad, 2010).

Palestinian Arabic is the mother language spoken of the Palestinian Territories. However, many Palestinians are multilingual, with several languages widely spoken such as English, Hebrew and French (Osaily, 2010).

The Palestinian daytime use survey in 2000 shows that most of the people spend their time within their houses. They spend about 11 hours in sleeping and self-care followed by cultural and social activities 3.09 hours. Using the media, working and house management are the next popular activities with 2hours average for each activity and leaves around 5.7 for everything else.

In spite of the fact that Palestine thought to be a various society, most population is Muslim, with a strong Christian presence as well. So is not surprising that Islam shaped the Palestinian community and affected every side of the citizen's life (Tawayha, Bragança, & Mateus, 2015).

Palestine has one of the highest population density and birthrate, however, Palestinian care for their children with an unruly passion ((PCBS) , 2016). This can strongly be noticed in the high education rate between the inhabitants ((PCBS), 2016).

2.6 LAND USE

The pie graph in Figure 2.5 shows the percentage of land use area in West Bank in 2011. At the first glance it is clear that pastures are the main use. The second most use is a natural reserve, 14%, followed by 8% for the built up area. The lowest percentage, 2%, is for forests and wooded land. In conclusion, the buildup area is contributing less than 10% of the land use because of strict laws to prevent urban sprawl, which is the main reason for the high population density in the West Bank.

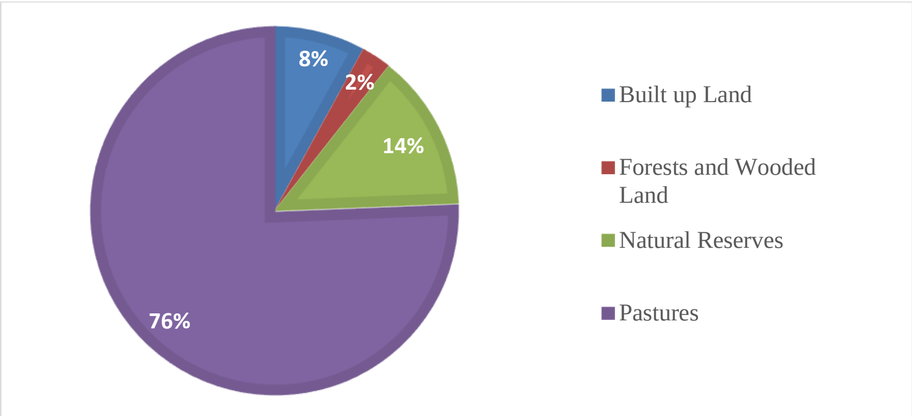


Figure 2.5–Percentage area of the land use in West bank, 2011 (PCBS, 2016).

2.7 ENVIRONMENTAL ISSUES

This small occupied area, West Bank, is facing many multiple problems at all levels: political, environmental, societal, and economical. Most of these problems directly linked to the Palestinian-Israeli conflict (Töpfer, 2002). The occupied West Bank after 86 years of occupation is subject to many serious environmental challenges and changes (PCBS, 2010). The most important problem is the depletion and destruction of environmental resources, especially water and energy caused by a number of Israeli actions (Saleh, 2016).

2.7.1 Water

The water issue is one of the most important components of the social, economic and political fabric of West Bank, Palestine. It is the symbol of continuing above the land and the basis of all economic and social development.

West Bank, Palestine has one of the lowest per capita water availability in the world and this crisis can be caused by two risk factors (PCBS, 2007). The first one is the scarcity of water natural resources. The second one is the Israeli politics actions against Palestinian water supply, being the most problematic one (Figure 2.6).

Figures 2.6 – Shows some of the sufferings of the Palestinian people according to the water crisis (Kestler, 2012).

The Israeli actions could be represented in controlling 90% of the main water suppliers, for instance, Jordan River basin, and the West Bank's aquifers. Besides, putting the restrict laws prevent Palestinians from adequate consumption, such as the Palestinian extraction from wells should not exceed 100 cubic meters per hour and for any extra pumping, they imposed heavy fines (Palestine Liberation Organization and Negotiations Affairs Department, 2014).

2.7.2 Energy

Energy resources in West Bank are quite limited. Palestinian do not produce fossil fuel resources and are almost completely dependent on the Israel market. 100 % of oil and 92% of electricity needs are imported from Israel (Yaseen, 2015).

As a result, Israel controls the value and the volume of imported energy, deciding how and when to supply. Furthermore, it has control over prices; which make the prices of electricity the most expensive, when comparing to the other countries, with an average of 0.13 $/kWh (Yaseen, 2015).

Recently, there is a national motivation in West Bank towards the renewable energy especially the solar energy to generate electrical power to supply power to the consumer at a better price and reduce the dependence on Israel power (Abu-Libdeh, 2017).

2.7.3 Biodiversity

Biodiversity is an important issue for future sustainable development in the Occupied Palestinian Territories but it is currently under pressure due to an array of factors. Israel is expanding its settlements and their infrastructure using Palestinian lands. As well as, the ongoing degradation because of the regular military operation as separation wall which cut the ecological and natural biodiversity. Furthermore, the soil pollution results from wastewater, solid waste, and excessive use of pesticides and chemical fertilizers. Lastly, increasing the human population on one hand and the refugee's crises into another within a small area play the central risk for destroying the biodiversity and natural resources.

2.7.4 Climate change

The main cause of Palestinian climate change is an accumulation of large amounts of carbon dioxide and other greenhouse gasses that are transferred from Israel's factories and coal-fired power plants to Palestinian atmosphere by the wind. Unfortunately, climate experts expect that gasses emitted from the Israel side will be risen by 40% by the year 2020 (PCBS, 2010).

The most significant environmental effects of climate change in occupied Palestinian territory, over the course of this century, are projected to be a decrease in rainfall and significant increase of temperatures. Notably, Intergovernmental Panel on Climate Change (IPCC) predicts that the annual temperature in Palestine will increase between 2.2-5.1 ºC rather than the normal temperature and precipitation rates are likely to fall down 10% by 2020 and 20% by 2050. In another word, climate change is guiding Palestine in the natural hazard including, water shortage, food sacristy, raise in the sea level, droughts, and floods during the winter season (Mtour, 2011).

2.7.5 Solid waste

Solid waste comes in a variety of different ways. In the first place, the population is increasing. Equally important, awareness of environmental health risks of hazardous solid waste is insufficient. Moreover, the data for solid waste management and skilled labors and expertise in this field are weak. Coupled with, years of Israeli occupation of the Palestinian Territory (Töpfer, 2002) and (PCBS, 2010).

The Israeli occupation plays central responsibility in the solid waste management problem. The occupation is using the Palestinian land as landfill sites for the industrial disposal of waste, this waste from high risk to the Palestinian environment as well as groundwater. In additional, Israeli security measures such as the apartheid wall, the closure, checkpoints, and curfews are stopping the access to the normal disposal sites and increasing the number of random dumping sites, especially near the residential areas. Moreover, the continuous destruction of buildings and Palestinian infrastructure is increasing the solid waste problems (Töpfer, 2002).

2.8 ECONOMICS

"*The Palestinian National Authority has no national currency. Palestinian banks accept deposits and withdrawals of foreign currencies. Major currencies that are used in Palestine include the Jordanian Dinar and the Israeli Shekel. Moreover, the US Dollar is quickly* *becoming the most popular currency for both deposits and credits in the Banks* (IBP, Inc, 2016)".

The occupied Palestinian territory has huge potential for economic development. It is a crossroad of commerce connecting Asia, Europe, and Africa (Palestine Investment Conferenc, 2008). It also has enormous tourist potential as the birth of the world's three monotheistic religions: Christianity, Islam and Judaism. The gentle climate and fertile soil allows the agriculture development. Moreover, educated rate is relatively high among the Palestinian people (Fannoun, 2008).

However, the Palestinian economy is subjected to restrictive Israeli measures since 1967. Israel controls the movement of people and goods and destructs the natural resources (Saleh, 2016). As a result, Palestine remains economically non-industrialized and standing on the agriculture and external aid. The number of the Palestinian Central Bureau of Statistics show that the unemployment rate reached 26.6% in 2015 and it expected to be 25.0% in 2016 (Awad, 2015) which still considered as a big disaster need an emergency solution.

In 2014, the largest sector in the economy in the West Bank is services, followed by construction and wholesale and retail trade. Together, these three sectors account for more than 45% of total GDP. Transportation and agriculture sectors contribute relatively little to total GDP in the West Bank.

2.9 CONSTRUCTION SECTOR

Construction sector is one of the main activities that has significant impact on the Palestinian economy and serviced the market, it could grow or shrink but will never disappear from the Palestinian economic map. This sector plays a vital role in offering job opportunity it employing some 11-15% of labor force. The construction sector was the second contributor in GDP with about 13% of the total GDP in the Palestinian economy in 2014. It also included the production of a number of building products: bricks, paint and floor tiles plants, aluminum, electrical materials, tools, and sanitation networks.

Construction sector influenced the economic situation in the country but it is also influenced by the situation there. Palestinian construction sector faces the same problems of the economics, being characterized by the use of poor construction technology and for necessity to import most of the used building materials, which increase the final price of the construction.

2.10 RESIDENTIAL BUILDING

Residential buildings take the majority of developed Palestinian land and construction sector and people spend a long period of their life inside them (Palestinian National Authority Ministry of Public Works and Housing, 2010). Houses compromise the most human needs water, power, sanitation and safe food. Housing affects health, well-being, and productivity in many different ways; they simply can make the inhabitants to live comfortable or make the inhabitant's life harsh.

Housing is a human right just like water and air. Paragraph 1 of article 25 of the universal declaration of human rights declares "*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*". Housing is not just a shelter and cover for human but it means providing someone with privacy, safety, and health at the reasonable cost to achieve the sustainable development.

The information about the Palestinian housing conditions, units, density, and ownership offers a fundamental understanding of the living conditions and future needs of the society. PCBS estimates, the average household size in the West Bank felt in the rate 0.06 per year from 1997 and 2007 where the household size was 6.4 and fell to 5.8. The number of housing units is expected to increase 55.9% in the year 2017, compared to the year 2007, by considering the household size reduction rate. According to the previous expectation, it is estimated that the number of the units will reach, in 2017, 360753 in the West Bank.

In 2013, 80.8% of the West Bank residents owned their houses, 8.4% rented it, and the remaining lived without paying or as a compensation of their work. The average monthly rent is 230€. The average room's number per West Bank housing unit is 3.4, however, 19.9% of households live in units with 1-2 rooms in 2013. While the average housing density was 1.5 persons per room, but about 9.5% households had three persons or more per room.

Palestinian housing problems are more persistent than ever. The average annual price of apartment increases 10% that has mainly due to political situation conducting with the limited land especially in areas (A,B), and we can also add the strong rise of the demand for apartments because of the rapid increase of population (Palestinian National Authority Ministry of Public Works and Housing, 2010).

In the next section of the document information about the household consumption and infrastructure will be presented.

2.10.1 The household consumption

Consumption is a key indicator of citizen's life value and the reflection of social relations and the relationship between human and nature. In other words, consumption is not just economic phenomenon it is a complex and comprehensive indicator that reflects the human lifestyle, which is influenced by social, political, cultural and psychological phenomena.

Household energy use in the West Bank is small, even by regional standards. In January 2015, the average annual Palestinian household consumption of electricity was 306 kWh, the average consumption of liquefied petroleum gas was 22 kg, and the consumption of kerosene was 21L.

Water is a basic human right. Until now the Palestinian people cannot be fully satisfied as a result of political policies. The average household water consumption per month is 18.7 cubic meters. The result of such the average Palestinian in the West Bank only consumes 70 liters of water per capita per day, which is well below the recommendations of World Health Organization. Most houses in Area C that are not connected to the water network, the average water consumption fall to 20 liters per capita per day.

In 2011, the average household's monthly expenditure was 1300 €, and share for food 35.55% of household monthly expenditure. Palestinian spend around 19.9% for housing followed by 12.9% for transportation. They spend 6.5% for clothing and 5.3% for smoking like the largest consumption percentages. From the Palestinian household consumption behavior, it is clear that there is a financial crisis where more than two-thirds of the income is spent on the basic human needs.

2.10.2 Household infrastructure

Housing Conditions Survey, of 2015, show that all (99.9%) of Palestinian households are actually connected to the public electricity network. The result of the survey of water revealed that 6.7% of people in Palestine are cut off from the water network.

The results of a survey of the domestic environment conducted in 2014 detected that about 54% of the Palestinian population is connected to the public sewage network. While the rest (46%) of Palestinian households are living in houses connected to cesspits, pits for the disposal of refuse.

In 2014, data showed that 40% of the Palestinian Households are connected to a telecommunication network and that the half of them have Internet Access at home which is the main place to use internet.

Renewable Energy in Palestine is well attended. Palestinians use biomass, wind, and several types of equipment to harvest solar energy. The use of solar energy for water heating is the most common. In 2015, more than the half (56.5%) of Palestinian households had solar heating and 90% of the solar water heaters are manufactured locally.

2.10.3 Household Durable Goods

The results of a Housing survey show that the electric refrigerator, gas stove, washing machine and television are the major available durable goods for the Palestinian households. Table 2.1 shows the percentage of the main household durable goods.

Table 2.1 – Show the percentage of West Bank Household Durable Goods.

Household Durable Goods	**The year**	**The percentage**
Refrigerator	2007	95.7%
Gas stove	2007	99.4%
Washing machine	2007	92.8%
Television	2014	97.1%
Computer	2014	63.1%
Satellite dish	2014	99.8%

2.11 ARCHITECTURE

Palestine has a verity of architecture heritage, reflecting a number of periods in its history. Throughout these periods, a series of changes occurs in the physical environment of Palestine. In fact, each period related to a different culture which has passed a different architectural style and created new elements and details there (Senan, 1992) .

Rapoport 1998, stressed that to understand the relationship between the architecture and culture it is important to follow all periods, all type of environments, all cultures and the whole environment. This thesis is related to the residential buildings in West Bank so, in the next section of this document, the most famous building types of this territory, during different periods, will be presented.

2.11.1 Traditional dwelling architecture styles

Driving throughout Palestine, we can see two main architectural styles for dwellings, traditional and contemporary. The remaining traditional style in Palestine is backed mostly to Ottoman[1] period while we still can see some of the Mamluk[2] and Umayyad[3] architectures (Hadid, 2002).

2.11.1.1 Peasant houses

Until the 1880s, the peasant house was the dwelling type for the urban and rural areas in Palestine. It is a cubic simple structure composed of one or two stories.

Peasant house is mainly constructed of stone, with thick walls (140-180cm). Windows opening was small for privacy and security reasons, and also because the wood was expensive on material. Commonly, the area of the house was small but it also variable depended on family members (Hadid, 2002).

The layout of the peasant houses expresses the harsh and hard lifestyle among the people. Simply, the cubic room was not big but it includes two parts. The family's part is made of three-quarters and raised from the other part, which is left for the animals (Hadid, 2002).

The simple rooms are adjusted to each other to shape a complex organic form that embraces a court inside called "Hush". As presented in Figures 2.7 and 2.8, the layout of the court is irregular due to the houses orientation which reflects the environmental and social necessities (Abu-Hilal, 2009).

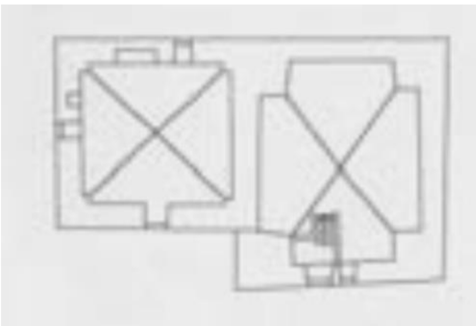


Figure2.7 –The peasant house plan (Hadid, 2002).

Figure 2.8 – A traditional image for Lifta, Jerusalem Village (Traildino, 2016).

[1] Ottoman period, Palestine under the occupation of the Turkish Ottoman Empire between 1516 and 1918.
[2] Mamluk period, Palestine under Mamluk control from 1187 to 1517, Mamluk refers to Muslim slave-soldiers and Muslim rulers of slave origin.
[3] Umayyad period, Palestine under Umayyad Caliphate controls from 661 to 750, Umayyad Caliphate was the second of the four major Arab caliphates established after the death of Muhammad.

2.11.1.2 Courtyard house

Throughout the Palestinian history, the courtyard was one of the primary design used for residences, palaces, and public building. In ancient times, a courtyard house would be occupied by a single, usually large and extended family, signifying wealth and luxury.

Courtyard house (Figure 2.9 and 2.10) is a central inward solution, the rooms are organized around a sky open courtyard. Its plan layout, in most cases, is rectangular on the axial plan of the court. Normally the main rooms in the house open toward the court, and the exterior walls may be windowless or with a small opening. The inner and exterior walls are thick and built from stone like the peasant house walls. In this case, the ceiling height is changeable according to the room size and its function, which can be bedrooms, guest room, kitchen, and store (Haddad, 2010).

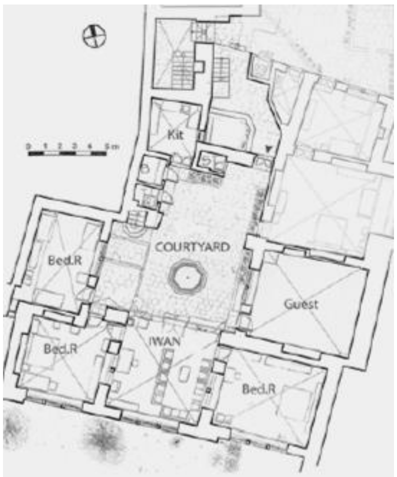


Figure 2.9 – Courtyard house plan.

Figure2.10 – Inside a traditional courtyard house.

This organization offers the house with private open space conduct with the entrance and consider like circulation, children's playground, and relaxing and welcoming area. As well as, it provides a comfortable indoor environment and saving energy (Hadid, 2002).

2.11.1.3 Liwan house (Hall house)

The hall house is a type of vernacular house that is very traditional in Lebanon. It was transferred to the Palestinian fabric during Turkish colonial period (Dawood, 2008). Liwan house is famous for its central hall. The hall is a simple rectangular large room that lies in the middle of the house as shown in Figure 2.11. In fact, the main function of the hall is a cross passage from the entrance to the other rooms and from one room to another (Hadid, 2002). In this type of construction, the exterior walls are more open outward and the number of windows is increased because of the disappearance of the courtyard. Besides, the buildings height and the stories number are increased (Tuffaha, 2009).

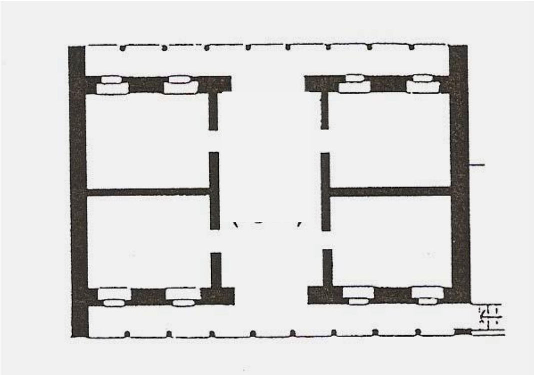


Figure 2.11 – Liwan house plan (Mahmoud, 2008).

Figure 2.12 – Liwan house in Ramallah, West Bank (tomorrowsYouth Organization, 2011).

2.11.2 Contemporary dwelling architectural styles

Contemporary architecture in Palestine is the final shape of the external colonial's power since the beginning of 20th century and the influence of the first generation of architects who graduated in different countries. British mandate and Israel occupation drag the built environment to the modernism in materials, construction methods, and the image of the identity as well (Badawy, 2012). In the same boat, the architects try to show their abilities in terms of concepts and forms to attract the public attention away from local architecture (Awad, 1999).

According to Central Bureau of Statistics (PCBS), the most used type in West Bank nowadays is the single house 54.0%. The second most used type is the apartment 44.00%. Villa, separate room, and the other type (e.g., tents, rooms, etc.) contribute just 1.8% to the total buildings (PCBS, 2016).

2.11.2.1 Single House

A simple separated house, normally for growing up families, can be found in the Palestinian villages and cities. It can be built out of concrete with a stone external wall or hollow block wall depending on the financial status of the owners. The simple design usually comprises 2-3 bedrooms, 1-2 bathrooms, kitchen, guest room, salon, and balconies while the total divers from one house to another. The circulation movements of most single houses are divided into two types. Horizontal movements as corridors and lobbies connect the same floor. The staircase is a vertical movement for the upper floors.

2.11.2.2 Apartment building

The Palestinian community converts toward the vertical expanding after the second half of the 20th century. Residential apartment is a solution of shortage land due to the modern population boom and increasing of political and environmental problems. In general, the building takes a block shape containing numbers of the floor which can reach 8 floors. Each floor has more than one unit and most of them share one or two walls with neighboring units. There is no specific area for the apartment, it could from $80m^2$ to $200m^2$.The building flats (Figure 2.13) have a similar function of the single house and the circulation, where the elevator is a main different feature (Badawy, 2012).

2.11.2.3 Multi-function building

A building designed to be multi-function so they would have commercial shops on the ground floor and apartments in the upper layers. This type of building is well common in cities, villages, and refugee camps[4]. While the dwelling units on the upper floors are same as in the previous type.

Figure 2.13– The apartments in Nablus (Al-hadath, 2016)

2.11.2.4 Villa

Figure 2.14 – Villa in Ramallah (Jordan Valley Witness, 2011)

Villa house is an eclectic and complicated design as can be seen in Figure 2.14. The idea of villa house is well-known among the wealthy families. It could be found in almost all the cities and villages. A large house mainly has two stories and in some cases, additional rooftop can be added. The lower floor is for daily spaces, kitchen, guest room, and salon where the upper is a private suit for sleeping purposes. Staircase in the design is a focal point for arriving guests leads to the upper floors, and decorate corridors, entrance lobby, and interior lobbies join horizontal planes. The stone is the finishing material for this type of construction.

2.11.2.5 Raw house

A house in a series of houses, often of similar design or characteristics, which shares wall with the houses next to it (Tuffaha, 2009).

[4] Palestinian refugee camps were established after the 1948 Arab–Israeli War to accommodate the Palestinian who lost both home and means of livelihood as a result of the 1948 conflict.

2.11.3 Architectural elements

For each place, there are physical symbols including built form, landscape, and all others elements. The physical objects and the relationships between them reflect the uniqueness character and the spatial sense of place.

2.11.3.1 Traditional elements

Table 2.2 represents the main architectural elements in the previous traditional house types.

Table2.2 – Shows the traditional housing elements and their details.

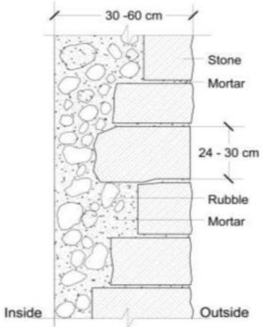
<table>
<tr><th>Elements</th><th>Elements type</th><th colspan="2">Detail</th></tr>
<tr><td>Walls</td><td>(1)One facing stone wall, figure 2.15.
(2)Two facing stone wall, figure2. 16.</td><td>

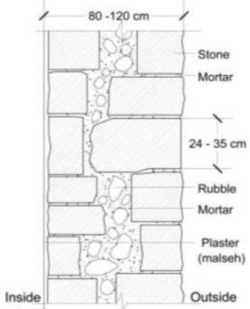
Figure 2.15– Section in a one facing stone wall (Ministry of local government, 2002).</td><td>

Figure 2.16– Section in a two facing stone wall (Ministry of local government, 2002).</td></tr>
<tr><td>Roofing</td><td>Flat roof

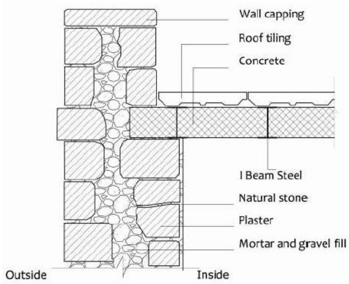
(1)Stone tiles roofing, figure 2.17.
(2)Mud roofing, figure 2.18.</td><td>

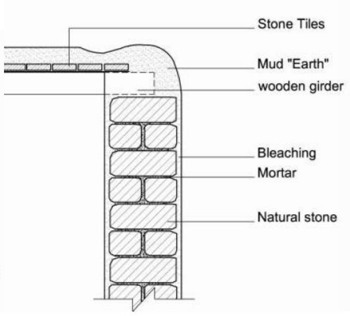
Figure 2.17– Section in a stone tiles roof (Ministry of local government, 2002).</td><td>

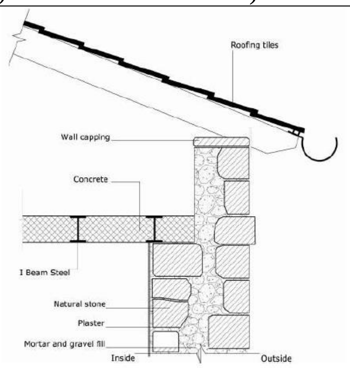
Figure 2.18– Section in a mud roof (Ministry of local government, 2002).</td></tr>
<tr><td></td><td>Pitched roofing, figure 2.19.</td><td colspan="2">

Figure 2.19– Section in a pitched roof (Ministry of local government, 2002).</td></tr>
</table>

Table2.2 – Shows the traditional housing elements and their details.

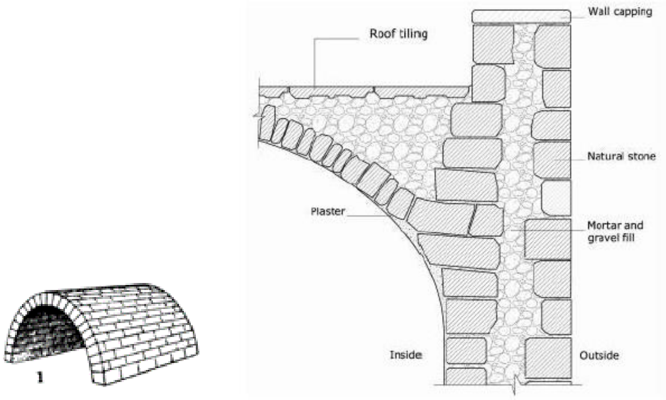
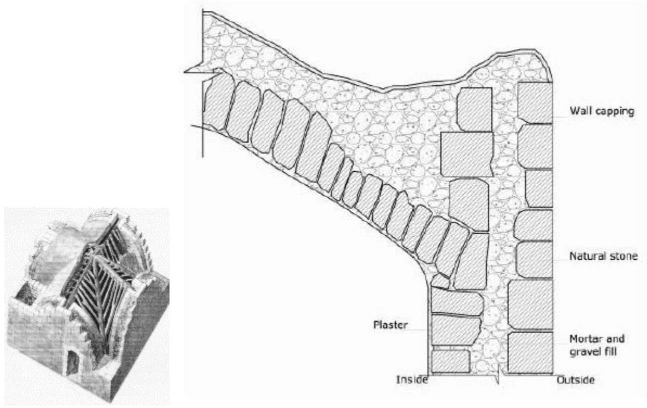
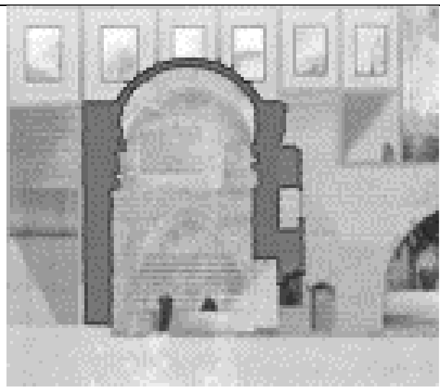
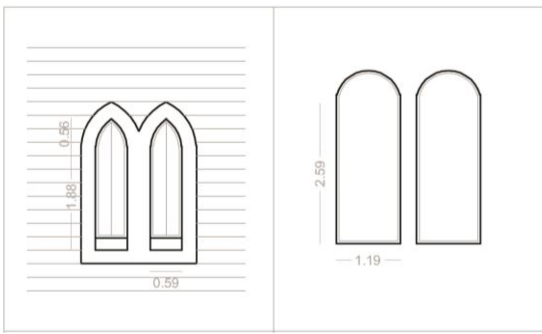
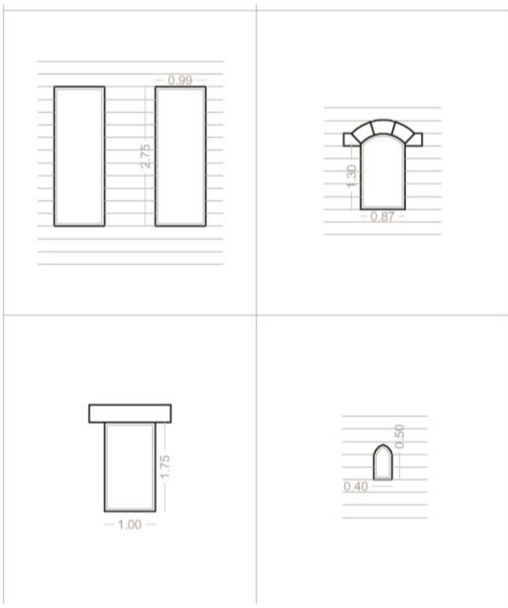
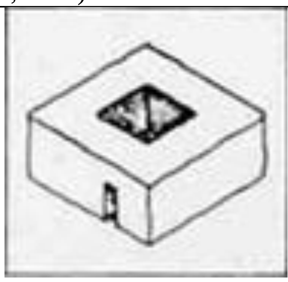
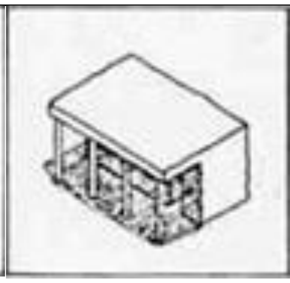
Elements	Elements type	Detail
Roofing	Barrel vaults, figure 2.20.	 Figure 2.20– Section in a barrel vaults (Ministry of local government, 2002).
	Cross vaults, figure 2.21.	 Figure 2.21– Section in a cross vaults (Ministry of local government, 2002).
	Domes, figure 2.22.	 Figure 2.22– Section in a dome in the Old City, Nablus (Horn, 2012).
Windows	There are a variety of traditional types and details windows, see figure 2.23.	

Table2.2 – Shows the traditional housing elements and their details.

Elements	Elements type	Detail
Windows		 Figure 2.23– Basic traditional windows design in West Bank (Dawood, 2008).
Outdoor elements	(1)Courtyard, figure2.24. (2) Arcade (Riwaq), figure 2.25.	  Figure 2.24–Courtyard. Figure 2.25– Riwaq.
	(1)Balcony, figure 2.26. (2)Window cover (Mashrabiya), figure 2.27.	 Figure 2.26– and elevation shows the balcony in the traditional house design (Ahmad, Style Analysis for Dwellings in Palestine In, 2008).
		 Figure 2.27– Traditional Mashrabiya.

2.11.3.2 Contemporary Elements

Table 2.3 represents the main architectural elements for the previous contemporary houses types.

Table2.3– Shows the contemporary housing elements and their details.

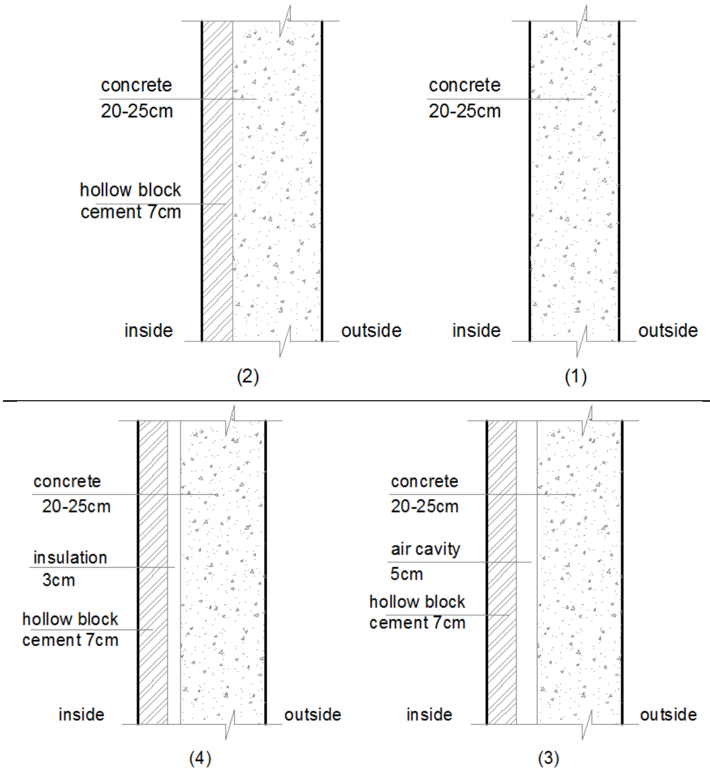
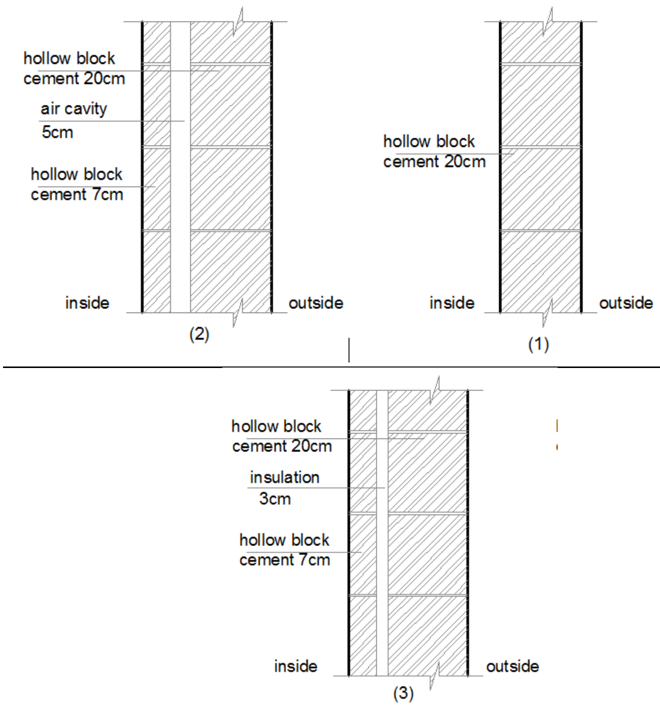
Elements	Elements type	Detail
Wall	(1)Concrete wall, figure2.28.	 Figure2.28–Sections in concrete wall types.
	Hollow concrete Block Walls, figure 2.29.	 Figure 2.29– Sections in hollow concrete block wall types.

Table2.3– Shows the contemporary housing elements and their details.

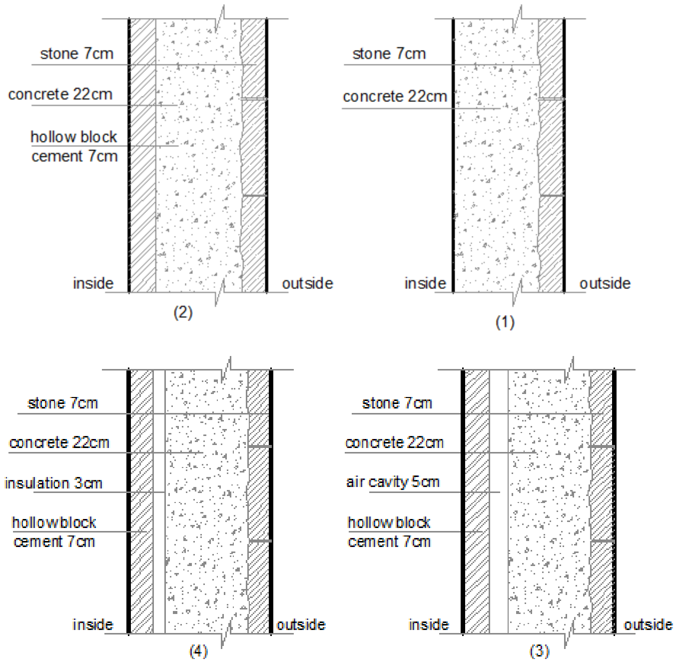
<table>
<tr><th>Elements</th><th>Elements type</th><th>Detail</th></tr>
<tr><td>Wall</td><td>External stone wall, figure 2.30.</td><td>

Figure 2.30– Sections in external stone wall types.</td></tr>
<tr><td>Roofing</td><td>Flat roof

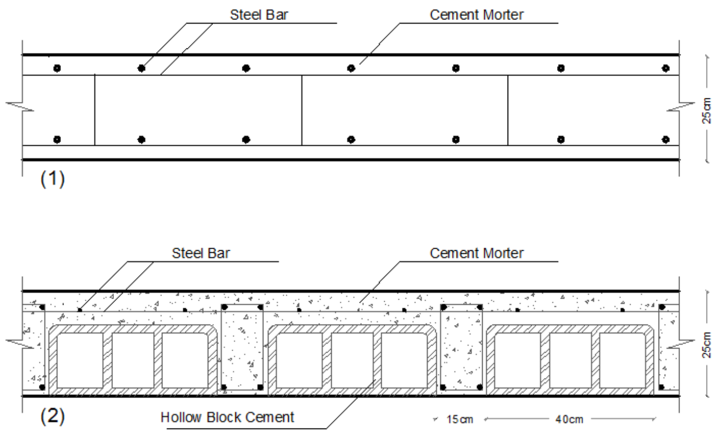
(1)Solid slab
(2)Ribbed slab, figure 2.31.</td><td>

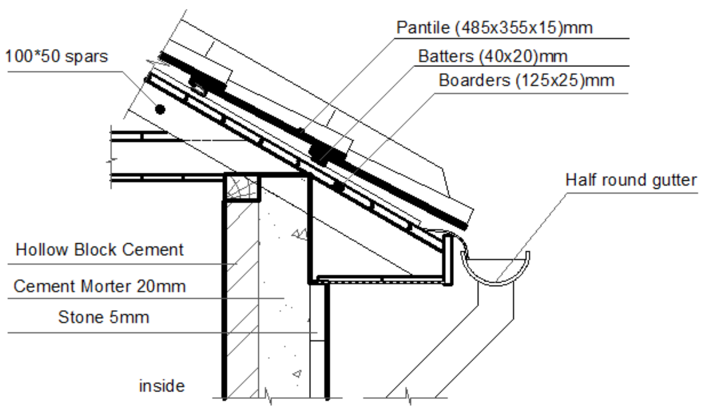
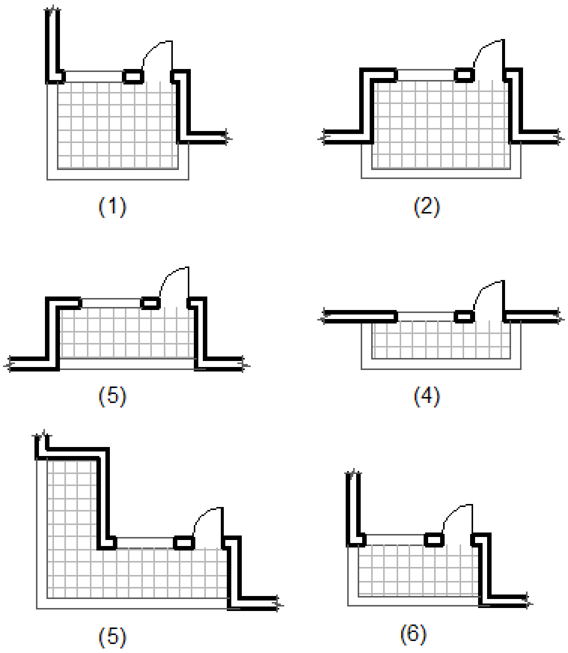
Figure 2.31– 1. section in a solid slab, 2. section in ribbed sab (Ardda, 2014).</td></tr>
<tr><td></td><td>Pitched Roof, figure 2.32.</td><td>

Figure2.32–Section in pitched roof (Hanen Ahmad, 2016).</td></tr>
</table>

Table2.3– Shows the contemporary housing elements and their details.

Elements	Elements type	Detail
windows	See figure 2.33.	 Figure 2.33– Basic window types (Salameh, 2012).
Outdoor elements	Balcony, figure2.34.	 Figure 2.34– Basic balcony types (Hadid, 2002).

2.12 MUNICIPALITIES COUNCIL RESIDENTIAL BUILDINGS CODES

West Bank municipalities requires some regulations regarding residential buildings and provides the explanation how building proposal should respond to its site and its context. In most of the municipalities in the West Bank, Palestine the councils building codes are similar. Regarding that, this research will discuss the residential buildings codes according to municipality of Nablus city as a case study.

2.12.1 Nablus

Nablus city is one of the biggest cities in the West Bank of Palestine, and the capital of a Palestinian commercial and cultural center (Figure 2.35). It is located in the northern part of the West Bank, between Mount Ebla and Mount Gerizim. It is well known around the word for its historical city, Nablus soap, and Al-Kunafa. The total area of the City is around 32,653 Km^2.

Nablus City is located at an altitude of 465-539m above sea level. Its climate is temperate, dry summer and cool rainy winter where the annual rainfall arranges from 471mm to 652mm. On average July and August are the hottest months in Nablus. At the opposite side, January is the coldest one. The average humidity is 60% whilst the annual average temperature is 16-18 C.

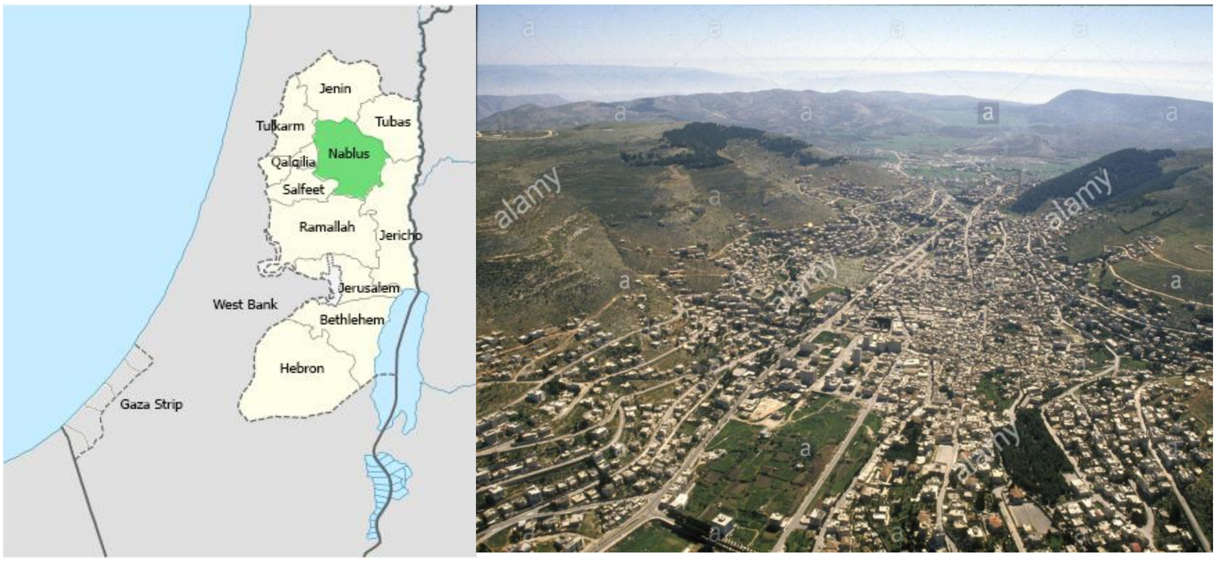


Figure 2.35– Study area, city of Nablus (Tuffaha, 2009).

2.12.2 Municipality Council building codes

Like all councils, Municipality Council of Nablus provides some regulations regarding residential buildings and provides the explanation how building proposal should respond to its site and its context.

2.12.2.1 Site aspects

The residential building design has to have one car park for each unit inside the site boundaries as a minimum. Where, the minimum dimensions of parking places shall be 2.5m width and 5.5m length with a maximum gradient of 20%. Moreover, the standards allow covering just the top, with a minimum high of 2.5m.

The municipality code allows constructing an additional separate construction as a service under these conditions, it is total area does not exceed 5% of area land or 50m², its maximum height is 2.6m, the frontal offset is equal to the regulation zone, and the rear and sides offsets are zero.

Figure 2.36 shows the city zoning for residential building.

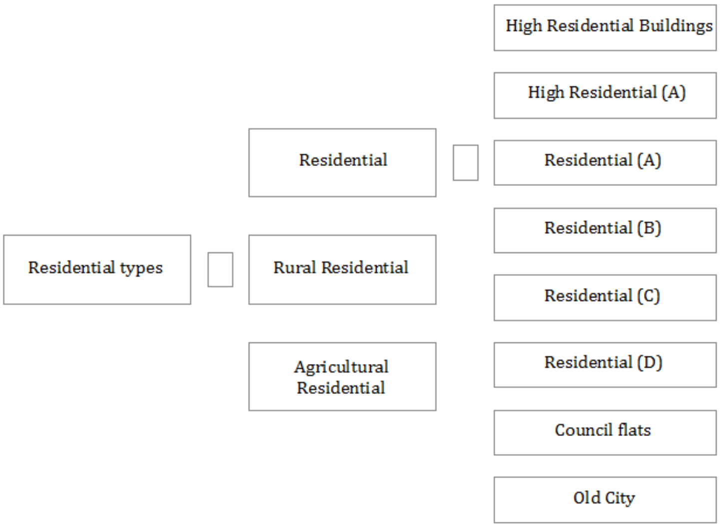


Figure 2.36 – Divisions of residential areas in Nablus city (Municipality of Nablus, 2016).

Table 2.4 clarifies the minimum area and length of the land in the zoning areas.

Table 2.4– The minimum land area and length for residential zoning building (Municipality of Nablus, 2016).

	Minimum land area (m^2)	**Minimum land length (m)**
High Residential Buildings	2000	40
High Residential (A)	1000	30
Residential (A)	1000	25
Residential (B)	750	18
Residential (C)	500	15
Residential (D)	300	15
Council flats	150	10
Old City	-----------------	---------------------

The building offsets, floor area ratio, and the maximum number of floors are described in Table 2.5, Table 2.6 and Figure 2.37.

Table2.5–The minimum offsets for the different residential zoning (Municipality of Nablus, 2016)

Minimum offsets (m)			
	Frontal	**Rare**	**Sides**
High Residential Buildings	12	8	8
High Residential (A)	5	6	6
Residential (A)	5	5	4
Residential (B)	5	4	3
Residential (C)	4	4	3
Residential (D)	3	3	3
Council flats	3	3	---------
Old City	----------	-----------	-----------

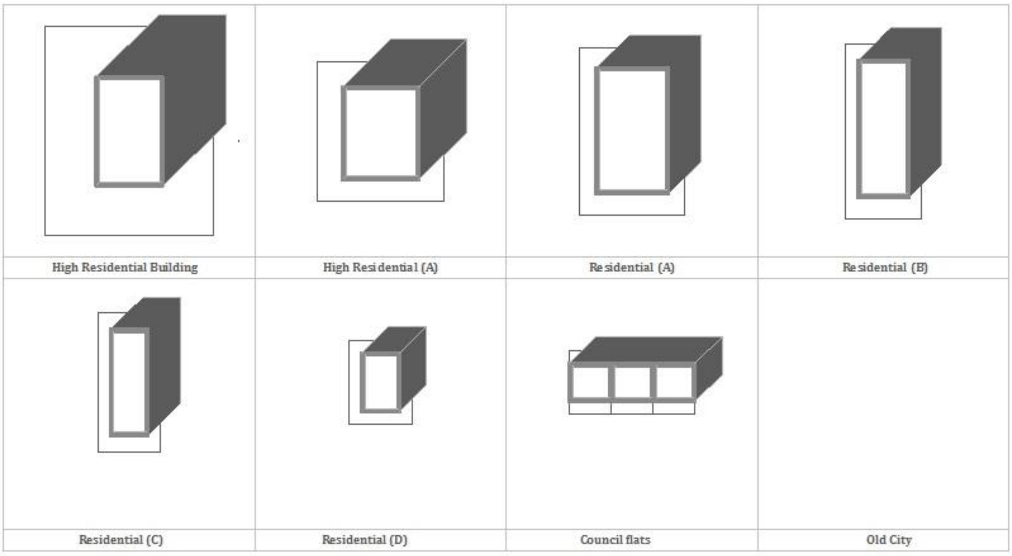


Figure 2.37–The relation between the minimum offset and the minimum land length for each zoning.

Table 2.6– Maximum building ratio, maximum floor area ratio, maximum floor number, and maximum building height for each zoning (Municipality of Nablus, 2016).

	Maximum Building ratio	**Maximum floor area ratio**	**Maximum Floor numbers**	**Maximum Building height**
High Residential Buildings	36%	288%	8	28(m)
High Residential (A)	40%	240%	6	22(m)
Residential (A)	36%	144%	4	15(m)
Residential (B)	42%	168%	4	15(m)
Residential (C)	48%	192%	4	15(m)
Residential (D)	52%	156%	3	12(m)
Council flats	60%	180%	3	12(m)
Old City	----------	-----------	-----------	--------------

2.12.2.2 Aesthetic aspects

In the residential building code, the designer has to use the natural stone in the exterior frontal facade, and the use of color should not be exceeded 25% of the facade area which should be as natural stone color (Figures 2.38 and 2.39).

Figure 2.38 - Exterior façade color in Ramallah (Harb, 2010)

Figure 2.39- Color use in Rawabi City (Rawabi, 2016)

The Eaves in the façade should not be more than 75cm and the lowest point of the Eaves should be above the sidewalk in minimum 2.5m (Figure 2.41).

The roof height should be 3m maximum, and its area 70m² or 25% from the total area, whichever less. Moreover, the municipality does not give building permits for any construction if its roof is made from iron sheets or asbestos sheets.

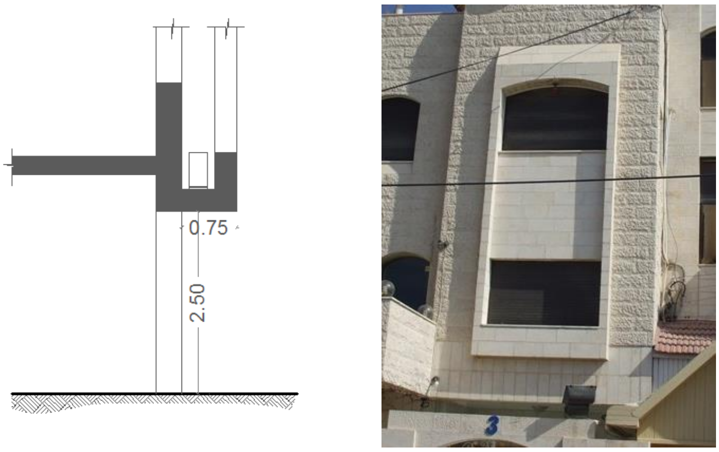


Figure 2.41. section in window's eaves.

2.12.2.3 Building aspects

Table 2.7 shows the minimum height for inner spaces according to the municipality standards.

Table 2.7- Minimum height for inner spaces in the dwelling (Municipality of Nablus,2016).

Inner space	The minimum height
Rooms dwelling and offices	2.40m
Kitchen	2.25m
WC and bath room	2.10m
Garage	2.25m

Regarding to the municipality standards, the corridors must be ≥1.00m. As well as, the staircase should be available when the design consists of width more than one floor with these standards (Table 2.8).

Table 2.8- The relationship between the building users and the length of tread and landing in stair design (Municipality of Nablus, 2016).

Building users number (x)	Minimum tread length (m)	Minimum Landing length(m)
(x)≤350	1.25	0.90
(x)≤450	1.40	1.00
(x)≤550	1.55	1.10
(x)≤650	1.70	1.10
(x)≤750	1.85	1.25

The building should have one elevator at least if its height more than 14m or the total floors above 4. Where, elevator number and cabinet must be commensurate with the building itself and its users.

In this code, the buildings have to employ natural ventilation by windows opening to the outside or to the void where the W.C and bathrooms opening shall be ≤5%of its floor area. The void space requirements are:

- The voids space for dwelling room should not be less than $10m^2$,and the side length should not be less than ¼ its height or 2.5m, whichever is longer .
- The voids space for kitchen and bathrooms must be ≤ 7.5m2, and the side length 2.5m.

2.13 CONCLUSION

We cannot isolate ourselves from the international architecture. At the same time we need to respond to the local cultural needs and aspirations. Successful house design, regardless its type and size, is the one that meets inspiration of the end user. It is predicted from the architect to create a brief to meet the desire of the owner. However, nor the method of housing design in Palestine neither the municipalities codes support the desire of the end user or the environment. In fact, the method of housing design in Palestine is shifted from the end user to the developers who focus on the cost reduction.

Today in the light of occupation, policy of demolishing houses, and clearing land in one hand and the lack of social and environmental standards for homes into another, Palestinian people need affordable healthy houses that reflect their family needs by balancing the price of building and the income of a Palestinian household to provide an adequate shelter and ensure their human dignity.

Therefore, keep attention to the housing sector and repair its infrastructure towards a sustainable lifestyle becomes an essential comprehensive to create suitable economically, socially and environmentally physical conditions which are an active strategy to improve living standards of the Palestinian people.

3 SUSTAINABL DEVELOPMENT

3.1 BACK GROUND

This chapter includes the definition of the sustainable development as a whole. Then clarify the definition from the construction sector point of view, considering the residential building as a topic for the discussion.

3.2 SUSTAINABLE DEVELOPMENT DEFINITION

"*We are faced not with two separate crises, one environmental and the other social, but rather with one complex crisis which is both social and environmental. Strategies for a solution demand an integrated approach to combating poverty, restoring dignity to the excluded, and at the same time protecting nature*" Pope Francis.

When the World Commission on Environment and Development (Brundtland Commission) published its report in 1987, it presented a new concept - sustainable development (Harris, 2003), this idea came due to the urgent call to pay attention to our ecosystem (Saleh, 2016). Since that time, the new trend became a widespread in the international agenda and the international communities. Where, it encouraged to shape their attitude towards economic, social and environmental development (Harris, 2003). As emphasized by Talwar (2014), the concept of sustainability is not new, it has a rather long history and its roots in forest management remote as early as the 12^{th} to 16^{th} centuries. However, over the last five decades, the idea has essentially expanded.

In the dictionary, Sustainable is defined as capable of being maintained or kept going (Harper, 2010) and the terms itself can be used in a variety of fields and professions. The Brundtland Commission's report defined sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". This definition, somewhat vague, mentions just the strategic objective for an integrated environmental and economic development. Rather than pointing the way for concrete action, for instance, the definition should include a clear idea of how to preserving the environment (Stepanova, 2011) . The architect and professor at The University of Michigan, Jong-Jin Kim, (1998) criticized the previous definition that it fails to include all constituents that participating in the global ecosystem and specify the ethical roles of humans for everlasting. Another commanded for Kates, Parries and Leiserowitz (2005), that the definition uses the word needs which means basic and essential. The use of this word has a major focus on that the nations have to share the resources equally forgetting the importance of the development on the citizens and the idea of locality.

The term sustainable development rose to significance after it was used by the Brundtland Commission. In the following years, many authorities presented various definitions for sustainable development concept. These definitions came as a complementary in order to make the world more understanding of the sustainability objectives:

- "Improving the quality of human life while living within the carrying capacity of supporting ecosystems" (Caring for the Earth, IUCN/UNEP, 1991);
- "development that delivers basic environmental, social and economic services to all residences of a community without threatening the viability of natural, built and social systems upon which the delivery of those systems depends" (International Council for local Environmental Initiatives, 1996);
- "Determined to promote economic and social progress for their peoples, taking into account the principle of sustainable development and within the context of the accomplishment of the international market and of reinforced cohesion and environmental protection, and to implement policies ensuring that advances in economic integration are accompanied by parallel progress in other fields" (Amsterdam Treaty, 1997);
- "It is about ensuring a better quality of life for everyone, now and for generations to come" (Consultation paper 3 on a UK strategy for sustainable construction, 1998).

McKeown (2002) clarified that sustainable development is a hard term to define because we have difficulties to imagine how sustainable the world could be and it still improves with ever changing human needs and perception, which makes it doubly difficult to define. However, we do not need to be confused, many truly great concepts of the human world such as freedom and justice are also difficult to define.

In 1999, the Board on Sustainable Development of the U.S. National Academy of Sciences presented a table in Brundtland Commission's report to create a standard definition of sustainable development, "Our common journey: a transition toward sustainability" which shows a relation between what is to be sustained and what is be to be developed for now and in the future by studying different sustainable definitions. This description Highlighted attention to the important aspects of sustainable development in different definitions.

As can be seen in Figure 3.1, three major categories are listed as nature, life support systems and communities as well as sub-categories for each one. It was found by the Board that the most emphasis was groped on life support systems such as resources, environment and ecosystem services. Likewise, there were three clear ideas about what should be developed: people; economy; and society. In the early literature was more focused on economic development such as sectors providing employment and desired consumption, but recently the focus shifted to human development with emphasis on increased life expectancy, equal opportunity and education (Kates, Parries and Leiserowitz, 2005).

Kates, Parris and Leiserowitz (2005), argued that sustainable development definitions propose linking what is to be sustained and what is to be developed. However, there are the distinctions extremes of "sustain only" and "develop mostly". The time period of concern was described in an ambiguous way in the standard definition "now and in the future" when it differ widely.

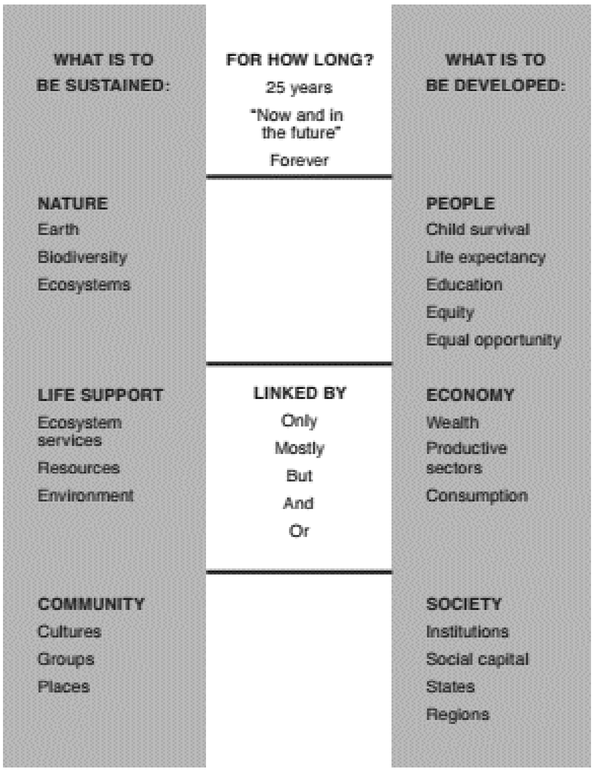


Figure 3.1- Different aspects of sustainable development definitions (U.S. National Research Council, Policy Division, Board on Sustainable Development, 1999).

In the 2012 World Summit of the United Nations Conference on Sustainable Development, the Future We Want, there has been a growing recognition that the truly sustainable development is a holistic approach respects the balancing between the three essential pillars environment, social and economic, at local, national, regional and global levels. People are at the heart of sustainable development, we need to work hard for their needs and aspirations to achieve sustainable development (UNDP , 2012). While this concept is the relatively new idea, there are no common agreements on the details of the three aspects, mostly the social characteristics pillar.

3.3 Three Pillar Basic Model of Sustainability

The three principles of sustainability economic, social, and environment are the powerful tool for easily grasped the sustainable development problem.

Economic: An economically sustainable system must be able to produce the desire goods and services in a responsible way to natural recourses by concern in reduction, reuse, and recycling of the natural resources that are input in the processes, to avoid extreme imbalances which damage the future production (Harris, 2000).

Environmental: An environmentally sustainable system must maintain a stable resource base by avoiding the depletion of renewable and non-renewable resource systems, and managing rate of waste and pollution which should not exceed the assimilative capacity of the environment. This also includes the maintenance biodiversity and ecosystem functioning (Harris, 2000).

Social: A socially sustainable system, such as a country, must be able to achieve the level of well-being at an adequate provision of social services including health and education, gender equity, political accountability and participation etc. to optimize healthy and good quality of life (Western Australian Council of Social Services, 2002).

The three interlocking circles are one of the most famous models to describe the interrelationship between triangle of the triangle of environmental (conservation), economic (growth), and social (equity) (Joshi, Ravindranath, Jain, & Nazareth, 2007). This model leaves a strong idea that it is important to think about the three pillars together for an effective sustainable solution because weakness in the one pillar can directly weaken the sustainable solution (figure3.2).

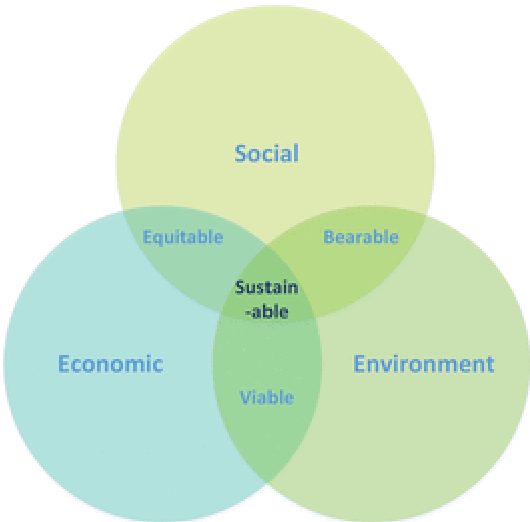


Figure 3.2- Sustainable development model (Castellano, Ribera and Ciuranad, 2016).

3.4 SUSTAINABLE DEVELOPMENT GOALS

In 2015, the global put a new goal for sustainable development. They are a set of seventeen aspirational comprise extensive numbers of targets. They hold the Millennium Development Goals areas among them end poverty in everywhere, promote economic growth, guarantee healthy lives and wellbeing for all inhabitants, ensure inclusive and equitable quality education, achieve gender equality ,and ensure environmental sustainability but add new issues such build sustainable infrastructure and encourage innovation, achieve sustainable consumption and production, find the urgent solution for climate change and its impacts, Make cities and human settlements inclusive, safe, resilient and sustainable, and promote peaceful and provide access to justice for all (Figure3.3).

Figure3.3-The goals for sustainable development (UN News Centre,2015).

The sustainable development goals are universal and voluntary framework. Every country either developed or developing has to implement them to understand the relation between the environmental, economic and social and crate a solutions for better world.

3.5 SUSTAINABILITY SCIENCE

Sustainability science is a new different structure field emerged in the 21st century; it can be usefully thought of as "neither ‘‘basic’’ nor ‘‘applied’’ research. This science serves to understand the interaction between natural and social sciences in series of displaces such as ecological, geographical, economical, medical, and engineering science to promote sustainability (Graighead, 2013).

3.6 SUSTAINABILITY IN CONSTRUCTION

“Creating cities, towns and communities that are economically, environmentally and socially sustainable, and which meet the challenges of population growth, migration and climate change will be one of the biggest tasks of this century” (Peter,2001).

The building and construction industry have a key part to play in supporting sustainable development. This industry plays a vital role in resource consumption and environmental pollution via a series of interconnected human activities and natural processes (Hong, Chiang, Shapiro and Clifford, 2007). It is considered one of the largest users of energy, material resources, and water, and it is a massive polluter. According to the United Nations Environment Program (UNEP, 2012) building and construction industry accounts for 25-40 % energy use; represents 24% of global extractions; contributes 20% of water consumption; emits 30-40 % of solid waste; and 30-40 % of harmful greenhouse emissions (Ju, Ning, & Pan, 2016). At the same time, it plays a significant role in addressing basic human needs and one of the most distinguished forms of economic activity (Hong, Chiang, Shapiro and Clifford, 2007).

Kim (1998), state that the professionals in the construction sector have to understand the fact that as a society's economic status improves, its demand for construction resources land, buildings or building products and material, energy, and other resources will increase . Thus intuitively will increases the impact of construction on the global ecosystem and humans. Sustainable design is becoming necessary for balancing the long-term economic, environment, and social. It offers a solutions that support the occupant's well-being and reduce the negative impact of building on the environment (Burdova and Vilcekova, 2015).

Sustainable building is clarified by the efforts made in the construction sector to improve the building according to the sustainable development (Kang, 2015). A definition of sustainability includes environment, economic and social which differs from the green movement which consider the protection of environment only. Therefore, a distinguish need to be made between what is sustainable building and what is simply green building (Castellano, Ribera and Ciuranad, 2016).

A study by team from University of Wolver Hampton and University of West of England argued that the idea of engaged the action of sustainable strategies in building industry receive well attention among organizations committed to environmental performance because building sustainability has a huge potential to make contribution in sustainable development. Awadh (2016), also believed that the construction sector has to move beyond sustainability development principle to reduce its risk on the ecosystem.

Role (2005) and Gibberd (2002), agreed that the sustainable development is important to the built environment, but, understanding when, how, and which procedure you apply to get correct sustainability is more important. The second concluded that the best way to get the most benefit from the concept of sustainability is to integrate the idea as early as possible with the building development. According to Awadh (2016), the most important role to sustainable construction industry is focusing in increase the social culture acceptance and awareness to concept such as regulations public policy, finance insurance industry, education and construction stakeholders.

3.7 SUSTAINABILITY IN RESIDENTIAL BUILDING

The building house fulfil the basic need for shelter and it ranks second after food. It also plays a crucial role in providing many great impacts on the quality of occupant's life, health, safety and security, well-being as well as productivity where most of the human life is spent within. Globally and traditionally, every civilization makes its own house form which is highly reflective of the historical cultural values and the socio-economic of the social organization.

Socially a house means a place, represent a family and its symbolic social status, functionally, it is rest and leisure place; socio-psychologically, it provides privacy and familiarity; economically, it is article required during purchase or rent, and expenses to facilitate the daily life (Ahmad and Thaheem, 2017).

Quite often, the house is the biggest purchase in the life of a person. While satisfying major personal requirements. House affects the life quality and considers as a tied with the guarantee of human rights, for instance, it provides a private space for nourish and leisure activities (Hall, 2011).

The value of the residential building for the human life cannot be counted but it does not mean they do not have negative impacts. Residential building, in comparison with the other type of building, they consume much more energy. The reason for that, homes are intended to facilitate the life of the people residing within them (UNEP, 2009).

Housing sector needs to require attention in terms of built environment. Because of its great impact on the environment and the resident health and well-being. Therefore, sustainability in residential building is considered as an important part of the sustainable community. Where sustainable housing can provide a personal space for individual, a place where the resident found the basic urban existence and a private place for family life without putting more pressure on the environment (Ahmad and Thaheem, 2017).

Sustainable housing could be defined as fairly combines the three dimensions of sustainability ecological, economic, and social requirements of individual needs and comfort (Hendler & Smeddle, 2009). Where designing a good physical and structural building for a house is not enough without deep reflection of the occupants housing satisfaction and the cultural, social-economic values of a society. A study done by Folaranmi (2013), shows that housing design will fail without reference to the house user.

Sustainable housing needs arbitrator planning to make it a cozy and comfortable place with a high quality, economic, and ecological performance. While efforts towards sustainable housing require well understanding to the social sustainability because it plays a key factor in housing design in one hand and it addresses as a priority in the developing country as Palestine into another the next section (3.8) will discuss the social sustainability in the residential building.

3.8 SOCIAL SUSTAINABILITY IN HOUSING SECTOR

"*The architecture was award winning - but the lifestyle? There's more going on at local cemeteries*." Der Spiegel Magazine. This statement expresses how much is difficult to create efficient and good looking design that will not attract the people.

Oxford Institute for Sustainable Development defines social sustainability as how individuals and communities live together and work to reach their objectives of development within the physical surrounding and the environment as a whole (Hall, 2011). This definition integrates traditional social principles with the sustainability emerging matters related to human rights and needs, economy and environment. Authors define social sustainability in different ways, but most of them agreed that is “the positive condition within communities and the process to achieve it”. They also proposed variety of issues and criteria supporting the social sustainability as a measurable condition as health, participation, safety, accessibility to education, identity and job opportunity, and security (McKenzie, 2004).

Social sustainability in communities is as important as economic and environmental sustainability, and its importance is increased when it’s related to sustainable housing. Houses design is critical elements in society life where they are woven inextricably into the fabric of our lives. The homes strongly reflect the identity of the community which is a formation of social culture values (Ahmad and Thaheem, 2017). This identity can be seen in all of our daily life, our beliefs, the place we live, the work we do, the food we eat etc. (Tawayha, Bragança and Mateus, 2015). That means house design is centered on and around the house inhabitant. Therefore, the better understanding of how to success in construct and measure social sustainability is essential and work to integrated this thinking with policy and professional practice to create social success for residents in the place they live in.

Rapoport (1998), argued that the best way to visualize the housing behaviors domain could be summarized in three questions:

- What is the biosocial, psychological, and cultural characteristics of the human being that effect characteristic of built environment?
- What are the environmental aspects that influence the group of people, and why?
- What is the mechanism that linked the interaction between the people and environment?

It is clear that the culture plays an important role in all three questions. However, there is a major issue in related to the culture description. That it is common to find the word “culture” without any further clarifications, as people think it is a clear concept do not need any more proof or clarifications. In fact, the discussion of the definition and its shape factors is significant to understand views of social sustainability.

Culture in the dictionary defined as “the way of life”, which refers to knowledge, experience, beliefs, spatial relations acquired by a group of people (Zimmermann, 2015).

Moalosi (2007), declared that the lifestyle and socio-cultural characteristics of the people have the deep influence on the design of their housing unit and settlement. The factors that shape the socio-cultural factors in housing design are listed by Dikmen (2005):

- Family Structure and Size: The family structure such as nuclear family and extended family determines qualitative requirements of the house design; while family size determines the quantitative requirements like the area of the house, the number of rooms and their facilities, etc.;
- Safety: Safety plays an essential factor in deciding house form, openings, palisades and fences;

- Privacy: Privacy can be clarified on three hierarchical levels. These are personal privacy, social privacy and public privacy. Public privacy has involved the interaction of the family members with its near surrounding. Social privacy requires the social communication distance with the people with whom one has no intimate relations. Personal privacy requires personal space which belongs to individual's activities;
- Religion: Religion makes up an essential part in the settings of the house design. It affects the form, spatial arrangements and orientation of the house.

Hall (2011), discussed that there are nine categories to be considered the most housing a priority from the point view of the residents. They are the good quality living environment, available good schools, safe environment, clean and friendly neighborhoods, pre-school child care, well integrated social housing, careful interagency planning, community outreach workers, neighborhood amenities, and security. While the main core social sustainability indicators according to the international standers ISO 21929-1 are universal access on site and within the building; ease access for disabled; access to private open space; Maintenance the architectural heritage; indoor air quality and ventilation; reduce outdoor noise; access by public transport; access to bicycle traffic; access to user basic services and access to green and open spaces.

While the environmental building performance influences habitants satisfaction and health in terms of the indoor air, thermal, visual, and aural quality (Awadh, 2016).

Ahmad and Thaheem (2017), argued that despite the importance of the social and cultural issues in overall sustainability there is a lack of a holistic view of social sustainability in the sustainable construction, which creates gaps in analytical support for sustainable decision making. Where, Hall (2011), declared the reason for that there is no shared understanding and agreement about the concepts itself. Each society has its own beliefs, language, and social lifestyle makes a challenge in the interaction and sharing the logic from one community to another. Moreover, social sustainability is hard to measure as the same way of environmental and economic due to the difficulties of enrolling the community needs in practical. Therefore, in many cases the social sustainability is restricted to the health and comfort they could be measurable factors (Kang, 2015).

Chapter (4) will examine the approaches for involving sustainability in the construction industry with more concentration in social sustainability in the residential buildings.

4 BUILDING ASSESSMENT METHODS

4.1 BACK GROUND

Building industry practitioners have begun to pay attention to controlling and improving their activities to reduce its impact on the environment through the implementation of sustainability objectives at all project stages. This transition was reflected in new technologies and approaches, developed at different levels. Building assessment rating tools and guides as BREEAM in the U.K. and LEED in the U.S, GB Tool in Canada (Kang, 2015), and Life-cycle assessment (LCA) as ATHENA (Canada) and LCA House (Finland) have been developed (Chen and Ng, 2015). These methods and system aim to minimize the impacts of building on the natural environmental and maximize the social and economic impacts without ignoring the importance of the harmony between nature and human (Gibberd, 2002). It provides an indicative guide to the performance of the building for the purpose of pre-design, design, construction, operation, maintenance and end of life through numbers of indicators (Burdova and Vilcekova, 2015) that typically include energy, site consideration, water, material usage, and indoor and outdoor environment (Hong, Chiang, Shapiro and Clifford, 2007). In fact, there are complex relations between the three pillars of sustainable development that the assessment tool cannot provide claim comprehensive yet (Gibberd, 2002).

The sustainable building assessment tool can be defined as a systematic guidance to the design team. Braganca, Koukkari and Mateus (2010), stated that the sustainable building assessment tool works as a guide helping to collect and report information for the building decision maker during the different building life cycle and evaluate the overall building performance. The assessment systems are directly used to evaluate the building enhance of sustainability and indirect way they provide better insight into sustainability development through analysis the information and valuation and comparison the results (Nguyen & Altan, 2011) . Burdova and Vilcekova (2015), also agreed that systems and methods for evaluating the building performance are used in all building phases from the cradle to grave, that can meet not only the sustainable development in terms of three primary pillars economic, environment and social but also the requirements for functional and technical performance of buildings.

Sustainability assessment is process of identifying, predicting and evaluating the potential impacts of initiatives and alternatives. It gives an important indication of how the performance of the building act in terms of sustainability (Ahmad and Thaheem, 2017).

Conscious efforts towards sustainable assessment tools not only increase the attentions of the designer to sustainable design but also they support the integrated design approach where all parties involved in the design process from the beginning and they encourage innovation thinking about the more efficient environmental material and new construction technologies with the break down the cost. At the end, they provide a strategy to guide both public and corporate policy-making and helps to reach the sustainability goals (Cole, Howard, Ikaga and Nibel, 2005).

Sustainable building shows an effective way to reduce the impact of building and construction of human on environment (Moktar, 2012), where the obvious result of green building is the positive effects on public health and environment (Ahmad and Thaheem, 2017). It also helps in reducing emissions, protecting the ecosystem, efficiently using energy, water, and other resources, it helps also in reducing the operation costs, increasing occupant productivity, and creating a sustainable community (Ali and Nsairat, 2009).

Fenner and Ryce (2007), discussed that despite the rapid growth of the building assessment system over the last years, where there could be found 600 building assessment systems around the world, the sustainable construction industry does not give the full understanding of sustainability and the scopes under its umbrella relied on the lack of its ability to optimize the economic and social factors. Another study argued that the sustainable assessment building tools that are already used by several countries focus only on environmental indicators, ignoring the importance of economic, social and cultural indicators (Burdova and Vilcekova, 2015).

Moreover, the systems have been criticied that they have not influenced and disseminated the practices of building sustainability because of its poor adaptation. From case study Williams and Dair (2007), found the reasons for this failure was the client did not required the sustainability measurement and the stakeholders could not force the client to follow the sustainability requirements when he feel it's too costly. Furthermore, other authors returned that for the lack of client understanding where the client though sustainability practice complicated and waste time (Häkkinen and Belloni, 2011). Kang, Lee and Kim (2016), blamed the different viewpoints interest and conception of stakeholder, and the barriers of technical language that do not serve the clients and decision makers.

In fact, the tools development process still face some difficulties, especially in defining regional sustainability level (Kang,Kim and Lee,2016). Pointed out that developing countries fell on the sustainability trap when they imported and borrowed the global assessment methods and they greatly used, however, these international systems reduced the foundation of the regional design strategies.

Kang (2016) argued that worldwide there is a hundred of building assessment system under the sustainability umbrella including BREEM, LEED, China Three Star and the SBAT. However, not all these tool are equal, there are variations based on differences system boundaries and local contexts.

Standing upon at that points, it is clearly important to have sustainable building references and supporting strategies in infrastructure deals with our own reality (Bellone, Piccoli and Moro, 2007) more than have a certified green building. Awadh (2016) stressed that each country has to have a building assessment system deals with its local level and driven at the same time with global standardizations. Some regions have already taken this step on it is accounts and starting to adopt sustainable building practices, e.g. Portugal (Sustainable Building Alliance), Italy (Bellone, Piccoli and Moro, 2007), Abu-Debi (Abu Dhabi Urban Planing Center , 2010), and South Africa (Gibberd, 2002).

Braganca, Koukkari and Mateus (2010), argued that both academic and practical sectors meet difficulties in developing a system for evaluate sustainability in building. That because of building sustainability combines a complex relation since it deals with three different priorities, nature, human and built environment (Kang, 2015). Moreover, different actors with various interests and aspirations involved in the design process add more complexity. For example, the contractor looking for reducing the building budget, whereas the owner gives more attention to comfort and health issues. For that reasons, the developer and the stakeholders who are involved in the decision-making tool have to manage the flow of information between extreme various levels of system to achieve the high-performance building (Burdova & Vilcekova, 2015).

Therefore, Kang, Lee and Kim (2016), argued that the sustainable building tools need to be target at the decision maker and the non-expert users to develop an effective solution for regional sustainable practice. Another study showed that the methods of sustainable tool have to increase the match's information between the experts and the building users and adjust their experiences and knowledge for tool usability (Lützkendorf and Lorenz, 2007).

The domain of building environmental assessment has matured remarkably vastly since the introduction of BREEAM in 1990, and the past twenty-fifth years have witnessed a rapid increase in the number of building environmental assessment methods in use worldwide (Bragança and Mateus, 2011). Today there are hundreds of building assessment tool that touches different area of sustainable development. Some of them focus on one concept as energy system design and other methods deal with the whole building (Fowler and Rauch, 2006). While all of the methods have the same target to construct a green building (Golbazia, 2016) by improving the environmental, social, economic and cultural performance of the building during all construction phases (Bragança, Mateus and Koukkari, 2010).

The assessment tools that assessed the building as a whole can be categorized into two categories: the rating tool and LCA. Table 4.1 shows some example of both of them.

Table 4.1- Assessment tool examples and their origin.

Assessment tool	Type	Country	Developer	Year
BREEAM	Rating tool	UK	Building Research Establishment	1990
LEED	Rating tool	USA	U.S. Green Building Council	1998
CASBEE	Rating tool	Japan	Japan Sustainable Building Consortium	2005
ATHENA	LCA	Canada	Canadian Company Capabilities	2001
BEES	LCA	USA	U.S. National Institute of Standards and Technology	2002
Eco-Quantum	LCA	Netherlands	IVAM Netherlands	1999

4.2 LIFE CYCLE ASSESSMENT METHOD

The Life Cycle Assessment (LCA) tools are sustainable building assessment methods based on quantity input-output data, generally on a complex algorithm that allows to understand the flow of the energy use, materials and other environmental impacts from the extraction to the decommissioning (Charlene Bayer, 2010). ATHENA and Eco-Quantum are the most well-known life cycle assessment tool (Kang, 2015).

From the technical perspective, the life cycle assessment methods present a number of advantages for cost and environmental impact. Because they have the capacity to set a wide range of alternative and a deep analysis of cost and environmental issues in one hand and support the process from early design stages into another, which leads the design to a more rigorous result (Castellano, Ciuranad and Ribera, 2016).

Awadh (2016) discussed that, however, the LCA methods are more rigorous than the other methods, they are still complex and need the specialist to apply them. Moreover, Castellano, Ribera and Ciuranad (2016) asserted that these tools are not easy to communicate and understand between non-specialists that make them time-consuming. In fact, the main decision makers are not specialists or technicians. They are in general clients, project owners, investors and managers.

In general, assessment tool is complex to implement, especially who based on the LCA because of the scarcity of clear guiding principles and shortage of the database (Bayer, Gamble, Gentry and Joshi, 2010). So, whenever the tools are easy to implement and understand its ability to change the market positively increased.

4.3 SUSTAINABLE ASSESSMENT RATING METHOD

A sustainable assessment rating method is a tool used to rate, rank, or assess (Kang, 2015) focus on how buildings, groups of buildings, or neighborhoods affect the environmental, economic, and social concerns compared to conventional practice or to ultimate goals (Retzlaff, 2008), taking into account the desire to improve the building performance.

These rating tools are based on evaluation of several criteria, leading to the total score (Kang, 2015). Many systems generally share the same categories: energy, water, sites, building materials, indoor air quality. However, the number of indicator and it is organized under the same categories, how they were developed, and how they are implemented are the differences (Asdrubali, Baldinelli, Bianchi and Sambuco, 2015).

To solve the building impact on the planet two generation of rating assessment building tools were developed. The first generation which only consider the ecological and energy sides for instance LEED and BREEM. Then a second generation of sustainable construction assessment tool emerged based on the result of the first one and consider the social and economic aspects such as SB Tool and DGNB (Castellano, Ribera and Ciuranad, 2016).

Ferreira, Pinheiro and Brito (2014), asserted that introducing the sustainable building rating system in construction sector is one of the clever way for pushing the sector into sustainability throughout using a large set of criteria draws more attention for more sustainable solutions especially the passive design.

Rating assessment systems encourage greater dialogue and teamwork in an integrated approach from the beginning to the end of the process (Ali & Nsairat, 2009). They motivate innovation, urging product and materials suppliers to develop new environmentally products, and new practices to bring the total cost down.

Nowadays a variety of sustainability assessment tools are available on the construction market, and they are commonly used to certify the buildings (Bragança, Koukkari and Mateus,2010) and they provide evidence supporting the financial and environmental benefits of green buildings (Hong, Chiang, Shapiro and Clifford, 2007). However, in most rating systems the indicators and their weighting reflect mainly the needs and priorities, problems, and the national standardization of the local context where they were developed (Bellone, Piccoli and Moro, 2007), means, in one way or into another, it could be useful only in the context where it is originally developed or it would be waste time and expenses (Bragança, Mateus and Koukkari, 2010). Awadh (2016), command that local systems involved criteria is not always accessible and perfectly overlap to the other regions and there is differences in the substance of these rating systems lead to different outcome for the same project when they are applied.

Moreover, in most of these systems environment aspects receive much more attention than the socio-economic factors. While, socio-economic aspects in developing countries are immerging issues to achieve the sustainability there (Ahmad and Thaheem, 2017).

The green building certification fashion among the construction sector is considered as another problem for these systems. Because of the interest of the green building certification hide the main goal of reaching sustainability targets. Unfortunately, the design team use the engine of green certification only in the design and construction stage to receive adequate score result to get the certificationو after that the building does not compromise enough attention. Moreover, in many cases, the building can get points from things that are not adding something to improve the building sustainability.

Often the investors decided to place the building on a certain level to avoid generate more cost caused by expensive experimental needed to gain more points such as the acoustic test in LEED and BREEM to get the acoustic credit (Castellano, Ribera and Ciuranad, 2016).

However, the international assessment tool can play a vital role in the research for developing a new system (Ferreira, Pinheiro and Brito, 2014). Therefore, the sections (4.3.1; 4.3.2 and 4.3.3) will discuss the three most wide use assessment tools LEED; SB Tool and BREEAM.

4.3.1 BREEAM

The Building Research Establishment's Environmental Assessment Method (BREEAM) was developed in the United Kingdom in 1990 to be the world's first sustainability rating scheme (Fowler & Rauch, 2006). It is a holistic and flexible approach cope with the sustainable building design in the United Kingdom, its principles also associated with a Core Technical Standard owned and managed by BRE Global Limited (BRE Global, 2014). However, the scheme is an international standard that can be adapted and applied to the other locations (BRE Global, 2014). In the light of that, up to date, BREEAM is being applied in over 70 countries around the world (BRE, 2016) (Figure 4.1).

BRE Global's team recognizes the overall objectives of BREEAM. These strategies aim to reduce the life cycle's environmental impacts, recognize the building according to its environmental performance, promote reliable building certification, and encourage the researchers towards sustainable buildings (Castellano, Ribera and Ciuranad, 2016).

Figure 4.1- BREEM in numbers worldwide in 2016 (Research Establishment Ltd , 2016).

The evaluation system is broken down into ten categories, which give clarification to the key objectives of the tool mentioned above. The categories and its aims can be listed as follow:

- Energy: Sub-metering, efficiency, and CO_2 impact of systems;
- Management: Commissioning, monitoring, waste recycling, and pollution Minimization;
- Health & Wellbeing: Adequate ventilation, humidification, lighting, and thermal comfort;
- Transport: Emissions and alternate transport facilities;
- Water: Consumption reduction, metering, and leak detection;
- Materials: Asbestos mitigation, recycling facilities, reuse of structures, facade or materials, use of crushed aggregate and sustainable timber;
- Land Use: Previously used land and use of remediated contaminated land;
- And another categories like waste management; pollution and innovations (BRE, 2016).

The project is assessed in the design, construction and operation phases against targets that relying on performance benchmarks. Where the assessments are carried out by independent, licensed assessors, and developments. The final evaluation of the examine project will be on a scale of 30% for pass certification, 45% for good, 55% very good, 70% for excellent and 85% for Outstanding (BRE Global, 2014).

Like all tools BREEM intent to set up the essence of sustainability in a simple, fixable, inclusive and credible way in all construction industry. Therefore, the rating system is adjusted annually based on the evaluation of the performance of existing sustainable buildings (BRE

Global, 2014), and different versions are developed exist depending on the building's typology like homes, industrial buildings, commercial units and schools (BRE, 2016).

But in order to compare more specific version related to research objective to develop residential building tool only BREEAM housing version (Code for Sustainable Homes) will be analyzed.

4.3.1.1 Code for Sustainable Homes

The code for sustainable homes is one of BREEM family schemes. This tool is mandatory in the England and Wales for assessing the environment and certifies the new residential buildings (Communities and Local Government, 2010). It was launched in 2006 to help in reducing carbon emissions and creating more sustainable homes in the UK (Designing Buildings, 2016). Castellano, Ribera and Ciuranad (2016), asserted that this assessment tool was a result of complex efforts of different players in the construction sector. As a result, the target study carried out a number of surveys in order to obtain the sustainable domains and subdomains for the three pillars of sustainability besides the relative weights for each domain.

Codes for Sustainable Homes has nine categories. The whole categories consist of 34 indicators, which are also divided into two groups of indicators. The first group is the mandatory indicators and the second is credit ones (Table 4.2).

Table 4.2- Summary of Environmental Impact Categories, Issues, Credits and Weighting (Communities and Local Government, 2010).

Code Categories	**Available Credits**	**Category Weighting Factor**
Energy and CO_2 Emissions		
Dwelling emission rate (M)	10	
Fabric energy efficiency (M)	9	
Energy display devices	2	
Drying space	1	
Energy labelled white goods	2	
External lighting	2	
Low and zero carbon technologies	2	
Cycle storage	2	
Home office	1	
Category Total	**31**	**36.4%**
Water		
Indoor water use (M)	5	
External water use	1	
Materials		
Environmental impact of materials (M)	15	

Table 4.2- Summary of Environmental Impact Categories, Issues, Credits and Weighting (Communities and Local Government, 2010).

Category Total	**6**	**9.0%**
Code Categories	**Available Credits**	**Category Weighting Factor**
Responsible sourcing of materials – basic building elements	6	
Responsible sourcing of materials – finishing elements	3	
Category Total	**24**	**7.2%**
Surface Water Run-off		
Management of surface water run-off from developments (M)	2	
Flood risk	2	
Category Total	**4**	**2.2%**
Waste		
Storage of non-recyclable waste and recyclable household waste (M)	4	
Construction site waste management	3	
Composting	1	
Category Total	**8**	**6.4%**
Pollution		
Global warming potential (GWP) of insulates	1	
NOx emissions	3	
Category Total	**4**	**2.8%**
Health & Well-being		
Daylighting	3	
Sound insulation	4	
Private space	1	
Lifetime Homes (M)	4	
Category Total	**12**	**14.0%**
Management		
Home user guide	3	
Considerate Constructors Scheme	2	
Construction site impacts	2	
Security	2	
Category Total	**9**	**10.0%**
Ecology		
Ecological value of site	1	
Ecological enhancement	1	
Protection of ecological features	1	
Change in ecological value of site	4	
Building footprint	2	
Category Total	**9**	**12.0%**
Total	**107**	**100.0%**

The mandatory indicators (M) are formed into three groups. First group, environmental impact of materials, Management of surface water run-off from developments and storage of non-recyclable waste and recyclable household waste is the most important mandatory group of criteria because it is the minimum entry with un-credited indicators that building performance must its requirement to get level one. The second group is credit awarded includes two indicators dwelling emission rate and indoor water use, and the building without it cannot achieve overall level 5. The third group has also two indicators (Fabric Energy Efficiency and Lifetime Homes), this group works as well as the second one but to obtain overall level six (Communities and Local Government, 2010). Figure 4.2 illustrates the Code weighting system methodology.

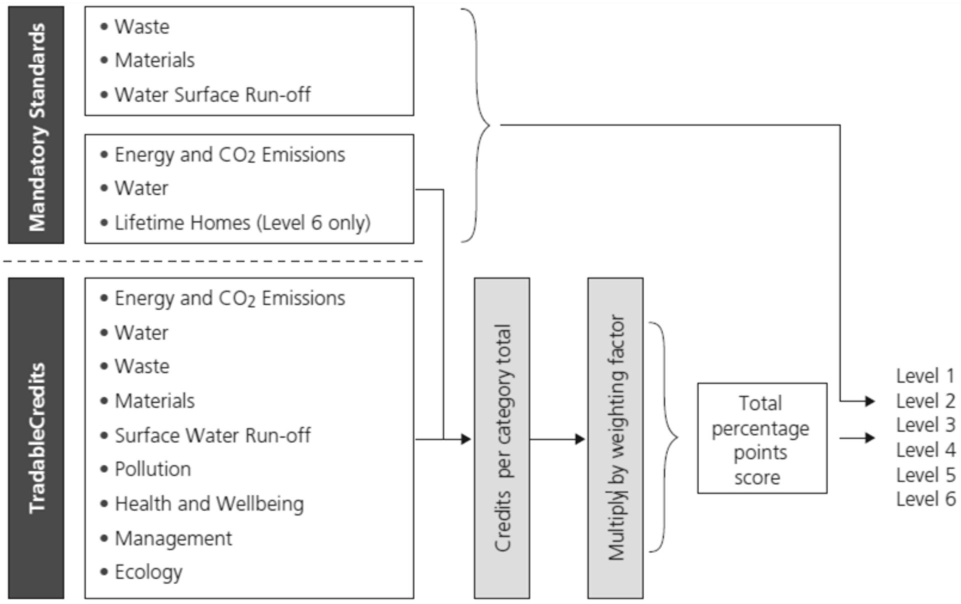


Figure 4.2- Scoring System for the Code for Sustainable Homes (Communities and Local Government, 2010).

System evaluation, is expressed as a maximum number, can be given for each indicator according to its performance. Then, the percentage of the total credit for each category is specified. After that, the percentage result is crossed by its weight. At the end, all the weighted value for the nine categories are calculated to find out one of the six possible certification classes which a raw of 1 to 6 stars (Table 4.3).

Table4.3-Relationship Between Code Level and Total Percentage Points Score (Communities and Local Government, 2010).

Code levels	**Total point score out of 100**
Level 1 *	36
Level 2 **	48
Level 3 ***	57
Level 4 ****	68
Level 5 *****	84
Level 6 ******	90

The Code for Sustainable Homes certifies the building only after its completion for being sure that all requirements are applied well. Where the assessment appends into two-stage procedure Design Stage and Post Construction Stage (Designing Buildings, 2016).

4.3.2 LEED

LEED, or Leadership in Energy and Environmental Design, is a rating system for green buildings used in the USA. The system is developed and administered by the U.S. Green Building Council (USGBC) (Retzlaff, 2008). In 1998, the first LEED version was launched and it was called LEED version 1.0. In fact, the concept was started in 1994 as one standard for new construction and grew to be a comprehensive system covering multi-criteria, standards (Environment and Human Health, 2010). It is worth mentioning that LEED is rated as one of the most effective green building rating systems, and the most widely used third-party verification for green buildings worldwide.

There are many goals for introducing the LEED rating system. The main goal is to reduce the negative impacts of buildings on the environment. It also aims to provide healthier places to live and work, cost-effectives, innovation, and an approach for the integrated design process (USGBC, 2016).

LEED-certified buildings are reported as resource efficient (Environment and Human Health, 2010). They are energy saving (30% lower consumption), water using saving about 30-50%, (Cathy Turner, 2008), 35% carbon saving, waste cost saving around 50-90% (Cathy Turner, 2008), and they have lower (13%) aggregate maintenance cost (Service, 2008). Moreover, it increases the overall of the building productivity and the reputation of the marketing (Environment and Human Health, 2010). Ibrik and Mahmoud (2005) argued that LEED has become a globally accepted benchmark because of its benefits for the construction industry. Other studies mentioned that numbers of countries adopted LEED to take the benefits of the green building, such as Egypt (Environment and Human Health, 2010), Mexico and India (Fowler & Rauch, 2006).

As well, LEED changes the construction market; the dynamic market changes the rating system, that led to a series of versions for instance LEED NCv2.0, LEED NCv2.2 in 2005, LEED 2009 and the last version LEEDv4 was introduced in November 2013 and last updating was in April 2017.

USGBC has developed LEED for nearly every building type “one-size-fits-all” (Wu, Mao, Wang, Song and Wang, 2016), from the design phase, throughout the construction phase, until the maintenance and the operation. Nevertheless, There are multiple rating systems under LEED, In place to provide more flexible rating systems for any building types, such as new construction, retail, homes, hospitality, or healthcare, While there are variations in the credits numbers and the distribution of the points for each system (USGBC, 2013).

LEED rating systems are based on credit allocation and can be classified into six categories (Wu, Mao, Wang, Song and Wang, 2016) except LEED-ND (Retzlaff, 2008). Each category contains requirements, some of them compulsory and the others carry a specific amount of rating credit (Environment and Human Health, 2010);

- Sustainable site planning;
- Safeguarding water and water efficiency;
- Energy efficiency and renewable energy;
- Conservation of materials and resources;
- Indoor environmental quality;
- Innovation.

There are four levels of certification for buildings in the LEED rating system: Certified, Silver, Gold, and Platinum. The number of points each building earns determines the level of LEED certification that it obtains.

The final result is obtained by adding the score of each set of indicator related to the same category, together to get the related score of the same category, then estimate the final score of the building by adding all categories together.

Despite the great effort in developing LEED rating system, the implementation of LEED still faces a number of issues. Firstly, the LEED weighting system concentrates the most on the energy efficiency 30-35 % in building (Schwartz and Raslan, 2013), meaning that a building may achieve "Platinum" without any points begin awarded for indoor quality or water efficiency (Environment and Human Health, 2010). Secondly, none of the minimum requirements address the importance of drinking water quality, protecting human health from chemical components in building materials, and workers' occupational risks (Wu, Mao, Wang, Song and Wang, 2016). Thirdly, LEED is more focused on input to building rather than on the environmental outcomes, for example, a larger building may receive "Gold" rating, however, its final impact on the environment will be great (Kang, 2015). Finally, LEED is more related to the overall company productivity than occupant's satisfaction (Environment and Human Health, 2010).

As in BREEM, the LEED for house design typology will be discussed in the section (4.3.2.1).

4.3.2.1 LEED v4for home design

LEED has adapted rating systems to the local codes and legislations for homes in U.S and the system is called LEED for Homes. It is promoted to transform the home building industry towards more sustainable practices. LEED for homes is designed to work with all sectors of the homebuilding industry. This rating system represents the consensus for green home building developed and refined by a diverse cadre of national experts and experienced stockholders.

LEED for Homes is available for building design and construction projects for single-family homes and multifamily projects up to eight stories. LEED for homes measures the overall of the building in eight categories. The categories are listed as follow:

- Innovation design process: Special design methods and unique regional credits,
- Location and linkages: The placement of the home in the society and it is impact on the environmental community;
- Sustainable site: Use the entire property to minimize the impacts on the site,
- Water efficiency: Efficient practices indoors and outdoors;
- Energy and atmosphere: Energy efficiency especially in the envelope heating and cooling design;
- Materials and recourses: Efficient use of materials, selecting the most appropriate with environment and minimizing the waste material during construction phase;
- Indoor environment quality: Improving indoor air quality by reducing exposure to outdoor pollution and the creation of a comfortable environment too;
- Education and awareness: The education of the homeowner and the building manger about the operation and maintenance of a green building.

LEED for home design works as LEED rating system by requiring a minimum level of performance through mandatory pre-requisites and others criteria. Each standard has its maximum number of available points. The categories and the weighting system in the Table 4.4.

Table 4.4- The weighting system and categories for LEED for homes.

Category	**Midrise**		**Homes**	
	Criteria weighting	**Category weighting**	**Criteria weighting**	**Category weighting**
Integrative Process		**2**		**2**
Location and Transportation		**15**		**15**
Floodplain Avoidance	R			
LEED for Neighborhood Development Location	15		15	
Site Selection	8		8	
Compact Development	3		3	
Community Resources	2		2	
Access to Transit	2		2	
Sustainable Sites		**7**		**7**
Construction Activity Pollution Prevention	R		R	
No Invasive Plants	R		R	
Heat Island Reduction	2		2	
Rainwater Management	3		3	
Non-Toxic Pest Control	2		2	
Water Efficiency		**12**		**12**
Water Metering	R		R	
Total Water Use	12		12	
Indoor Water Use	6		6	
Outdoor Water Use	4		4	
Energy and Atmosphere		**37**		**38**
Minimum energy performance	R		R	
Energy metering	R		R	
Education of the homeowner	R		R	
Annual energy use	30		29	

Table 4.4- The weighting system and categories for LEED for homes.

Category	Midrise		Homes	
	Criteria weighting	Category weighting	Criteria weighting	Category weighting
Efficient hot water distribution	5		5	
Advanced utility tracking	2		2	
Active Solar Ready Design			1	
HVAC start up credentialing			1	
Home size			R	
Building orientation for passive solar			3	
Air infiltration			2	
Envelope insulation			2	
Windows			3	
Space heating and cooling equipment			4	
Heating & Cooling Distribution Systems			3	
Efficient Domestic Hot Water Equipment			3	
Lighting			2	
High Efficiency Appliances			2	
Renewable Energy			4	
Material and recourses		**9**		**10**
Certified tropical wood	R		R	
Durability management	R		R	
Durability management verification	1		1	
Environmentally Preferable products	5		4	
Construction waste management	3		3	
Material Efficient Framing			2	
Indoor environmental quality		**18**		**16**
Ventilation	R		R	
Combustion venting	R		R	
Garage pollutant production	R		R	
Radon-Resistant Construction	R		R	
Air Filtering	R		R	
Environmental Tobacco Smoke	R		R	
Compartmentalization	R		R	
Enhanced Ventilation	3		3	
Contaminant Control	2		2	
Balancing of Heating and Cooling Distribution Systems	3		3	
Enhanced Compartmentalization	3		1	
Enhanced Combustion Venting	2		2	
Enhanced Garage Pollutant Protection	1		2	
Low Emitting Products	3		3	
No Environmental Tobacco Smoke	1			
Innovation		**6**		**6**
Preliminary Rating	R		R	
Innovation	5		5	
LEED AP Homes	1		1	
Regional Priority		**4**		**4**
Regional Priority: Specific Credit	1		1	
Regional Priority: Specific Credit	1		1	
Regional Priority: Specific Credit	1		1	
Regional Priority: Specific Credit	1		1	
TOTAL		110		110

The evaluation system procedure in LEED for homes is simple since there is no specific weighting for each category. The final value is calculated by adding up all the points that the project awarded where the total point are 110. The rating system has four levels of certification, depending on the points that the project achieved after the evaluation (Table 4.5).

Table4.5- Certification levels in LEED for homes.

LEED for homes certification levels	Number of LEED for home points required
certified	40-49
silver	50-59
gold	60-79
platinum	80-110
Total available points	**110**

4.3.3 SB Tool

SB Tool is an international rating system that engaged more than 20 countries throughout Europe, Asia and America since 1998. It was developed by the International Framework Committee to rank U.S. buildings for the Green Building challenges. The tool is a generic qualitative and quantitative measurement framework for building assessment, that design to adapt by sponsors and local non-commercial organizations to reflect and develop rating system relevant to the local context (Larsson, 2015) where The SB Tool has inspired a number of national systems e.g. Italy, Spain and Portugal. Because of that, it require high technical expertise to implement more than the other rating system (Fowler and Rauch, 2006).

There are two modules for assessment in SB Tool, one is related to the site and the other to the building itself, with a different scope to implement the system, minimum, mid-size, Maximum, and developer version. Each scope involves a different number of criteria and may include 10 up to 115 + criteria, between mandatory and optional criteria. The rating system address standers and local norms and handles with both retrofitted and new buildings in all conditions and includes different life-cycle stages: pre-design, design, as built, and operations. SB Tool is designed to include a number of indicators under specific categories (Larsson, 2015). The major categories could be summarized in (Fowler and Rauch, 2006):

- Energy consumption: It is assessed through the total use of renewable and non-renewable energy;
- Resource consumption: It is assessed through the use of materials, water, building systems, and occupants use;
- Indoor environmental: It is assessed through indoor air quality, ventilation, daylight, temperature, relative humidity, and acoustics and noise issues;
- Environmental loadings: It has site impacts, greenhouse gas emissions, solid and storm water, wastewater, and other local and regional impacts;
- Site selection: In the side of land use, access to the transportation, and Brownfield;
- Project planning and urban design;

- Other categories include building controls, functionality, maintenance of operations, and a few social and economic gauges.

The system has two type of indicators: compulsory and normal indicators. Compulsory indicators must get a minimum score, like 3 or 3.5, to avoid having a building with poor performance in the serious sustainability areas. For the other indicators all of them must be scored, to provide a full picture about the building under assessment.

After obtained the numerical weight value for all the indicators, each value is multiplied by its weight factor. Then, the final value for the indicator, at the same category, are added together.

In the end, all of the seven categories values are crossed by their specific weights and results are then added up to get the overall certification classes.

SB Tool added good advantages to the sustainable building development. It gives space to develop much meaningful assessment that deals with the local context and does not neglect the importance of renovating building issues. It promotes the use of renewable energy, especially the solar energy. The system includes an IDP management support tool to insure that the design teams are involved in all stages and work more effectively. Moreover, the SB Tool provides a detailed approach to solve the problem of weighting system points. However, it needs specialists with wide range experience to adapt the system and the standards to local context and it is reality.

In this research SB Tool PT-H, which is a Portuguese housing version tool, based on the international SB Tool will be analyzed, as the nearest tool for the thesis goal.

4.3.3.1 SB Tool PT- H

SB Tool PT- H is the first Portuguese tool based on the SB Tool international one, and it allows the assessment and recognition of the sustainability mainly for the scale of the residential building or group of the same function in Portugal (Figure4.3). It belongs to the second generation of sustainability assessment tools and uses the life cycle approach.

The SB Tool PT - H aims in one hand to support the project teams from the early design stages in building sustainable housing and allow the evaluation and certification of sustainability of existing buildings, new and renewed, located mainly in urban areas and in another hand to increase the awareness of decision makers in the Portuguese construction market towards the importance of sustainable building solutions.

SB Tool PT-H has 24 indicators that are distributed in nine categories based into the different dimensions of sustainable (Table 4.6): climate change and outdoor air quality; soil use and biodiversity; energy; materials and solid waste; water; comfort and health of users; accessibility; awareness and education for sustainability and life cycle costs.

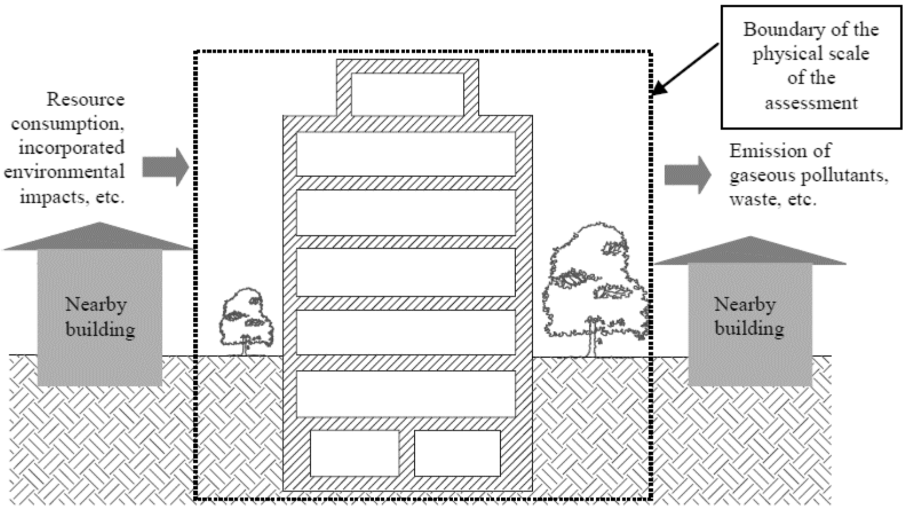


Figure 4.3- Physical boundary of the assessments using the methodology SB Tool PT– H (Bragança & Mateus, Evaluation Guide SBTool PT – H, 2009).

Table 4.6- Indicators, parameters and categories of the methodology SB Tool PT– H and their weighting (Bragança and Mateus, 2009).

Dimensions	(W)	Categories	(W)	Indicators	Parameters	
End – Environmental	40%	C1 – Climate change and outdoor air quality	13%	• Environmental impact associated with the life cycle of buildings	Aggregated value of the environmental impact categories of the life cycle of useful floor area and per year	P1
		C2 - Soil use and biodiversity	20%	• Urban density	Used percentage of the available liquid utilization index	P2
					Waterproofing index	P3
				• Reuse of previously built or contaminated soil	Percentage of the intervention area previously contaminated or built	P4
				• Use of autochthonous plants	Percentage of green areas occupied by autochthonous plants	P5
				• Heat island effect	Percentage of plant area with reflectance equal to or above 60%	P6
		C3 - Energy	32%	• Non-renewable primary energy	Consumption of non-renewable primary energy in usage phase	P7
				• Energy produced locally from renewable sources	Amount of energy that is produced in the building from renewable sources	P8
		C4 - Materials and Solid Waste	29%	Reuse of materials	Percentage in cost of reused materials	P9
				• Use of recycled materials	Percentage in weight of the building's recycled content	P10
				• Use of certified materials	Percentage in cost of organic based products that are certified	P11

Table 4.6- Indicators, parameters and categories of the methodology SB Tool PT– H and their weighting (Bragança and Mateus, 2009).

Dimensions	(W)	Categories	(W)	Indicators	Parameters	
				• Use of cement substitutes in concrete	Percentage in mass of cement substitute materials in concrete	P12
				Storage conditions of solid waste during the building's use phase	Potential of the building's conditions for promoting the separation of solid waste	P13
		C5 - Water	6%	• Water consumption	Annual volume of consumed water per capita inside the building	P14
				Reuse and use of non-potable water	Percentage of reduction in potable water consumption	P15
SP – Social	30	C6 - Comfort and health of users	60%	• Efficiency of natural ventilation in indoor spaces	Potential of natural ventilation	P16
				• Toxicity of finishing materials	Percentage in weight of finishing materials with low VOC content	P17
				Thermal comfort	Level of annual average thermal comfort	P18
				Visual comfort	Average of the Medium Daylight Factor	P19
				Acoustic comfort	Average level of acoustic isolation	P20
		C7 – Accessibility	30%	Accessibility to public transport	Index o - accessibility to public transport	P21
				Accessibility to amenities	Index of accessibility to amenities	P22
		C8 - Awareness and education for sustainability	10%	Formation of occupants	Availability and content of the building user's guide	P23
EP – Economic	30	C9 – Life cycle costs	100%	• Initial cost	Value of the initial investment cost per m2 of working area	P24
				• Usage costs	Present value of the usage costs per m2 of working area	P25

Note, W is equal to weight.

The assessment process through the use of the SB Tool PT- H is divided into three sequential phases and allows the evaluator to check the building performance in each level. In the phase number one the assessor measures the performance of each indicator. After that, the building performance is measured due to the categories and dimensions of sustainable development and qualified the Sustainability Level. At the end, the Sustainability Certificate is completed (Figure 4.4).

The assessment of each indicator includes two-step. The numerical signals are used for every criterion to minimize the subjectivity. Then the numeric indicator is converted into qualitative scale to ease the communication and avoid the problem of "bigger is better" and "bigger is worse" (Castellano, Ribera and Ciuranad, 2016). In the second step the system use the Diaz-Balteiro equation (4.1) (Bragança and Mateus, 2009).

$$\bar{P_i} = \frac{P_i - P_{*i}}{P_i^* - P_{*i}} \forall_i \qquad (4.1)$$

In this equation, Pi is the result of the normalization of the parameter i, Pi is the value resulting from the quantification and Pi * and P*i are the benchmarks of the parameter i, representing respectively the levels of best practice and standard practice.

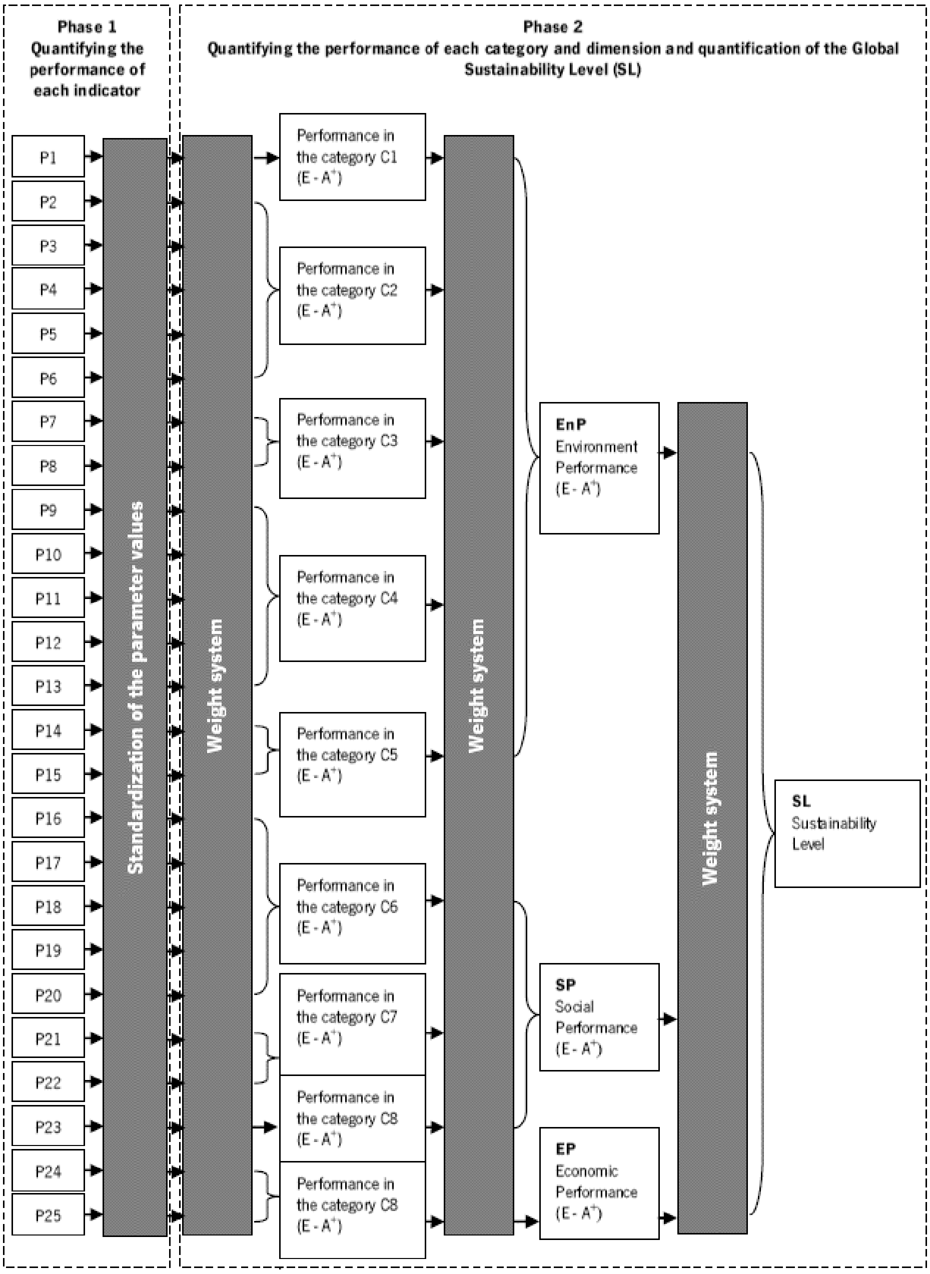


Figure 4.4-Schematic representation of the three stages of the evaluation process and communication of sustainability of SB Tool PT - H (Bragança and Mateus, 2009).

The indicators are combined to summarize the building performance at level of the category they belong to. In the next step, the categories related to the same dimension are aggregated to provide the sustainable performance for each dimension. The final sustainability score is then obtained by adding the three dimensions value, multiplied by the weight of each dimension.

SBTool PT – H has six level to express the sustainability performance: from E (less sustainable) to A + (more sustainable), where D corresponds to the standard practice and A corresponds to the best practice (table 4.6).

Table 4.7- conversion of normalized quantitative parameters into a qualitative scale.

Class	Value
A+	P > 1.00
A	0.70 < P ≤ 1.00
B	0.40 < P ≤ 0.70
C	0.10 < P ≤ 0,40
D	0.00 ≤ P ≤ 0.10
E	P < 0.00

4.3.4 Analysis between Sustainability rating systems for residential building

Code for Sustainable Homes, LEED for Homes and SB Tool PT- H are all rating system for residential building, whereby the project is evaluated according to a number of categories under environmental, economic, and social dimensions in order to embed sustainable building within their countries that way each rating system has different categories distribution.

In this section, it is essential to mention that the LEED for Homes and Code for Sustainable Homes do not divide the categories based on its domain environment, social, and economic because of that some social indicators will be found within energy and atmosphere category as an example. Thus in this section, attention is taken into account for a better aggregation to reflect the sustainability dimensions (Table 4.8).

Table 4.8-weights of sustainability dimensions in the three rating system.

Dimension	Code for Sustainable Homes	LEED for Homes	SB tool PT- H
Environment	71.3%	69.7%	40%
Economy	___	_____	30%
Social	24.6%	23.4%	30%
Procedural	4.5%	7.2%	_____

Regarding the three sustainability domains, SB tool PT- H is the most successful tool in achieving the balance between the three dimensions because of its primary division into three domains with proper weights.

Even though, as Table 4.8 illustrate, in all the systems, the environment is always considered as the most important between the three sustainability dimensions, because these tools are above all focused in reducing the building impact on the ecology.

The second most important domain is the social one. That is because the concept of the house is a shelter for people where they are looking for comfort, safety and good services, as being of some of the social aspects that aim to increase well-being value.

For Code for Sustainable Homes and LEED for Homes economy is the less importance. That because both of them related to the first tool generation where the life cycle cost is not relevant. However, indirect economic advantages are included in other issues like energy and water efficiency.

Awadh (2016) argued that the cost and economics aspect it is considered the engine of the design process, therefore, its importance will be covered in one way or into another. However, the social sustainability is not provided with an adequate weighting comparing with the environmental issues. Because of that, it is at stake of not being significantly incorporated in the design process.

The following charts (Figures 4.5, 4.6, and 4.7) show the categories that contribute to each rating system and the weights of each of them.

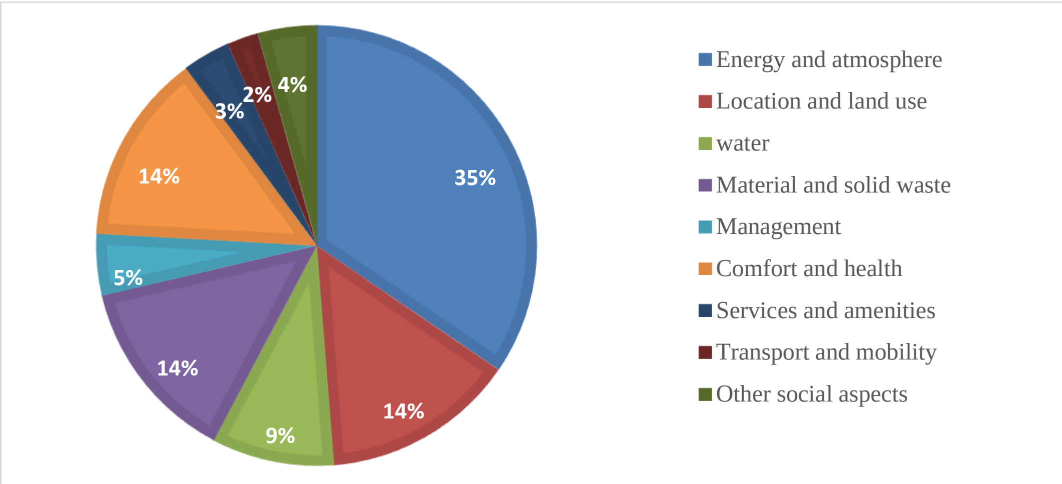


Figure 4.5- The categories and their weights for Code for Sustainable Homes.

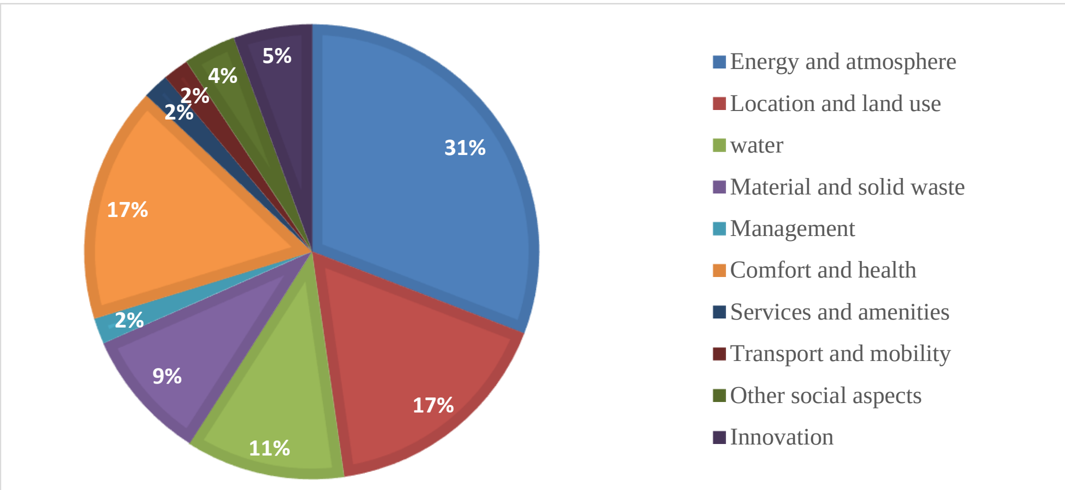


Figure4.6-The categories and their weights for LEED for Homes.

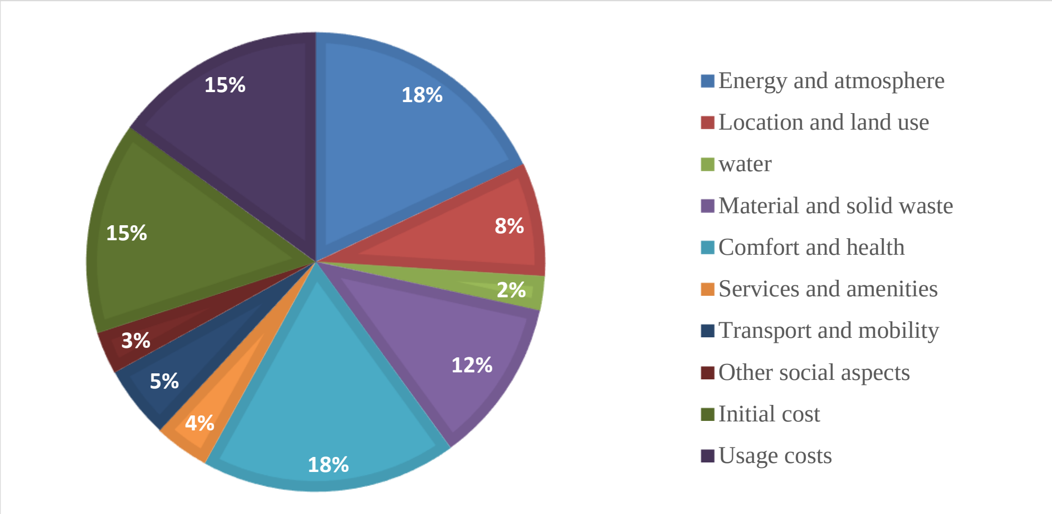


Figure 4.7- The categories and their weights for SB tool ^{PT}- H.

The pie charts in figures 4.5, 4.6 and 4.7 show that energy and atmosphere category is the most important category in the three presented tools. The reason for that is clear, where all countries try to address the global priority in climate change and energy security.

It is also clear that the energy and atmosphere category weight contribute the most in Code for Sustainable Homes, 34.5%, followed by 30% for LEED for Homes. While in the SB Tool PT-H the biggest slice of the weight that is 18% devote to two categories, energy & atmosphere and around comfort & health.

The second most contributing category differs somewhat between the three rating systems. Code for Sustainable Homes gives around 14% for both comfort and land use has the second largest weight. LEED for Homes gives the second biggest weight for health and comfort, and Land use categories, around 16.5%. Initial cost and operation cost in SB Tool PT-H have the same weight 15% and are the second most important categories in this tool.

Land use, material and water deserve some attention too. However, SB Tool PT-H reduces the importance of water efficiency weight in a comparison with Code for Sustainable Homes and LEED for Homes.

The lowest weighting amount in the three systems it also different. The transport and amenities categories weigh the smallest amount 1.8% in LEED for Homes, whereas, the transport category is the lowest contributor (2.3%) in Code for Sustainable Homes. About the SBT PT-H, water category is the lowest one, 2.4%.

Finally, the charts in Figures 4.5, 4.6 and 4.7 show that there is general agreement between the three systems. Nevertheless, it is clear that there are differences between the structures of the tools in the definition of sustainability dimensions. This means that there is no international rating assessment tools and that rating system is developed to reflect the local context and the opinion of the experts and people there.

In the page 62, a comparison between the systems in relation to social aspects will be presented.

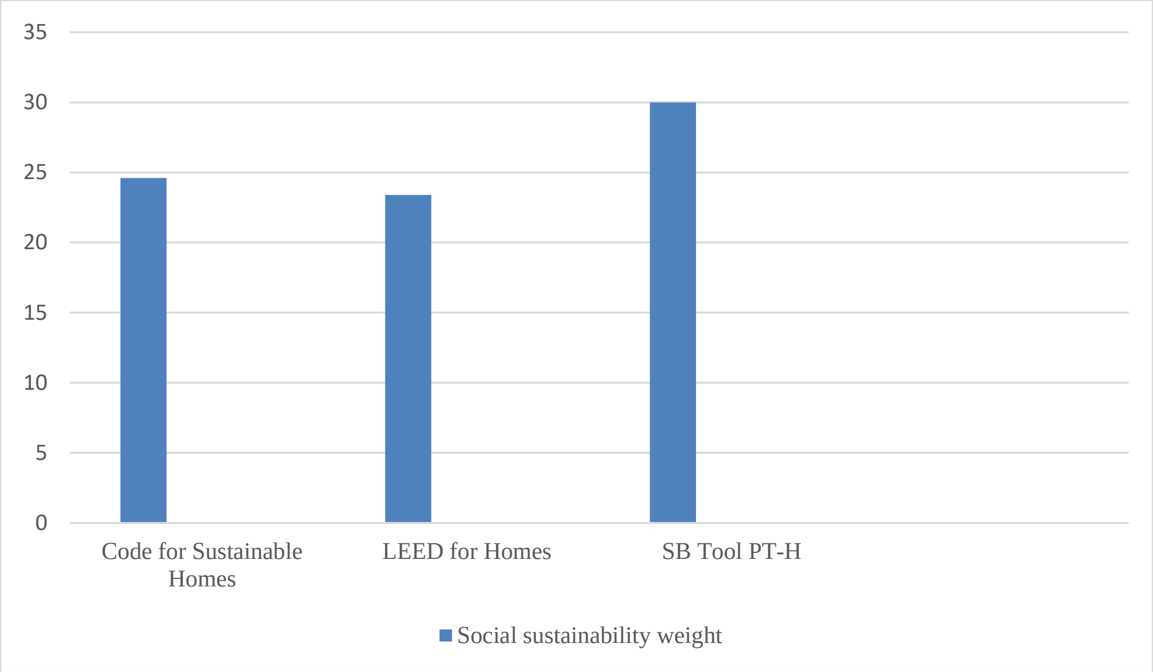


Figure 4.8- Social sustainability weighting variation between the three systems.

Table 4.9- Related social aspects of Code for Sustainable Homes, LEED for Homes and SB tool PT-H rating systems.

Social indicators	**Code for Sustainable Homes**	**LEED for Homes**	**SB tool PT-H**
Providing security, design where people feel safe and secure	2.2%		
Availability of home user guide	3.3%		3%
Possibility to adaptable the construction to meet future occupants needs /Lifetime homes	4.6%		
Providing drying space for drying clothes	1.17%		
Providing a space for working/ home office	1.17%		
Providing private outdoor space	1.16%		
Accessibility to community amenities and services		1.8%	3.9%
Accessibility to transportation	2.3%	1.8%	5.1%
Potential of natural ventilation			2.1%
Providing average Level of daylighting	3.5%		4.5%
Providing level of average thermal comfort		4.5%	5.7%
Providing Sound insulation	4.6%	1.8%	3.6%
Reducing exposure to airborne chemical contaminants		2.7%	2.1%
Installing Mechanical Ventilation and air Filtering in the kitchens, bathrooms and other sources of moisture.		2.7%	
Limiting the leakage of combustion gases		1.8%	
Minimizing the exposure of building occupants to indoor air pollutants		3.6%	
Free smoking area		0.9%	
Addressing geographically specific environmental and social equity/ Regional Priority		3.6%	

The bar graph presented in Figure 4.8 compares the percentage of the social dimension weight in the Code for Homes, LEED for Homes and SB Tool PT-H. It can be seen that social sustainability has the highest percentage in SBTool PT-H, 30%. By contrast, the lowest percentage it is in LEED for Homes, around 23%.

In summary, social domain participation is the greatest in SB Tool PT-H and in the other tools are almost similar.

As the social aspects in the rating systems do not perfectly overlap, the comparison will be done to show the similarities and differences in the Code for Sustainable Homes, LEED for Homes and SB Tool PT-H rating systems.

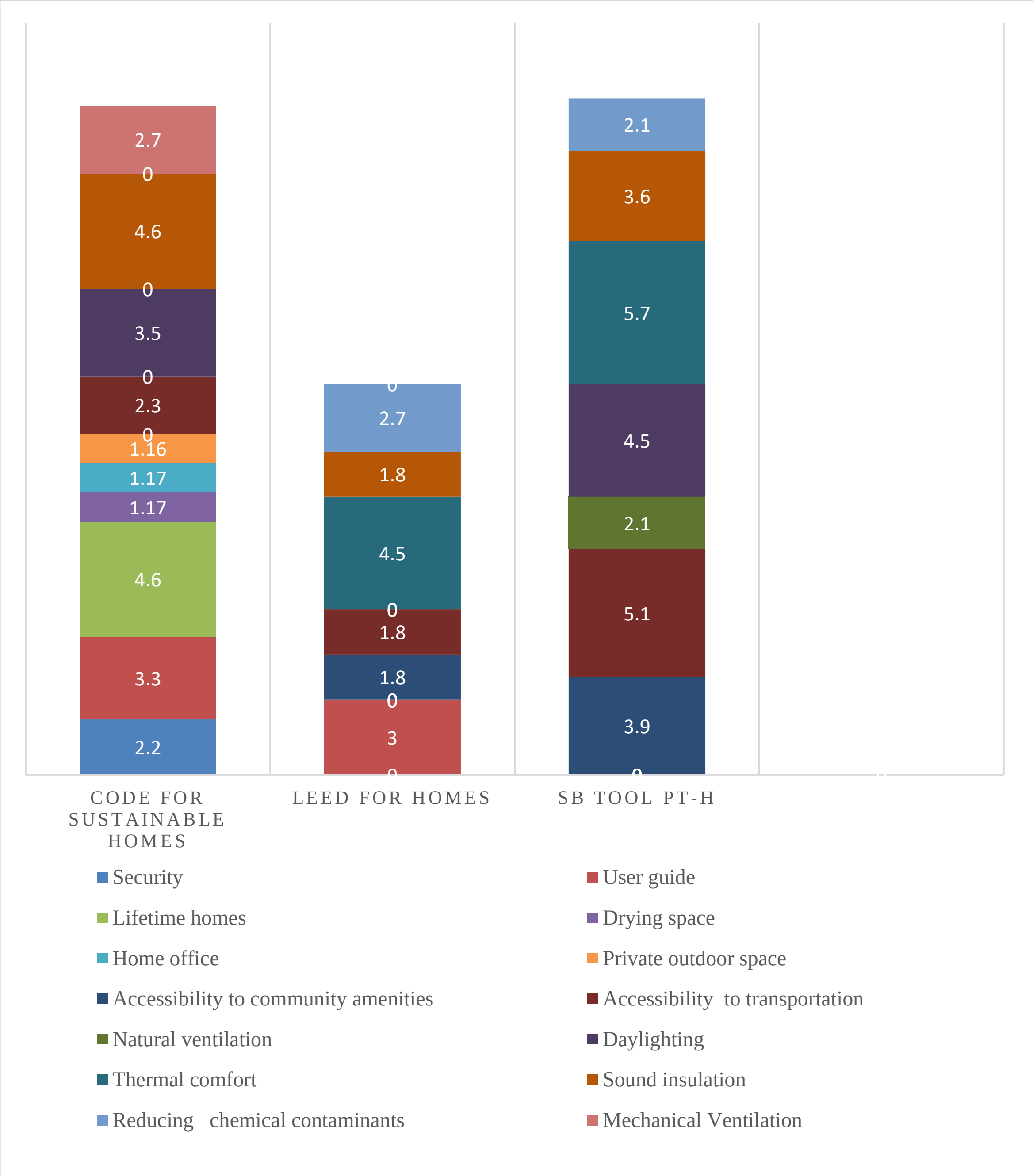


Figure 4.9- Social aspects weights of the three rating systems.

As can be seen from the Table 4.9, each rating tool addresses the social aspects from a different logic, which makes the direct comparison not applicable. However, providing sound insulation and accessibility to transportation indicators are taken into consideration by all systems.

It is clear from the Table 4.9 that SB Tool PT-H and LEED for Homes are the most overlap. Thermal comfort is highlighted in the two systems emphasizing the importance of a comfortable thermal environment for the residents. Accessibility to community amenities and services and reducing exposure to airborne chemical contaminants have been considered in both of them as well.

Code for Homes and SB Tool PT-H share more two indicators. The first indicator is the availability of home user guide, which aims to increase awareness the occupants about how to operate their house efficiently. The second indicator is providing average level of daylighting, which improves the quality of life and reduce the need for energy to light the home.

The Figure 4.9 up shows the social aspects weights of the three rating systems. SB Tool PT-H provides the priority for thermal comfort. LEED for homes is also more focused on thermal comfort in addition to minimizing the exposure to indoor air pollutants. It seems to be that Code for homes is the more different than the other tools where it is highly concerned in daylighting and Lifetime homes.

In contrast, the lowest attention in Code for Homes is given to private space. While in the SB Tool PT-H reducing exposure to airborne chemical contaminants and natural ventilation indicators are less encouraged. In comparison, LEED for homes provides only less than 1% for free smoking area indicator. Social sustainability is not far away from that. Resident life quality depends on the building atmosphere, size and layout. However, this is not enough, the developer should look for the regional factor including building location, accessibility to the transportation, and availability of community services (Ahmad & Thaheem, 2017).

Finally, Table 4.9 and Figure 4.9 show that the general agreement between the three assessments at the concept of social sustainability system is limited. It is obvious that LEED for Homes seek to improve more the health and well-being of occupants by reducing the exposure to the harmful substances. As Code for Homes is more concentrated to enhance the security and privacy by providing a private atmosphere inside the house. While SB Tool PT-H is aiming to increase the quality of life and residents health by improving the house indoor environmental quality.

4.3.5 Conclusion

The discussion is about Code of Houses, LEED for Homes and the SB Tool PT –H assessment tools criteria and their weights, with more focus on the social aspects. The study uses a conceptual qualitative way to compare the tools, which mean the accuracy of the system application is not consider.

The analysis shows that the main purpose of all of the assessment tools is to encourage the sustainability principles in the housing sector despite their different approaches.

Code of Houses, LEED for Homes and SB Tool PT-H are given the most weighting for the environmental domain and especially for energy category. That is because of the scarcity of the environmental resources where its presence is essential for our survival. But, a large variation range is found in the economic dimension.

I would argue that designing for the sustainable building if it is a house or another building type, is more than the how much the building consume energy, material or water. It should be a livable and comfortable place, affordable and more durable as well.

SB Tool PT-H is the most balanced rating system according to the study. It is followed by LEED for Homes and the last balanced is Code for Homes, this could be related to local environmental issues and legislations. However, Code for homes is the housing version of BREAM and LEED for Homes is the LEED housing version, where both of them are the most internationally applicable systems.

Social sustainability is one of the most important issues for a sustainable house design. But the weight of social domain is largely reduced in most of the assessment tools. Even so, there is a presence of social dimension in all of them.

In terms of social sustainability, this study concludes that the applied of this domain is also varies in all tools. The importance of the domain weight, the indicators that are involved in the evaluation as well as their weighting.

Sound insulation and accessibility to transportation indicators have the consensus in the three sustainability assessment methods. In fact, the natural ventilation did not receive appropriate attention among most of the tools despite of its importance in bring fresh air and natural light into a building and getting rid of the hot polluted air.

Social privacy and regional factors are also considered as essential factors to shape the housing design, as it will be discussed in the next section. However, mostly there is a lack of considering these issues among the systems.

Based on this discussion, adaptations of sustainable rating systems offer a guide that help in construct the sustainability goals in the building. However, there is no global rating system, which can be applied in every region or project. It is clear that there are substantial differences between the ratings systems, which will lead to different outcomes.

Therefore, to apply sustainable building practices correctly we should develop a resource for promoting sustainability based on a suitable sustainable assessment rating system that suits the local conditions. Which is a challenge to keep up with all updates and changes.

In chapter five, the basic framework for developing and assessment rating methodology for West Bank residential buildings will be presented. The categories of social dimension and their related indicators will be presented. Additionally, the weights of the indicators and categories will be calculated.

5 DEVELOPING AN ASSESSMENT TOOL FOR WEST BANK RESIDENT BUILDINGS

5.1 BACK GROUND

The construction industry has enormous value for creating job opportunities but also is consuming resources. It has a huge impact on economic, society and the environment. For more development in the society the sustainability in building industry must be considered.

Agenda 21 for Sustainable Construction in Developing Countries 2002, stressed that developing countries will have to follow sustainability as a necessity in construction to solve their settlement issues such as adequate housing, rapid urbanization and lack of infrastructure, where there is no more time left to decide that.

West Bank, Palestine is not just a part of developing country, need urgent sustainable construction application to improve its construction sector but also a special case suffering from occupation since 1967. It also facing the global issues of shortage of water and energy, climate change, and increasing of pollution.

The residential buildings take the majority of the developed Palestinian land and it is the one of the most pressing problems of West Bank construction industry. Palestinian housing obstacles can be summarized in shortage of residential buildings and their utilities and services, weakness in construction technology, and rapid increasing in apartment prices due to the extensive of imported building materials and scarcity of land (Palestinian National Authority Ministry of Public Works and Housing, 2010). Hence, the sustainability foundation is necessary to formulate a new environment for housing and Palestinian construction.

The benefit from sustainability into the future is dependent on the application that must be taken today. These applications link the sustainability science with action like polices, planning or products (Sala, Ciuffo and Nijkamp, 2015). Applying Assessment sustainability is one of the applications that provide a proof that the building succeeded in to achieve a level of sustainability (Kang, 2016). Therefore, developing an assessment rating system could solve some of the West Bank residential building problems.

This study aims to be a basis for the development of a residential building sustainability rating tool, which appropriate for Palestinian environment, traditions and society, and national building codes, under the global topics.

Based on the definition of sustainable building, the dimensions of sustainability can be divided into the environment, economic, and social dimensions. In this case study, the tool is limited to the socio-cultural dimension on one hand, due to the limited research period; on the other hand, the Agenda 21 for Sustainable Construction in Developing Countries (2002), Jeremy Gibberd (2005), and Ali and Naira (2009), state that human beings at developing countries should be at the center of sustainable development.

The methodology to develop the sustainability assessment system should include the following characteristics: (CIB, UNEP-IETC, 2002); (Awadh, 2016); (Braganca, Koukkari &Mateus 2010);

1. Understand similar processes done by other countries and to develop suitable framework that addresses the socially and ecologically problems for the context where it is going to be applied and to avoid blindly copying (CIB, UNEP-IETC, 2002); (Kang, Kim and Lee, 2016); (Ali and Nsairat, 2009); (Ahmad and Thaheem, 2017) :
2. The developers have to understand the desire goals for the application ;
3. The sustainability dimensions environment, (social, economic and cultural) should be respected and balanced according to the local and global priorities ;
4. The involved domains, categories and the indicators in the developed tool should respect the local context within them and be based on the global concerns;
5. The developed tool have to address the sustainable issues in the whole life cycle of the building, including design, construction, operation, repair, renovation and retrofit and demolition ;
6. The developed tool should fit the typical building project to avoid business failure;
7. The developed tool must be address the knowledge from both experts and non-experts to have most practical tool reflect the regional issues;
8. The developed tool should be appropriate, transparent, practical and flexible enough to users.

The framework of this assessment tool case study is based on quantitative and qualitative approaches and this study is organized into three phases: definition of the system boundaries; selecting indicators; and evaluating the assessment items. This approach was also used by: Ali and Nsairat (2009), Ahmad and Thaheen (2017), Braganca, koukkari and Mateus (2010) and Kang (2015).

5.2 SYSTEM BOUNDARIES

The first step for developing an assessment methodology is to define the system boundaries. System boundaries are generally divided into spatial boundary and time boundary. In sustainability assessment, the spatial boundary can cover components form the followings: construction material; construction product; building or set of buildings; small urban area or neighborhood; city or urban area and region or ecosystems (Bragança & Mateus, Evaluation Guide SBTool PT – H, 2009).

According to Kang (2015), the rating tool has a more correctly result when the spatial boundary is limited to the building, including the site area and materials, where wider scales need a large amount of data which is considered wasting time and resources. Therefore, this study is concentrated in the residential building including the building site in additional to some wider aspects are considered important to assess the social sustainability such as the accessibility to the public transport.

In terms of time boundary, it is the target period of the assessment. Building is considered as product so the period of assessment has to cover the whole building life cycle, from the construction phase throughout operation until the demolition phase. As an example, Table 5.1 provides a list of social sustainability factors that must be applied in the different life-cycle stages of a project.

Table 5.1- Social indicators related to the lifecycle (Ahmad and Thaheem, 2017).

Social factors	**Project Stage**				
	Inception	**Design**	**Construction**	**Operation**	**Demolition**
Land	Land use (ensuring that project land site protects cropland and natural resources)				Land for new development (for implementing projects according to local community needs)
Heritage	Natural and cultural heritage conservation				
Employment	Local employment opportunities		Direct and indirect employment		Job opportunities
Infrastructure	Infrastructure capacity building		Infrastructure improvement and Infrastructure burden		
Safety	Assessment of future safety risks to public and project users	Safety design for emergencies	Construction and public safety		Operational safety
Other	Community amenities provision	Security consideration		Provision of facilities and services	Communication to public

5.3 CATEGORIES AND INDICATORS SELECTION

The second phase, after deciding the system boundaries, is to find the appropriate and adaptable social indicators to implements the sustainable project in West Bank. Indicators can be defined as worthy information attach social, economic, or physical systems with relevant numerical data (Bragança, Mateus and Koukkari, 2010). They help to provide different solutions for the project and they also describe the relationship between cause-and-effect.

Usually, indicators are formed in a cluster shape, aggregated or categorized, where subgroups combine the indicators in a hierarchical way. When the indicator has high importance value, it can be organized to additional parameters and sub-indicators which can result in further precise and efficient result (Kang, 2015), where the main aims to the parameters are to transfer complicated subject from many sources in a simple and accessible manner to facilitate the communication along with quantification

Sustainability social indicators are different from one community to another because they are representing the unique identities of each communities. Moreover, these indicators are also difficult to select and measure, comparing to the environment and economic ones, that is because it is difficult to understand the needs of the community and enroll then after that in practice (Ahmad & Thaheem, 2017). However, there are some common social indicators that are easy to measure such as health, indoor quality, safety, and accessibility (Castellano, Ribera and Ciuranad, 2016).

The sustainability is a relatively new concept in West Bank construction industry. Therefore, defining the sustainability indicators at micro-level is still a hard task. Ding (2008), stressed that solving this problem could be by employing the main principles of the international standards to the regional condition in a particular way. This adaptation facilitate the focus on the global topics in one hand and implementation the local strategies and regional condition into another.

Kang, lee and Kim (2016) and many other authors, proposed a methodology for decision makers to define the assessment indicators. This methodology is divided into three stages:

- At the first stage, indicators and related parameters of the assessment tool should be identified from the globally recognized values to serve an obvious beginning for method developers. For example, the standardization of ISO and CEN especially ISO 21929-1, and other lists prepared internationally for assessment tools;
- At the second stage, based on (ISO 15392:2008)[5] the regional strategies should be added to the global one to meet the local context which absolutely different from one context to another, and that also including decisions of related to the objectives of the project and relations between the stakeholder;
- At the last stage, the needs of the project users must be represented in the assessment indicators, because the assessment tool cannot get the most benefit in isolation from them.

The following section introduces the definition of the list of social sustainability indicators for West Bank residential building based on the previous method.

5.3.1 Methods

The purpose of this study is to find out the most appropriate social sustainability assessment items for West Bank residential building. The indicators and categories selection relied on a mixed methods approach, which combined the quantitative and qualitative data collection and analysis methods. Combining these methods facilitates a better identifying and understanding of the West Bank social assessment indicators.

[5] ISO (15392:2008), is the general principle of sustainability in building construction.

5.3.1.1 Literature review

Published work is used to identify the first draft list of social sustainability indicators that can help in inform the qualitative interview guide. The collected data was based on the global standards for social sustainability and the most related sustainability rating systems to the study.

Another literature review was conducted to the West Bank context. This study serves in defining the local context such as residential building regulation; climate condition and the local community in order to develop valid assessment indicators for the West Bank social assessment tool.

5.3.1.2 Interview

The qualitative stage used semi-structured interviews, which were organized between 15 and 30 of January 2017. Invitation emails were sent to (10) specialists from private sector and academia to voluntarily participate in these interviews. Of the 60% positive responses, Skype interviews were carried out with four architects, one civil engineer and one researcher. The interview guideline was established and sent to the experts before the interviews by email. It took place whenever suitable for the participant, after they agreed to be interviewed.

The questions asked were open-ended in order to avoid influencing the interviewees, the seven questions could be found in Appendix A. The interviewees were required to answer the interview questions and provide their advice and opinion on indicators that influence the Palestinian residential buildings, and further information about the current sustainability situation in West Bank.

With this method, it was possible to define the first draft of the social sustainability indicators and parameters, which was after used to form of the questionnaires for the building users and engineers to find the final indicators list.

5.3.1.3 Questionnaire

Social sustainability is the most connected dimension with the human needs. Maxneef (1992), stressed that to solve our problems in a sustained way people should be the main actors in finding out the solutions and alternatives for these issues. Therefore, integrated people into this study gives everyone a chance to develop the residential building and to build a bridge between the human needs and the new strategies.

Two questionnaires were formed to define the final list of indicators and their relative weight, One for the experts and the other for the non-experts, where the questionnaire is considered as an effective tool for data collection in mass communication research (Rajasekhar, 2008).

The descriptive methodology was the used methodology in these questionnaires. Descriptive research involves gathering data that describe events and then this data is organized, recorded and described (Fluid Surveys Team, 2014).The research was mainly intended to define the opinions, attitude and behaviors held by the target groups on the priorities of the social indicators, and the descriptive method was the best possible method.

The questionnaires themes emerged from referencing, periodicals, papers and master thesis related to the same subject, the Internet and the interviews with professionals through four steps described in Figure 5.1.

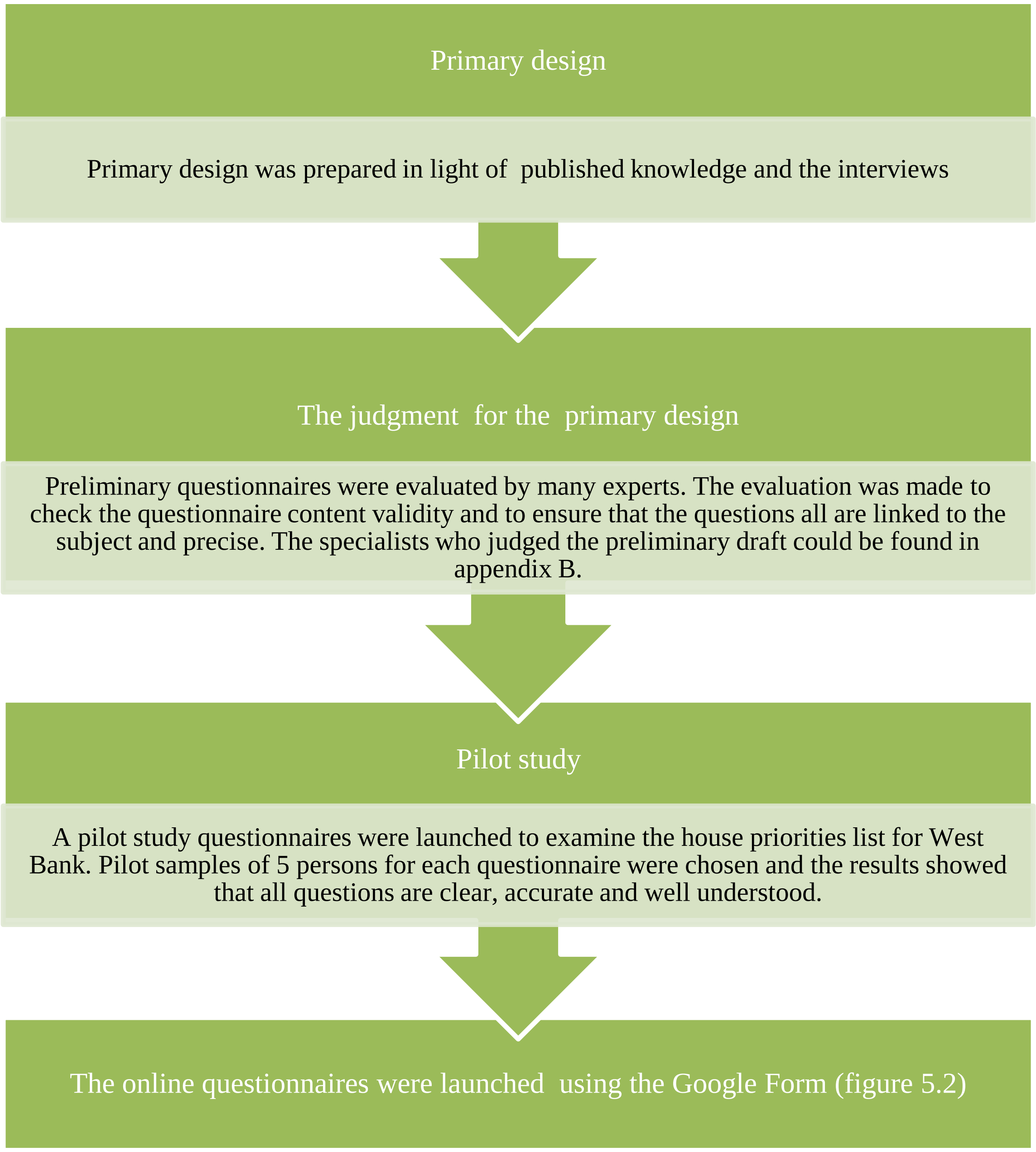


Figure5.1- The design questionnaires steps.

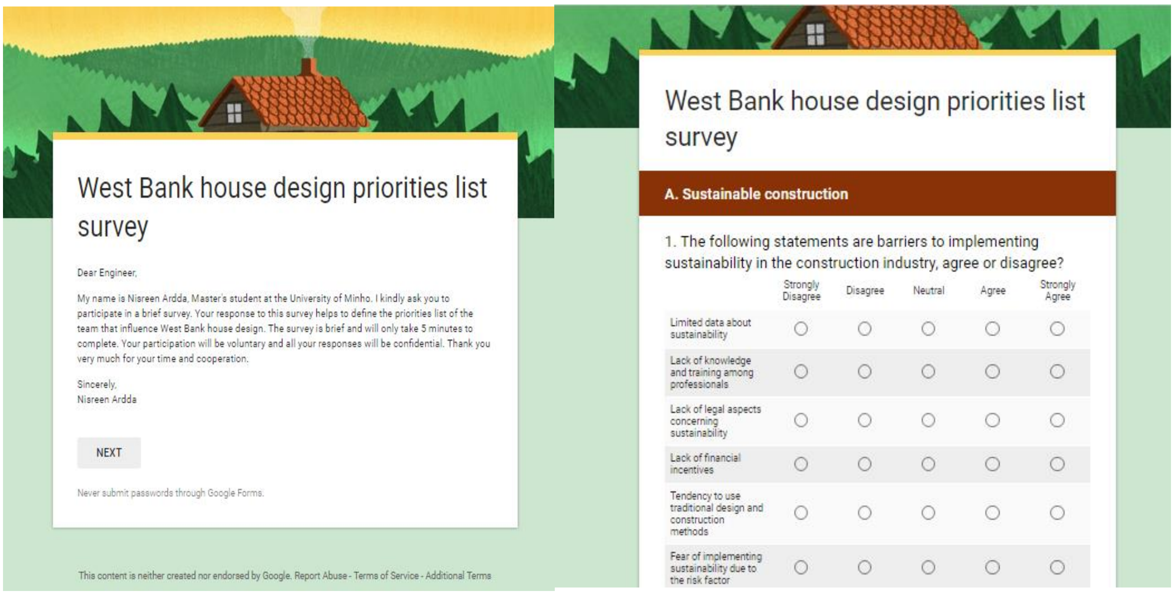


Figure 5.2- An example of launched online questionnaire.

A. First Questionnaire (expert's survey)

The first questionnaire was a structured (closed-ended questions). The form could be found in Appendix C.

A.1 Dimensions of the Questionnaire

The first questionnaire was organized into four parts:

1. A covering letter which indicates the objectives of the research, ending by a commitment from the researcher to participants that their participation will be voluntary and the personal information will be confidential.
2. The second part was aimed to gather information about the barriers to implementing sustainability in the West Bank construction industry, the current residential situation according social sustainability and evaluate the importance of developing the social sustainability assessment tool as well as the social sustainability.
3. The third one was composed of seven parts representing the categories and 27 questions referring to the indicators. In seven parts are shown in Table 5.2 with the number of questions in each part. This checklist was developed to evaluate the importance of the suggest indicators. Each indicator should be assessed independently with Likert scale. The scale breaks into 5 options which are not important at all (1), of little importance (2), important (3), very important (4) and extremely Important (5). Likert scale gives the survey an opportunity of analyzing the variety of respondent stance by percentage distribution so that the importance of indicators could be stand out. Table 5.3 shows an example of the Likert scale at the questionnaire.

Table 5.2- Survey contents on part two.

Survey contents		NO. of questions
Part1.	Cultural issues	4
Part2.	Heritage issues	3
Part3.	Functional issues	3
Part4.	Indoor quality issues	6
Part5.	Health and well-being issues	4
Part6.	Safety and service quality issues	3
Part7.	Accessibility issues	4
		Total(27)

Table 5.3- Example of a Likert scale presented in question part 2 (category 1, Cultural issues).

1. Social issues		1	2	3	4	5
1.1	Visual privacy	□	□	□	□	□
1.2	External views	□	□	□	□	□
1.3	Access to private open space (e.g. balcony, garden, terraces, etc.)	□	□	□	□	□
1.4	Easy access entrance for disabled persons	□	□	□	□	□

4. The fourth part contained demographic questions such as age, gender, education level and specialty.

A.2 sampling process

The population will be the professionals classified in Engineers Association- Nablus who had a history in sustainable development or residential building industry and new engineers in the field as well. According to the last classification in 2014, 491 engineers were classified in the Association distributed between the different fields as shown table 5.4.

Table 5.4- The distribution of the classified engineers (Association- Jerusalem Engineers, 2015).

The filed	Architectural Eng.	Building Eng.	Civil Eng.	Electrical Eng.	Mechanical Eng.	Urban Planning Eng.	Total
Percentage	38%	6%	36%	9%	10%	1%	100%
Frequency	187	29	177	44	49	5	941

Table 5.4 illustrates that the largest percentage of classified engineers is 38% for the Architectural engineers. The second position is respectively for the civil engineers. This reality is due to the importance they have in the construction industry.

Based on the distribution of the population, an online questionnaire was sent to a group of stakeholders was consisted of (50) persons, by email or Facebook inbox. The study sample was selected among professionals who had a background in sustainable development and residential building industry in the fields of architecture, civil and electrical engineering, mechanical engineering, urban planning and building engineering, and the reasoning for that is to rise the applicability of the result to set the assessment tool.

A.3 Questionnaire Delivery and Recovery

The surveys were conducted from 15 to 25 of February 2017. An internet-based questionnaire was sent to the list of the stakeholders by emails, LinkedIn or Facebook with attached cover letter to describe the reason for this study and express that the response is voluntary. Of these, 49 responded and the response rate was 98%. This rate approved that the online surveys may achieve higher response rates than the paper-based ones.

Table 5.6- The response number from each field.

The filed	Architectural Eng.	Building Eng.	Civil Eng.	Electrical Eng.	Mechanical Eng.	Urban Planning Eng.	Total
Frequency	21	4	13	4	3	3	49
Percentage	43.8%	8.3%	27.1%	8.3%	6.3%	6.3%	100%

B. Second Questionnaire

The second questionnaire was also a structured questionnaire. The form could be found in Appendix D in both English and Arabic.

B.1 Dimensions of the Questionnaire

The second questionnaire was divided into seven division consisted of 32 questions;

1. The questionnaire started with a cover letter included an expression about what respondents were kindly asked to answer and the participation in research will be voluntary and all the information provided will be kept confidential.
2. The next first five parts after the cover letter consisted into questions focused on overall occupant satisfaction and their opinions about the importance of the social houses issues under these titles:
   - Cultural heritage architecture issues;
   - Indoor quality;
   - Health and well-being;
   - Safety and services issues;
   - Accessibility house issues.

   The Likert scale was used mostly to assess satisfaction and opinions in additional to yes/no and multiple choices questions. The combined between the occupant satisfaction and the opinions is necessary to understand the full picture of the current situation and how would the satisfaction of occupants affect their opinions.
3. The final part of the questionnaire, contained personal data related to the gender, age, education and the monthly income. The personal information took place at the end of the questionnaire to avoid influencing the participants' answers.

A.2 sampling process

Nablus Governorate is in northern West Bank, is one of the largest Palestinian governorate with a population of more than 389 thousand people, according to Palestinian Central Bureau of Statistics for the year 2016. Nablus governorate includes 61 population localities with total population of 214,903 inhabitants in the urban areas, inhabitants in the rural areas, 137,009, and 37,416 inhabitants in the refugee camps.

Table 5.7-Population percentage of each area in Nablus Governorate (PCBS, 2016).

The area	**Urban**		**rural**	**camps**	**Total**
	City	**Old city**			
Percentage	51%	4%	35%	10%	100%

The study sample was chosen stratified randomly to the three main areas; the city, villages, and the old city of Nablus in the age group (20-60) years, where the refugee camps were excluded because these areas are not under the municipality controls. A total of 150 online-questionnaires were distributed.

A.3 Questionnaire Delivery and Recovery

A second questionnaire to explore house design properties was distributed in Nablus, West Bank between 4 to the 21 of March, 2017. Occupant responses were collected via an internet-based questionnaire in Arabic. One hundred and three from a universe of one hundred fifty answered the questionnaire. Respondent rate as 68%, and this was distributed between the three areas the city as illustrated in Table 5.8.

Table 5.8 - Response number from each area.

The area	**The city**	**The village**	**The old city**	**Total**
Nº.	59	38	6	103
%	57.3%	36.9%	5.8%	100%

5.3.2 Results & Analysis

5.3.2.1 Definition of the first list of social sustainability criteria

The definition of the first list of social sustainability indicators was based on literature review and analysis of the following data:

- The international sustainability indicators ISO 21929-1 and SB Tool master list;
- The international assessment tools for sustainable housing Code for Sustainable Homes; LEED for Homes and SB Tool PT-H.

Table 5.9 shows a brief interpretation of social and cultural sustainability categories and related indicators.

Table 5.9- The first social sustainability list.

Social indicator	ISO 21929 -1	SB-Tool master list	Code for Sustainable Homes	LEED for Homes	SB Tool PT-H
Cultural indicators					
Visual privacy in dwelling units		■			
Views		■			
Universal access on site and within the building	■	■			
Ease access for disabled	■	■			
Access to private open space	■	■	■		
Provide drying space			■		
Provide home office			■		
Heritage indicators					
Maintenance the architectural heritage	■	■			
Use the local materials and techniques		■			
Compatibility of the design with local cultural values		■		■	
Functional indicators					
Availability of home user guide			■		■
Efficiency of vertical or horizontal systems		■			
Spatial efficiency		■			
Possibility to adapt the construction to meet future occupants needs		■	■		
Functionality of layout		■			
Indoor quality indicators					
Thermal comfort		■		■	■
Indoor air quality and ventilation	■	■			■
Efficiency of mechanical ventilation		■		■	
Appropriate daylighting		■	■		■
Illumination		■		■	■
Reduce outdoor noise	■	■	■	■	■
Reduce indoor noise		■			
Health and well-being indicators					
Free smoking area				■	
Minimizing the exposure of building occupants to indoor air pollutants				■	
Installing Mechanical Ventilation and air Filtering in the kitchens				■	
Limiting the leakage of combustion gases				■	
Reducing exposure to airborne chemical contaminants	■			■	■
Safety indicators					
Building maintenance	■	■			
Safety from fire		■			
Safety from flooding		■			
Safety from earthquake		■			
Providing security			■		
Accessibility indicators					
Access by public transport	■		■	■	■
Access to bicycle traffic	■				
Access to user basic services	■			■	■
Access to green and open spaces	■			■	■

A broad research of the literature of the West Bank municipality's codes for residential building and the regulations of Engineers Association was prepared. The aim of this step was to match indicators between the first list in Table 5.9 and building codes in West Bank. Then, the match indicators were identified as a mandatory in the assessment tool. Table 5.10 illustrates the obligatory indicators.

Table 5.10- The obligatory social indicators in the assessment tool.

The parameters	The local code resource
Safety from fire	Municipality codes of Nablus
Safety from earthquake	Seismic design, Engineers Association- Nablus

5.3.2.2 Skype interviews

The interview questions and the interviewee's names can be found in Appendix A and the results of the six interviews were as follows:

A. Contemporary residential building market

The first part of the questions helped to determine a point of view about the sustainable building barriers and generate sustainable recommendations for the local market.

All the interviewees agreed that lack of knowledge among professions and legal aspects could be the main barriers to implementing sustainability. They think that using the traditional building technology would be in the second position. At the third position, some of the interviewees agreed that the financial situations and the fear of the risk factor could be also some of the barriers.

In order to encourage the sustainability of the residential, sustainable residential buildings should be increased in number by the continuous support of the municipalities; architectural and engineering confirms should also consider being sustainable in their agenda under project development and feasibility works; academic circles should improve their abilities to support public and professional sustainable education and certification systems is another subject could be a key player to guide the firms for more sustainable building.

The interviewees were asked if they were agreed to set up sustainable residential building, assessment tool. The interviewers consider that as a positive idea if it will reflect the social and environmental aspects of the Palestinian case.

B. Social sustainability categories and related indicators for West Bank residential buildings

The answers to the second part of the interview questions helped me to define the first draft of the list of social sustainability categories and related indicators.

From these discussions, some parameters that were considered as a necessity, were added and some were excluded because they are not quite relevant to the Palestinian reality or they are not practical for assessing. These parameters are mentioned in Table 5.11.

The engineers suggested modifying some indicators to be more precise for the West Bank residential building, Table 5.12 illustrate these parameters and the interviewee's point of view.

Table 5.11- Parameters that were added or removed from the preliminary list of indicators

The added parameters	**The main reason**
Accessibility to the work	The movement and access restriction in the West Bank

The subtracted parameters	**The main reason**
Safety from flooding	West Bank rainy season is not a season of heavy rains
Access to bicycle traffic	Bicycling is not a habit among West Bank residents
Efficiency of mechanical ventilation	Residential buildings mostly rely on natural ventilation
Provide drying space	Palestinian people usually use the open space for drying the clothes e.g. roof, balcony, etc.
Provide home office	Due to the limited area for the main functions in the house design
Spatial efficiency	Is not easy to assess
Functionality of layout	Is not easy to assess
Universal access on site and within the building	Do not fit the assessment boundary

Table 5.12- The modified indicators as requested by specialists.

Modified parameter	**Suggested parameter**	**Point view**
Free smoking area	Non-smoking area	Due to the limited area for the main functions in the house design
Efficiency of vertical systems	Provide fixed space for installing the lift in the house design	Because installing a lift is not always a mandatory requirement at the building code
Indoor air quality and ventilation	Good air quality and natural ventilation	To encourage the passive design

At the end, the first draft of the list of social sustainability indicator for West Bank residential buildings has (27) indicators, divided between seven categories (Table 5.13).

Table 5.13-Structure proposed for the second list of the categories and related indicators.

Cultural issues	**Heritage issues**
1.Visual privacy	1. Respect the cultural value and surrounding context
2.External views	2. Use of traditional local materials and techniques
3.Access to private open space	3. Maintenance of the heritage value of an existing facility
4.Easy access entrance for disabled	
Indoor quality	**Health and well-being issues**
1. Air temperature and relative humidity	1. Installing mechanical extract ventilation in the kitchen and bathrooms
2. Appropriate daylight	
3. Appropriate illumination	2. Reducing the exposure to airborne chemical contaminants
4. Good air quality and natural ventilation	
5. External noise reduction	3. Reducing the exposure to toxicity of finishing materials
6. Internal noise reduction	4. Nonsmoking area
Safety and service quality issues	**Functional issues**
1. Regulated building maintenance	1. Availability of a user manual
2. Security of the house	2. Provide fixed space for installing elevator in the design
3. Security of the neighbourhood	4. Possibility to modify the house construction
Accessibility issues	
1. Accessibility to the public transport	

2. Accessibility to the work place
3. Accessibility to exterior public spaces
4. Accessibility to public services

5.3.2.3 Questionnaire

Microsoft Office Excel 2010 was applied to perform the statistical analysis and evaluate the data set based on frequency distributions and competitions.

A. First questionnaire result and analysis

This section aims to analyze the empirical data which were collected through the first questionnaire distribution.

A.1 Sample characteristics analysis

The overall sample consisted of 36.7% architectural engineers, 34.6% civil engineers, 8.1% building engineers, 8.1% electrical engineers, 6.1% mechanical engineers and also 6.1% urban planning engineers. That reflects the true statistics of the architectural and civil engineers are having the highest percentages with comparison with other fields. Table 5.14 refers of the sample specialty summery.

Table 5.14- Distribution of the sample with respect to specialty.

Variable	Classification	Frequency	Average
Specialty	Architectural Engineering	21	43.8%
	Building Engineering	4	8.3%
	Civil Engineering	13	27.1%
	Electrical Engineering	4	8.3%
	Mechanical Engineering	3	6.3%
	Urban Planning Engineering	3	6.3%
	Total	49	100%

Table 5.15 illustrates that 61.2% of the respondents were female and 38.8% were male. It seems from the sample distribution that Palestinian women are playing a crucial role in engineering.

Table5.15-Demographic characteristics of the survey.

Variable	Classification	Frequency	Average
Gender	Male	19	38.8%
	Female	30	61.2%
	Total	49	100%

However, a quarter of them was a master degree holder, which indicates their awareness about interestingly, the majority of the sample (56.3%) consisted of respondents between 23 and 29 years, which is reflective of the young demographic found in the Association of Engineers the importance of education and professional improvement. Even though the study focused on the engineers with a high background in the construction industry, the number of participants was significantly small, 2.1%. Table 5.16 refers the sample age summary.

Table 5.16- Demographic characteristics of the survey.

Variable	Classification	Frequency	Average
Age	23-29	27	56.3%
	30-39	11	22.9%
	40-49	2	4.2%
	50-59	7	14.6%
	60-69	1	2.1%
	Total	48	100%

Figure 5.4 illustrates that around 45% of the engineers are postgrad, which is, a relatively high value by regional and global standards.

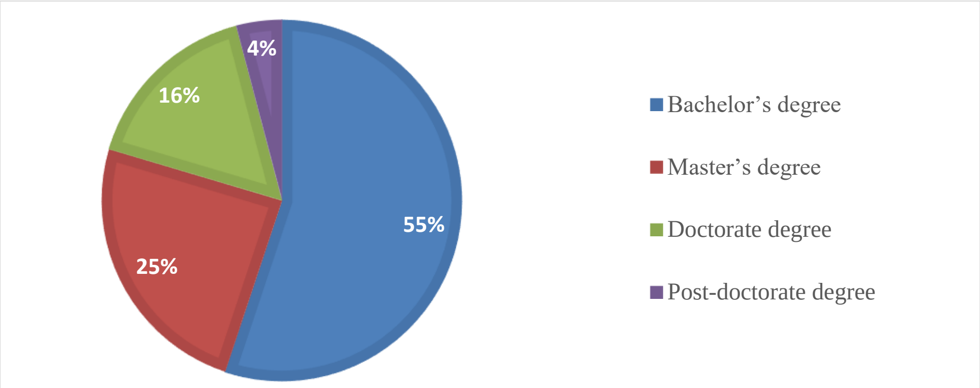


Figure 5.4- Demographic characteristics of the survey, level of education.

A.2 Sustainable construction

A.2.1 Sustainability developing barriers

Skype interviews were carried out in the first part of this survey in order to identify the main obstacles on the way to sustainable development in West Bank construction industry. The results are presented in Figure 5.5 and this result helped to generate some recommendations for sustainability at the local market.

The first part of the online questionnaire starts with a question asking if the limited data about sustainability is a barrier to implementing sustainability in the construction. Maked among 49 answers, 67% of the respondents agreed on the statement. Around 20% of the respondent disagreed on that.

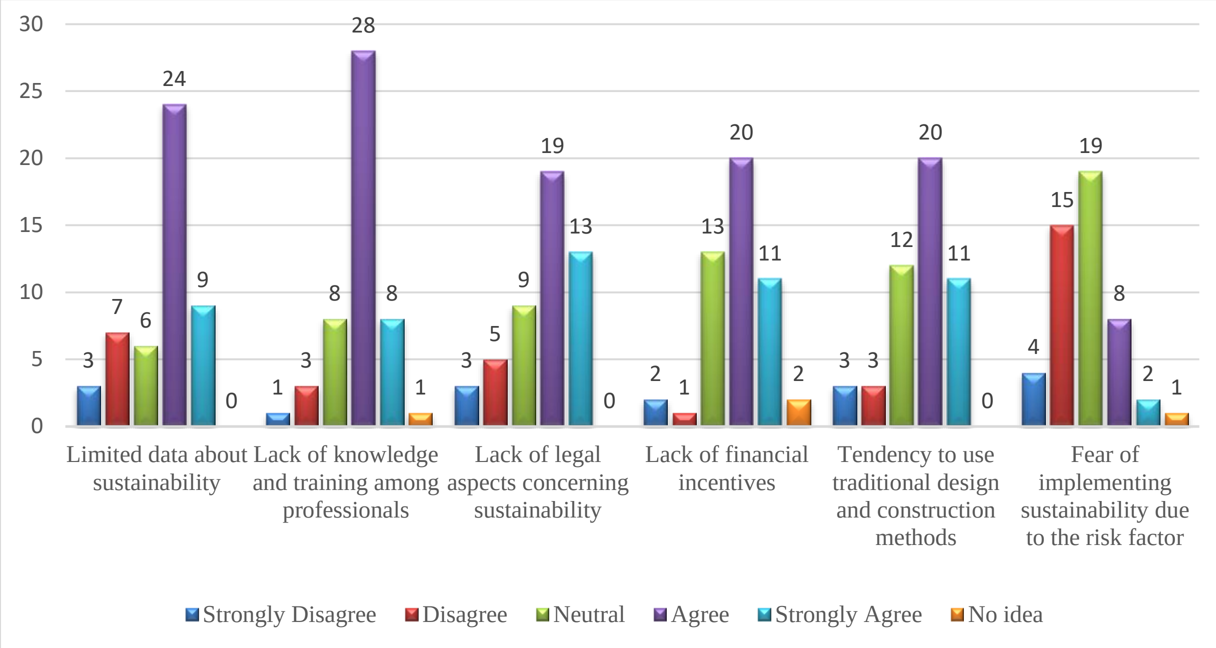


Figure 5.5- Sustainability barriers survey results.

In the second question, the lack of knowledge and training among professions as a barrier is tested. 75% of the respondents believed on the statement, and this result is the highest percentage between all barriers. It is a really pessimistic number for such a high percentage of educated people. And that means both education satisfaction and the construction sector should seriously include the sustainable education.

32 out of 49 respondents believed that the lack of legal aspect and codes concerning is an obstacle for implementing sustainability and 13 out of them strongly believed it.

In economic terms, 2 respondents skipped the question and among 47 answers 65% linked the sustainable development to the shortage of the financial investment. This high percentage either because of the experience of the engineers or their expectation that sustainable building always cost more than the conventional. Only 6% of the engineers disagree on the statement is a barrier. I believe that sustainable development is one solution for economic problems so a good strategy should fulfill the sustainable knowledge gaps to enhance sustainable construction, especially with the project decision makers.

The respondents strongly believed that resistance to change traditional design is one of the most important reasons for delaying sustainability implementation. This statement is in the line with the next statement: fear of implementing sustainability due to the risk factor. However, only 20% of the respondents reported that statement as a problem for implementing sustainability in West Bank construction sector. If the construction sector does not have that fear of use new resources and methods, the previous statement could be invisible if the municipalities and engineers unions support the new systems for more sustainable design.

According to the overall result, people are the main barriers to implementing sustainability due to the scarcity of training and knowledge, with no legal aspect to encourage them. Refreshment in municipalities and unions, laws, sustainable education at universities and sufficient training for all the stakeholders in the construction sector is a vital to address sustainability in West Bank.

A.2.2 Residential building industry according to the social and culture aspects

The first question was asking if the current residential building industry respects the social cultural aspects. The satisfaction with the social accepts of West Bank residential building differed between experts. 53% of the experts in the West Bank construction industry were dissatisfied with the societal houses issues, whereas only 25% of respondents expressed satisfaction. 23% of respondents were neither satisfied nor dissatisfied. The level of dissatisfaction, that has got the highest rate, includes mainly the male expert group where 74% of them were dissatisfied (Figure 5.6).

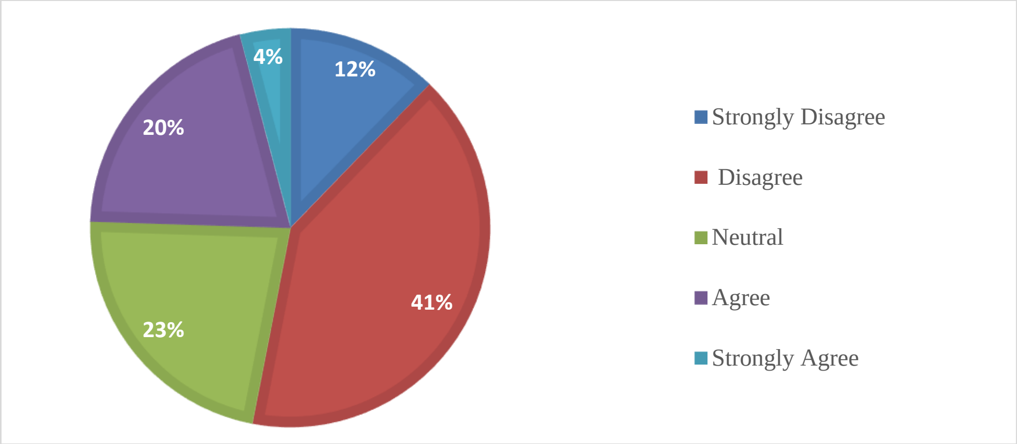


Figure 5.6- Respondents satisfaction on the social aspects of West Bank residential building.

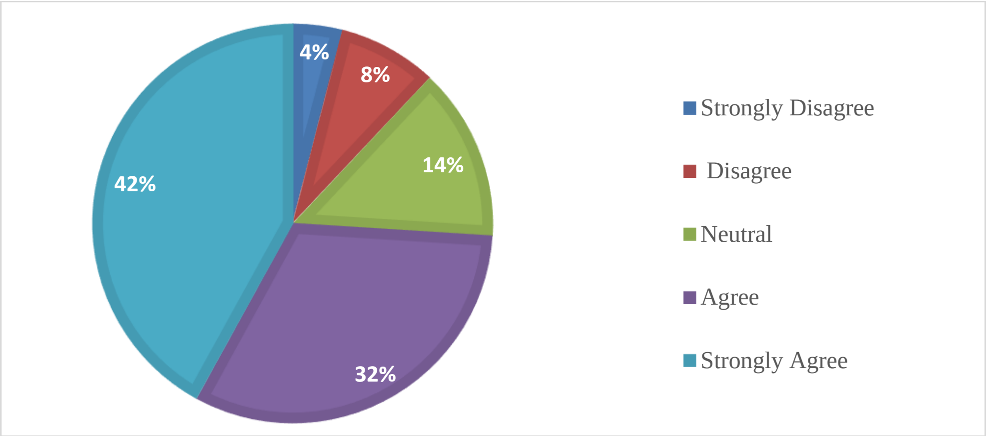


Figure 5.7- Respondents about the development a sustainable residential building assessment tool.

The following question tests the necessity to develop a sustainable residential building assessment tool. Because 32% of experts agreed with developing a tool and 42% of them strongly agree, the level of agreement of developing a sustainable residential building assessment tool almost 75%. The result validates the need for developing this research (Figure 5.7).

About 75% of the respondents also agreed to merge the sustainability with the municipality's codes in the third question. That expressed how much is important to bind the sustainability with the government units, which is considered the strongest way to benefit from the sustainable development in the countries (CIB & UNEP-IETC, 2002).

In conclusion, developing a sustainable residential building assessment tool and considering it with the regulation could be a useful approach to solving some of the social residential buildings problems.

A.2.3 Social architecture house issues

Figure 5.8 presents the result of the survey in terms of the opinion of respondents about the importance of each sustainability dimensions and social indicators, for a five-point response item.

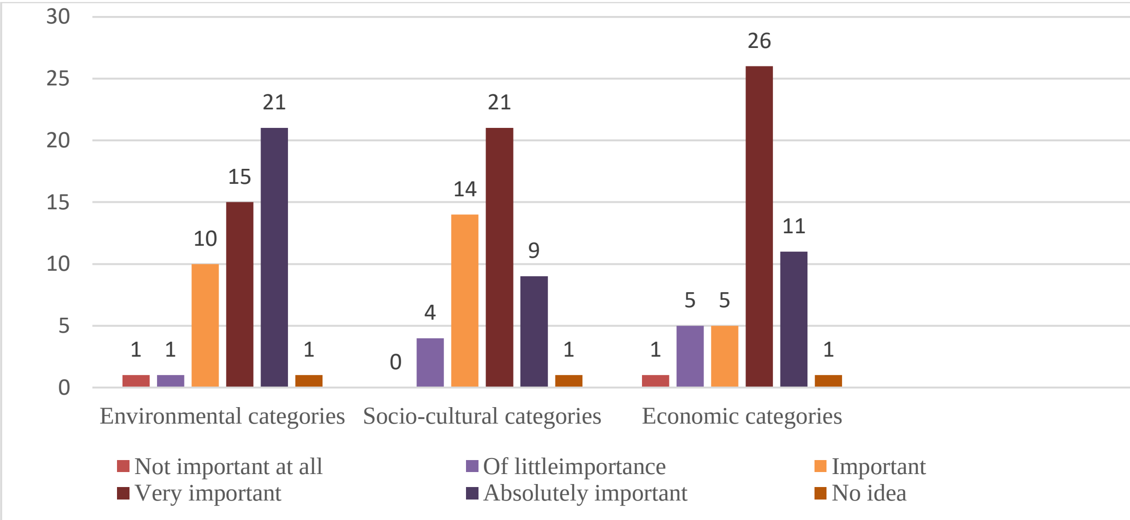


Figure 5.8- The respondents' opinion about the importance of the sustainability dimensions.

Environmental dimension was argued as the absolutely important dimension of the sustainability, then the economic, and finally the social dimension, as shown in Figure 5.8. Personally I expected a higher rate of positive answer about social dimension but once again the professionals can judge the Palestinian reality situation better.

Table 5.17 shows that the respondents agreed that all the suggested indicators are important. And there were no additions from them.

Cultural category is a vital issue according to the respondents, were 70% believed that visual privacy was a very important indicator. 59% agreed that easy access entrance for disabled is a very important one. While 45% stressed that external view and accessibility to private open space were very important.

The second and the third category, tests the importance of the heritage and functional indicators respectively, generally, were less fortunate than the first one. For the heritage issues, the highest level of importance was 50% for the maintenance of the heritage value of an existing facility. And for functional issues, the highest level was 42% for the availability of a user manual.

Table 5.17- The respondents' opinion about the importance of the social house issues.

	Indicator	1 Not important at all	2	3	4	5 Absolutely important	No idea
	Cultural issues						
1.	Visual privacy	1	0	10	22	13	3
2.	External views	0	2	23	15	6	3
3.	Access to private open space	0	1	22	16	7	3
4.	Easy access entrance for disabled	1	7	11	15	14	1
	Heritage issues						
1.	Respect the cultural value and surrounding context	1	5	19	15	8	1
2.	Use of traditional local materials and techniques	2	11	18	10	6	1
3.	Maintenance of the heritage value of an existing facility	0	5	16	13	12	3
	Functional issues						
1.	Availability of a user manual	2	7	19	17	3	1
2.	Provide fixed space for installing elevator in the design	0	11	20	9	7	2
3.	Possibility to modify the house construction	1	9	22	12	4	1
	Indoor quality						
1.	Air temperature and relative humidity	0	2	11	18	17	1
2.	Appropriate daylight	0	1	8	18	19	3
	3.Appropriate illumination	0	2	8	22	15	2
4.	Good air quality and natural ventilation	0	1	7	14	22	5
5.	External noise reduction	1	1	9	22	15	1
6.	Internal noise reduction	0	5	11	20	12	1
	Health and well-being issues						
1.	Installing mechanical extract ventilation in the kitchen and bathrooms	0	8	23	9	9	0
2.	Reducing the exposure to airborne chemical contaminants	0	5	13	17	12	2
3.	Reducing the exposure to toxicity of finishing materials	0	5	11	12	20	1
4.	Nonsmoking area	1	6	17	8	13	4
	Safety and service quality issues						
1.	Regulated building maintenance	1	6	13	14	14	1
2.	Security of the house	0	7	6	13	20	3
3.	Security of the neighbourhood	0	7	11	15	13	3
	Accessibility issues						
1.	Accessibility to the public transport	1	6	14	15	11	2
2.	Accessibility to the work place	2	8	16	14	8	3
3.	Accessibility to exterior public spaces	0	8	24	11	5	1
4.	Accessibility to public services	1	11	17	9	9	2

Only 2% of the respondent felt that appropriate daylight and good air quality and natural ventilation indicators were not important. 4% believed that external noise reduction, appropriate illumination and air temperature and relative humidity indicators were not considered important, while 10% argued that internal noise reduction was not an important issue.

20 respondents agreed upon reducing the exposure to toxicity of finishing materials is an extremely important issue 13 of them indicated nonsmoking area as extremely important one. The reduction of the exposure to airborne chemical contaminants is considered an extremely important indicator for 12 of the respondents, while only 9 of them agreed that installing mechanical extract ventilation an extremely important one.

33 out of 49 respondents supported that security of the house, safety and security category is a very important indicator, while 28 of respondents indicated the regulated building maintenance and security of the neighborhood indicators as a very important ones.

Lastly, a quarter of the respondents believed the accessibility to public services is not that important. However, the accessibility to public services is considered as a critical performance criterion for the house social sustainability (Hall, 1880).

B. Second questionnaire result and analysis

This section aims to analyze the empirical data which were collected through the second questionnaire distribution.

B.1 Sample characteristics analysis

This section explains the background of respondents. The background of the respondents will increase the confidence in the reliability of data collected and eventually the findings of the study. As a result, the relevant socio-demographic variables of respondents that this research covered included gender, age, the level of education and the average monthly income.

There are fewer women in West bank than men, however, the results from table 5.18 did not confirm this observation as 60 percent of the respondents were females and the remaining 40 percent were males. This could be attributed to the nature of the cultural systems in West Bank, where males are expected to work to provide income for the family, which may mean they do not have time to respond to such a questionnaire.

Table 5.18- Demographic characteristics of the survey, gender.

Variable	Classification	Frequency	Average
Gender	Male	41	40%
	Female	62	60%
	Total	103	100%

56.3% of the respondents were between 20-29 years of age, 23.3% were between the ages of 30 and 39 years, 13.5% were between the ages of 40 and 49 years and just 6.7% were between the ages of 50 and 69 years. From the result it is evident that the young consist a large percentage of the total population, this supports the observation that the Palestinian society is a youth society.

Education is a key factor that shaped the opinions of the respondents. Most of the respondents were well educated, as no one do not had a secondary education, only 6% of the respondents had just the high school education, 6% had technical training or college after the high school, 75% had a bachelor’s degree and 1% of the respondents had doctorate degree. This is perhaps attributed to the idea that education is the only investment in Palestine.

Table 5.19- Demographic characteristics of the survey, age.

Variable	Classification	Frequency	Average
Age	20-29	58	56.3%
	30-39	24	23.3%
	40-49	14	13.5%
	50-59	5	4.8%
	60-69	2	1.9%
	Total	103	100%

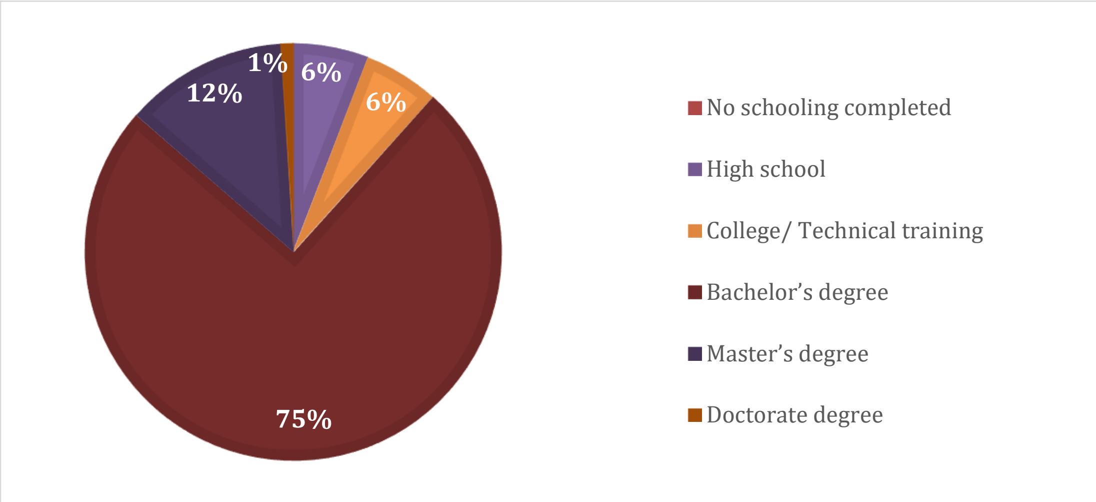


Figure 5.9- Demographic characteristics of the survey, level of education.

The desired level of well-being and satisfaction is strongly related to the level of wealth of the household in which they live. Therefore, a summary of occupant's average monthly income could help to determine the desired house quality of the respondents and if they really reflect the whole population. Figure 5.9 shows that 29% respondents earned less than 1500 NIS. 32% respondents earned between 1500 NIS and 2500 NIS, also 29% earned between 3000 NIS and 6000 NIS, 2% respondents earned above 1500 € while 8% of them skipped the question. This shows that most of the respondent were Lower-middle income which provides a fair idea of the average Palestinians income.

B.2 the physical characteristics of the residential buildings

A short description of physical characteristics of the residential buildings compositions of respondents in the study area (Table 5.20) show that 58% of the respondents lived in the city, 37% lived in the village and 6% in old city. Respondents' data on building types showed that most of the buildings were apartments and single-family houses. These findings supports that most of the West Bank residential building types are apartments and single-family houses.

It is evident from Table 5.20, that the exterior walls of buildings were generally constructed with conventional building materials derived mainly from stone. This result was expected because the stone is the commonly available building material in West Bank.

Table 5.20- The physical characteristics of the residential buildings sampled.

Variable	Classification		Frequency	Average
1.House location	City		60	58%
	Village		37	36%
	Old City		6	6%
	Total		**103**	**100%**
2.House Type	Apartment		50	48%
	Single family house		42	41%
	Raw house		6	6%
	Villa		5	5%
	Total		**103**	**100%**
3. Apartment description	**A. The apartment level**	Ground floor	9	18%
		First - Third	31	62%
		Forth	4	8%
		Fifth-Sixth	4	8%
		Seventh - Eighth	1	2%
		Over Eighth	1	2%
		Total	**50**	**100%**
	B. open side	One side	10	20%
		Two sides	19	38%
		Three sides	16	32%
		Four sides	5	10%
		Total	**50**	**100%**
	c. Number of the apartment in each floor	One	9	18%
		Two	23	46%
		three	13	26%
		Four	5	10%
		Total	**50**	**100%**
4.The exterior wall materials	Stone		69	67%
	Concrete		15	15%
	Hollow block cement		19	18%
	Total		**103**	**100%**
5. Floor area in m2	Less than 100		17	17%
	Between 100-149		32	31%%
	Between 150-180		34	33%
	More than 180		20	19%
	Total		**103**	**100%**
6. Number of residents of the house	One-three		20	19%
	Four-five		36	35%
	Six-seven		35	34%
	Eight-nine		10	10%
	Ten		2	2%
	Total		**103**	**100%**
7.Number of years lived in the house	$X<5$		26	25%
	$5\leq X<10$		18	17%
	$10\leq X<15$		17	17%
	$15\leq X<20$		19	18%
	$20\leq x<25$		14	14%
	$25\leq X<30$		7	7%
	$30\leq X$		2	2%
	Total		**103**	**100%**
8. Daily hours	$X\geq 6$		1	1%
	$6<x\leq 9$		9	9%
	$9<x\leq 12$		11	10.5%
	$12<x\leq 15$		43	42%
	$15<x\leq 18$		23	22%
	$18<x\leq 21$		4	4%
	$21<x\leq 24$		12	11.5%
	Total		**103**	**100%**

In the case of the residents' apartments, 18% respondents reside on the ground floor, 62% reside in the first and third floor, and 8% live in the fourth and fifth floor and as well in the sixth and seventh floor while only 4% of the occupants occupied higher floor levels. Only 18% of the respondents do not share a wall with their neighbors, while just 10% of them enjoy the natural ventilation and light from the four sides. That means that the apartment building in the sustainable design needs a special treatment to balance between all the sustainable design factors.

The result shows that a typical floor area is between 100 and 180 square meters. 81% of the respondents have a household size between four to ten persons, where the average household size is is 5.3 persons. The study also revealed that 25% of the respondents had lived in the buildings less than five years, around 50% of them had lived in the buildings between five and nineteen years, while 23% between twenty and thirty years. The survey respondents reported spending an average of 63% of their time inside the house.

As described in Figure 5.10, 66% of occupants are satisfied with the house layout, the majority of them indicated that the spaces provided in their current houses were adequate in meeting its function and occupants needs. However, around 30% of them would like to have additional spaces. Interestingly, this high percentage of satisfaction was due of the fact that 85% of the respondents had carried out changes on their houses. Many factors were considered as responsible for that, however, the common thing is the occupants carried out changes to reflect their socio-cultural issues as shown in the Table 5.20.

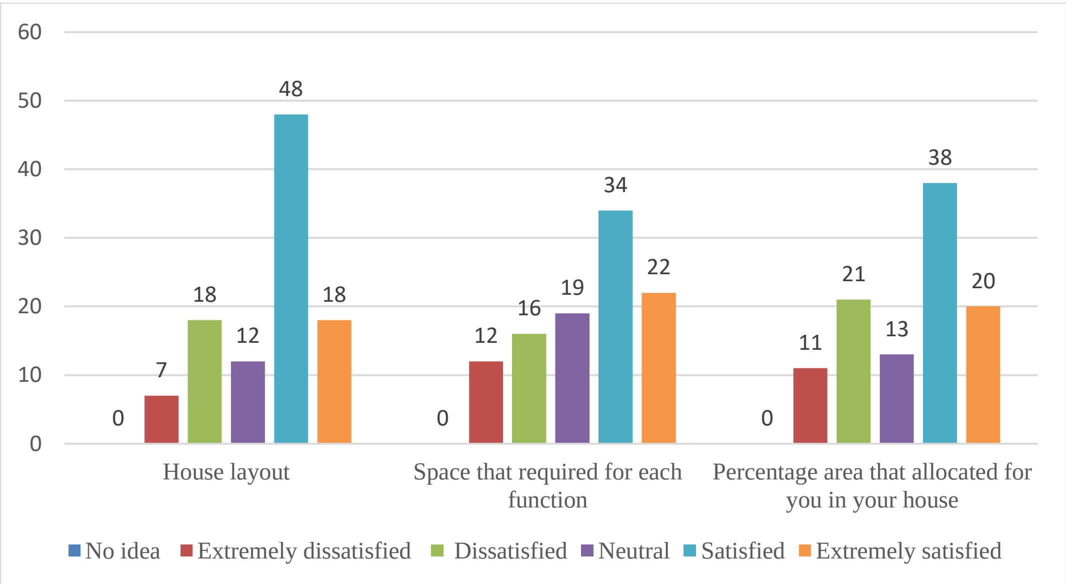


Figure 5.10- The respondents' satisfaction about the functional about the house layout and affordable spaces.

The figure 5.11 indicates that 17% of the respondents designed their houses by themselves without restrictions from any designer or contractor. In contrast, 49% of them did not have any participation in the house design. A total of 10% of the respondents made joint decisions about the design of the house, while 25% of them did not have any idea about the responsibility of the final house design. The high level of non-participation in the house design is because occupants were merely renting the houses or bought the houses from previous owners. The last factor is also a strong reason that justifies the need to introduce changes in the house.

Table 5.21- The frequency of changes carried out on respondent's houses and the main reason for it.

Variable	Classification	Frequency	Average
Changes carried out on house	Changes in space use	12	11%
	Physical changes	8	8%
	Decorative changes	35	34%
	Changes in space use & Physical changes	3	3%
	Changes in space use & Decorative changes	20	19%
	Physical changes & Decorative changes	2	2%
	Space use, physical and decorative changes	8	8%
	No change	15	15%
	Total	**103**	**100%**
Main reason for carried out changes	Cultural issues (privacy)	13	15%
	Changes in family size	7	8%
	Improve the indoor quality	38	34%
	Luxury	30	34%
	Total	**88**	**100%**

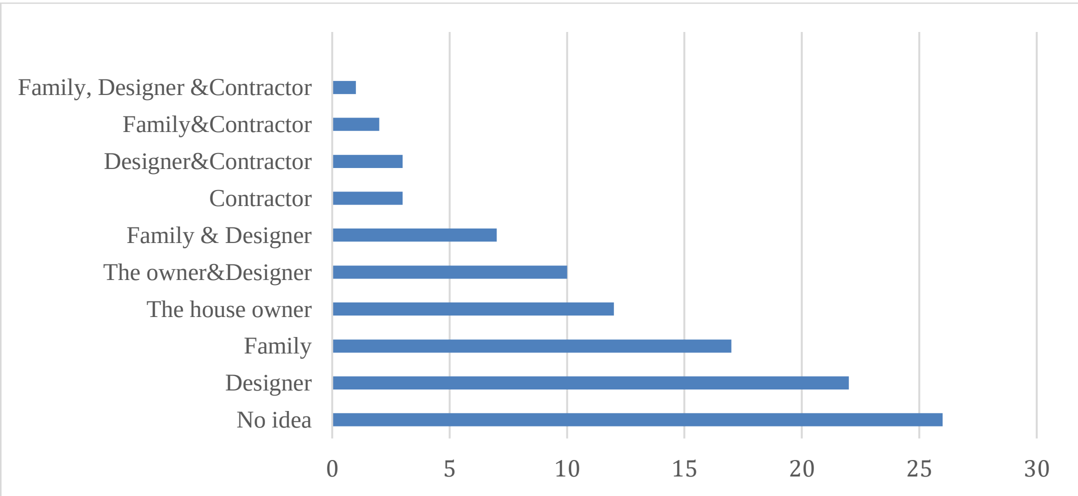


Figure 5.11- The frequency of the participated persons in the respondent's house design.

B.3 social sustainability house indicators and the level of house satisfaction

This section examines the importance of the social sustainability house indicators according to the occupants of the house, and compared that with their level of satisfaction.

Table 5.22 presents the opinion of the respondents about the importance of the functional indicators. 74 of the respondents agreed that possibility to modify the house construction is a very important issue and 70 of them agreed that providing a fixed space for installing the elevator in the design also a very important issue. While 57 of the respondents feel that availability of a user manual is a very important aspect for the house design.

Table 5.22-The respondents' opinion about the importance of the functional house issues .

	Variable /Indicator	Not important at all 1	2	3	4	Absolutely important 5	No idea
	Functional issues						
1.	Availability of a user manual	5	20	21	44	13	0
2.	Provide fixed space for installing elevator in the design	7	8	17	37	33	1
3.	Possibility to modify the house construction	1	11	16	55	19	1

Figure 5.12 presents the respondent's level of importance with the heritage house issues. It was found that the highest importance was recorded for maintenance of the heritage value of an existing facility with the percentage of 81%, followed by the respect the cultural value and surrounding context, with 74%, which indicate that the cultural values were very important for the residents of Nablus city.

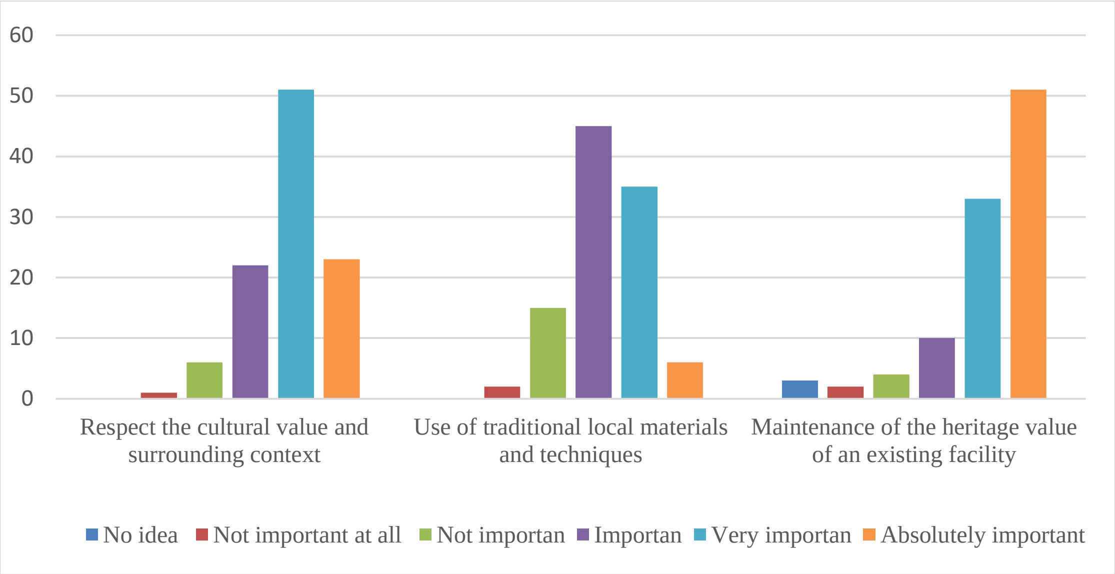


Figure 5.12-The respondents' opinion about the importance of the heritage house issues (Author, 2017).

According to the Figure 5.13, a vast majority of respondents reported that indoor house quality issues are very important in the design of the house. While more than 45% thinks that good air quality and natural ventilation, the appropriate daylight and the thermal comfort are extremely important issues. This indicates that the basic human needs are considered as a necessity for the occupants in the house design, and cannot be ignored.

However, the result of house indoor quality satisfaction shows that around 20% of the occupants were dissatisfied with their indoor air quality issues. It should be emphasized that the possible explanation is that the design of the house was not oriented in an appropriate way to benefit the most from the passive cooling and heating system, where less than 6% of respondents mentioned within the survey that they modified the temperature in the hot or cold weather inside the house by opening or closing the windows only.

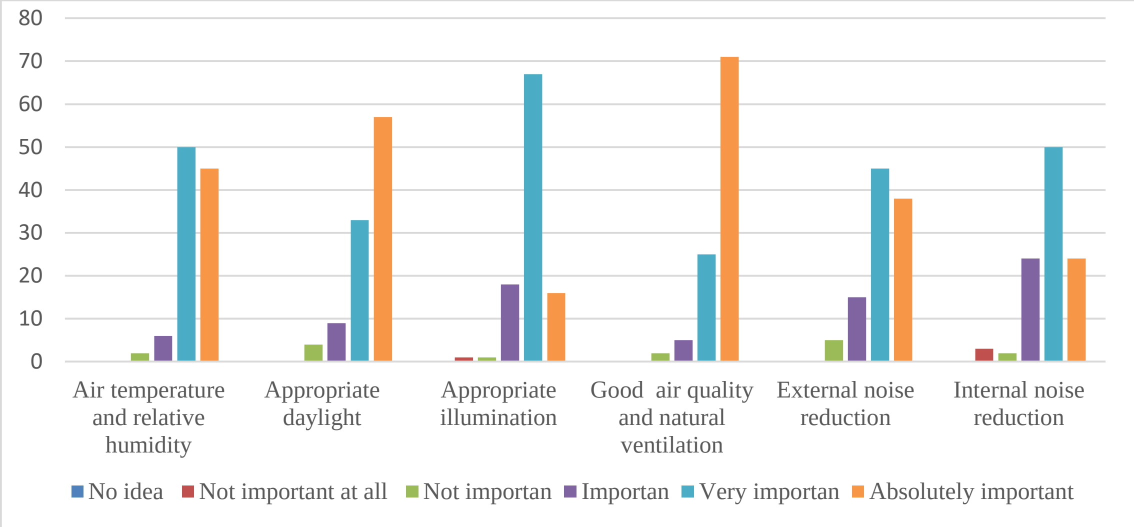


Figure 5.13- The respondents' opinion about the importance of the indoor quality house issues.

Analyzing Figure 5.14 it is possible to see that there is no significant difference between the respondents about the importance of the cultural house issues. In general, most of the respondents agreed that all issues were very important. This means that the building location and type, and the different demographic of the respondents were not affecting the opinions about the cultural issues.

According to the current house cultural issues, also most of the respondents were satisfied with all of the indicators except the ease access entrance for disabled persons.

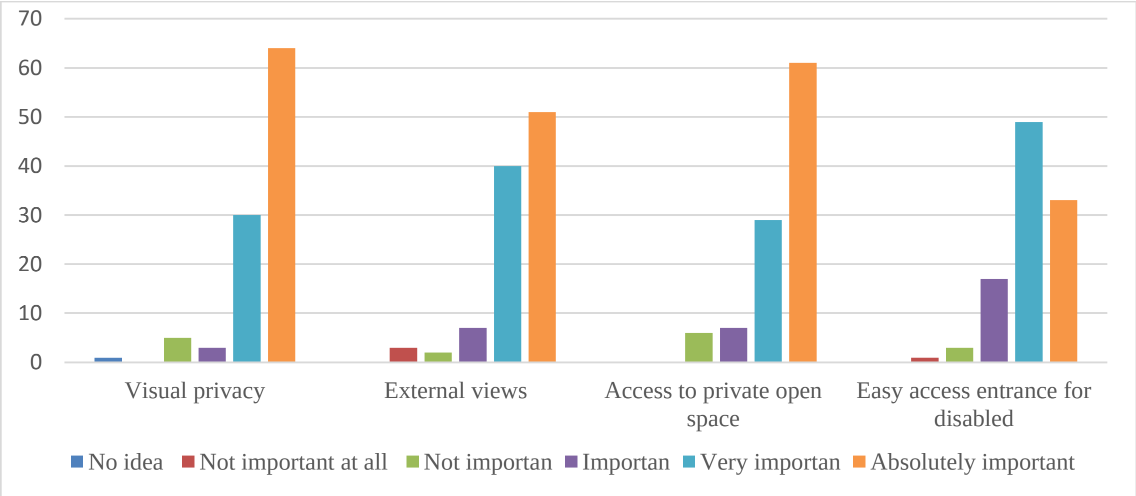


Figure 5.14- The respondents' opinion about the importance of the cultural house issues.

88% of the respondents supported the reduction of the airborne chemical contaminants as a very important health and well-being issue. Around 75% believed that the reduction of the exposure to toxicity of finishing materials and preventing smoking inside the house are very important issues. In contrast, 30% of the respondents thought that installing mechanical ventilation in the kitchen and in the bathroom was not that important for the house health issue. However, 30% of these respondents already had mechanical ventilation inside their houses.

Despite the high rate of building pathologies among the survey, 84% of the respondents believed that the regulated building maintenance is a necessity to achieve the safety of the house. One possible explanation is that most of the respondents are from the low-middle average income, which means they do not have enough money to repair these pathologies.

Regarding the house and neighborhood security, respondents were highly satisfied and they also stressed it as a very important issue for house design in Nablus.

The response about accessibility issues is not different from the other categories as shown in Figure 5.15, where 10% felt the accessibility to exterior public spaces was not important while just less than 4% thought the other three indicators were not important.

It also important to highlight that around 25% of the occupants were dissatisfied with the accessibility issues of their current houses, especially the accessibility to the public transportation.

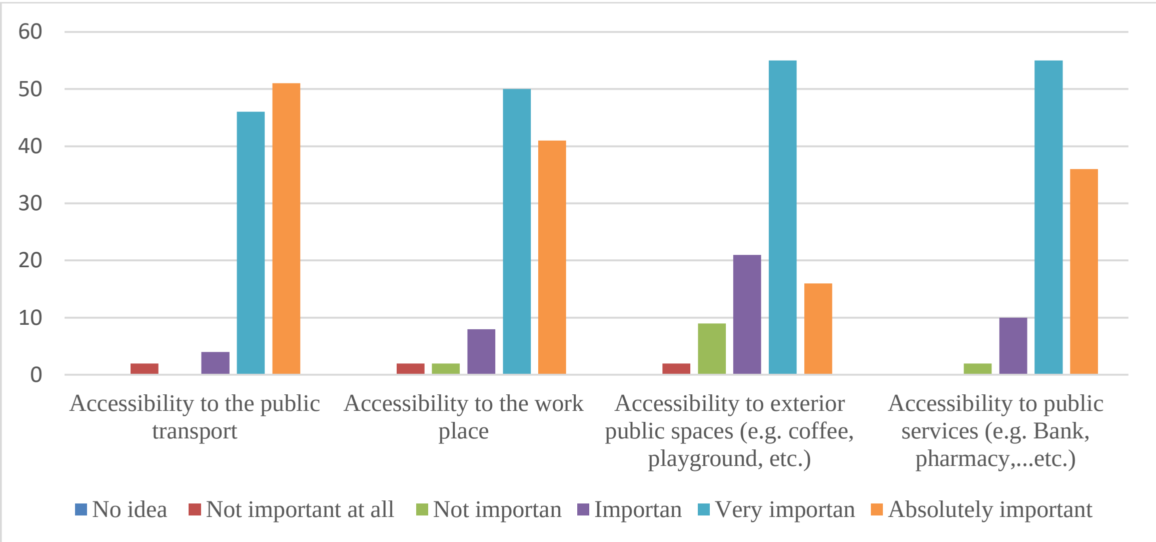


Figure 5.15-The respondents' opinion about the importance of the house accessibility issues (Author, 2017).

In conclusion, usually in such a case, people empower their opinions to meet their unsatisfied needs. From the previous results, it is possible to understand that the occupant's satisfaction about their houses did not affect their opinions about the importance of the social house issues. For example, when a respondent is unsatisfied at a certain issue, he does not always evaluate it as having a very important score. That means it is their true opinion about the aspects, and make the result more reliable.

5.4 ASSESSMENT ITEMS WEIGHTING

There are two possible ways to learn about anything, a feeling or an idea. The first is to examine the entity in itself draw conclusions from the observations about it. The second is to study that object relative to other similar objects and relate it to them by making comparisons.

Under these two methods, different weighting methods can be used to define the weight of sustainability indicators (Table 5.23).

Table 5.23-Classification of weighting method.

Monetary valuation methods(feeling)	**Non-Monetary valuation methods (idea)**
Reveal willingness to pay	Proxy methods
Express willingness to pay	Distance to target methods
Input willingness to pay	Panel weighting methods
Political willingness to pay	
Avoid cost	

There is no best weighting method for sustainable construction assessment tool, however, the study for SB Tool PT-H, LEED, DGNB and BREEM present that the non-monitoring weighting process is used by all of them. The reason for that might be that it is very subjective to introduce an economic value for every environmental impact.

Panel weighing is considered as the most accurate method for sustainable building, where the larger and more representative the panel, more accurate is the result (Kang, 2015). Because of that, to evaluate the list of indicators the Analytical Hierarchy Process (AHP) panelists' method was applied. This method provides a way of breaking down the general method into a hierarchy of sub problems, which are easier to evaluate the gathered information, in order to develop a good judgment for the developing tool.

5.4.1 Analytical Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is an organizing and analyzing mathematical method for complex priorities and decisions. It was developed by Thomas L. Saaty in the 1970s. Since that, it used to use as a methodology for human decision makers priorities in fields such as government, business, project selection, healthcare and education (Saaty, 2008).

AHP is considered as a simple technique that is able to translate the evaluations of both qualitative and quantitative data made by the decision maker into a multi-criteria ranking. In addition, the AHP includes a useful tool for checking the consistency of the decision maker's evaluations, thus reducing the bias in the decision making process (Ali and Nsairat, 2009).

AHP involves the following three-step to make a decision in an organized way to find priorities of objects (Saaty, 2008):

1. Model building, structure the decision hierarchy from the top to bottom with the goal of the decision;

2. Create a set of pairwise comparison matrices, the matrix is a ($m \times m$[6]) real matrix, where m is the number of evaluation criteria considered. Each entry (XY) of the matrix represents the importance of the (X) criterion relative to the (Y) criterion[7].
3. Use the priorities obtained from the comparisons to weigh the priorities of the alternatives, the higher in weight, and the more important correspondent criterion.

To make paired comparison, a scale of numbers is required to indicate how many times more important one element is over another element with respect to the criterion with respect to which they are compared, The relative importance of two criteria is measured according to a numerical scale from 1 to 9 as shown in Table 5.24:

Table5.24- The fundamental scale of absolute numbers (Saaty, 2008).

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgment slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very strong	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favoring one activity over another is of the highest possible order of affirmation

When the matrix is built, it is possible to obtain from the matrix the normalized pairwise comparison matrix norm by making equal to 1 the sum of the entries in each column. Matrix norm is computed as in equations 5.1.

Finally, the criteria weight vector w is built by averaging the entries on each row of matrix norm, w is computed as in equation 5.2.

$$\text{XY norm} = \frac{\text{XY}}{\sum_{k=1}^{m} \text{entries}} \qquad 5.1$$

$$\text{weight vwctor (w)} = \frac{\sum_{k=1}^{m} \text{entries norm}}{m} \qquad 5.2$$

The consistency technique relies on the computation of a suitable consistency index, (CI). Consistency index is obtained by using the following equation.

6 m refers to the total number of entities

7 For a matrix X denotes the entry in the row and Y in the column.

$$CI = \frac{z - m}{m - 1} \qquad 5.3$$

Where z= weight vector (w) divided by the total of the weight vectors.

The value (weight vector) is considered consistent if the (CI/RI) less than (0.1). RI is the Random Index, the consistency index when the entries of the matrix are completely random. The values of RI for small problems ($m \leq 10$) are shown in Table 5.25.

Table5.25- Values of the Random Index (RI) for small problems.

m	2	3	4	5	6	7	8	9	10
RI	0	0.85	0.9	1.12	1.24	1.34	1.41	1.45	1.51

5.4.1.1 Model building

Twenty-seven (27) indicators which were identified in the Skype interviews were presented to the experts and building occupants to solicit their views. On each of the 27 variables, respondents were asked to indicate the importance of these indicators to the house design in Nablus, West Bank, based on a five-point scale where: 1-not important at all, 2-not important, 3-important, 4-very important and 5-Absolutely important. In order to define the relative importance scale, the relative importance index (RII) was employed. Relative Importance Index or weight is a type of relative importance analyses. RII creates values ranging from 0 to 1where 0 denotes least significance and 1 denotes highest significance.

In the calculation of the Relative Importance Index (RII), the formula 5.4 below was used:

$$RII = \frac{\Sigma W}{A * N} \qquad 5.4$$

Where, W—weighting given to each statement by the respondents and ranges from 1 to 5; A—Higher response integer (5); and N—total number of respondents.

Based on the equation, RII was obtained for each indicator. Accordingly, the category index is the average of the relative importance index for the indicators in the various categories.

$$\frac{\Sigma RII}{n} \qquad 5.5$$

Where, ΣRII – sum of RII of indicators in each category, and n-total number of category indicators.

The results of applying the (RII) to each dimension, category and indicators for both groups are presented in Tables 5.26 and 5.27 respectively.

Table5.26- Index of the relative importance for each dimension.

	Dimension	Expert respondents IIR
1.	Environmental	0.83
2.	Social	0.74
3.	Economic	0.77

Table5.27- Index of the relative importance of each indicator and categories in the two groups.

	Category/Indicator	Expert respondents RII	Expert respondents RII Average	Occupants respondents RII	Occupants respondents RII Average
C1	**Cultural category indicators**		**0.774**		**0.864**
In.1	Visual privacy	0.80		0.90	
In.2	External views	0.71		0.86	
In.3.	Access to private open space	0.73		0.88	
In.4.	Easy access entrance for disabled	0.74		0.81	
C2	**Heritage category indicators**		**0.689**		**0.76**
In.5	Respect the cultural value and surrounding context	0.70		0.77	
In.6	Use of traditional local materials and techniques	0.63		0.65	
In.7	Maintenance of the heritage value of an existing facility	0.74		0.85	
C3	**Functional category indicators**		**0.646**		**0.731**
In.8	Availability of a user manual	0.65		0.68	
In.8	Provide fixed space for installing elevator in the design	0.65		0.76	
In.9	Possibility to modify the house construction	0.64		0.76	
C4	**Indoor air quality category indicators**		**0.814**		**0.842**
In.10	Air temperature and relative humidity	0.81		0.87	
In.11	Appropriate daylight	0.84		0.88	
In.12	Appropriate illumination	0.81		0.79	
In.13	Good air quality and natural ventilation	0.86		0.92	
In.14	External noise reduction	0.80		0.83	
In.15	Internal noise reduction	0.76		0.77	
C5	**Health and well-being category indicators**		**0.735**		**0.818**
In.16	Installing mechanical extract ventilation in the kitchen and bathrooms	0.68		0.74	
In.17	Reducing the exposure to airborne chemical contaminants	0.75		0.87	
In.18	Reducing the exposure to toxicity of finishing materials	0.80		0.83	
In.19	Nonsmoking area	0.72		0.83	
C6	**Safety and service quality category indicators**		**0.763**		**0.864**
In.20	Regulated building maintenance	0.74		0.85	
In.21	Security of the house	0.80		0.87	
In.23	Security of the neighbourhood	0.75		0.87	
C7	**Accessibility category indicators**		**0.678**		**0.828**
In.24	Accessibility to the public transport	0.72		0.88	
In.25	Accessibility to the work place	0.68		0.84	
In.26	Accessibility to exterior public spaces	0.65		0.74	
In.27	Accessibility to public services	0.66		0.84	

According to the above table, all the indicators for both groups reached an RII greater than 0.5, and it is notable that RII values for the occupant's respondents more than the RII values for the expert's respondents. Therefore, the social sustainability is more important for the occupants than experts.

For evaluating the result based on (AHP) a relative scale is needed. In order to do that, according to the definition of the method, it was decided to assume the highest RII in each group is extremely more important than the lowest RII in each group. Therefore the relative scale was divided into 8 intervals. Figure 5.16 illustrates this concept in a graph.

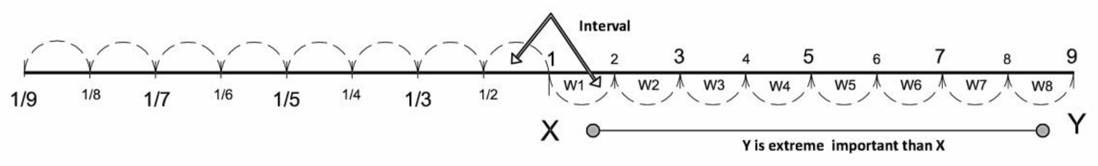


Figure 5.16- The AHP scale for the study goals.

The highest RII value was (0.83) for the environmental issues and the lowest was (0.77) for the social one. For the first group (experts), the highest RII value for the indicators was (0.86) and lowest one was (0.63), and for the occupants group, the highest RII was (0.92) and the lowest one was (0.65). The intervals calculation are presented in equation 5.6, 5.7 and 5.8, respectively.

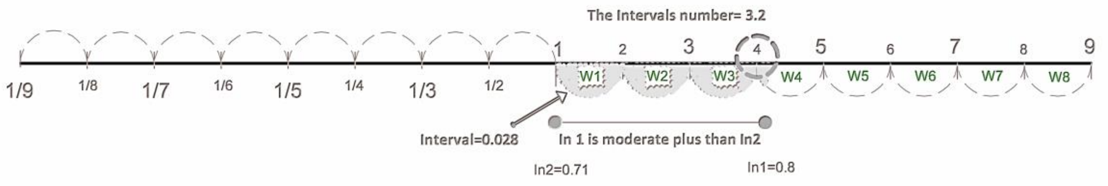
$$\frac{(0.83-0.77)}{8} = 0.008 \quad 5.6$$

$$\frac{(0.86-0.63)}{8} = 0.028 \quad 5.7$$

$$\frac{(0.92-0.65)}{8} = 0.038 \quad 5.8$$

5.4.1.2 Create a set of pairwise comparison matrices

To make paired comparisons, first it is necessary to compare each two items and measure the relative weight between them (e.g. In1 vs In2, In2 vs In3, etc.) using the relative scales found in the section 5.4.1.1. Figure 5.17 shows an example.



(In1)vs (In2) in (group one) = $\frac{(\mathrm{RII(In1)-RII(In2)})}{\mathrm{Interval}}$ =Intervals numbers, $\frac{(0.8-0.71)}{.028}$ = **3.2** intervals

In1 vs In 2 = 4/1, (In 1) is moderate plus than (In2)

Figure5.27- Example of making the relative importance between two items.

Table5.28- Example of built matrix.

	In1	In2	In3	In4
In1	1	8	2	4
In2	1/8	1.00	1/7	1/5
In3	1/2	7	1	3
In4	1/4	5	1/3	1

In4/In1

To apply the AHP calculation process, pairwise comparisons matrix was created between the alternatives (indicators at the same category, categories, dimensions) using the weight ratio (Table 5.27). After that the matrixes were built, the matrixes norm were derived by making equal to 1 the sum of the entries in each column, Table 5.29.

Table5.29- Example of finding the norm matrix.

	In1	In2	In3	In4
In1	1.00	8.00	2.00	4.00
In2	0.13	1.00	0.14	0.20
In3	0.50	7.00	1.00	3.00
In4	0.25	5.00	0.33	1.00
Total= column sum	1+0.13+0.5+.25= 1.88	21.00	3.48	8.20

Calculate Σ values for each column

	In1	In2	In3	In4
In1	0.53	0.38	0.57	0.48
In2	0.06	0.04	0.04	0.02
In3	0.26	0.33	0.28	0.36
In4	0.13	0.24	0.09	0.12

=4/8.2

Normalize the values = $\frac{\text{value}}{\text{column sum}}$

The criteria weight vector (Eigenvector) was built by averaging the entries in each row of the norm matrix, (Table 5.30).

Table5.30- Example of calculating criteria weight vector.

	Eigenvector	%
In1	(0.53+0.38+0.57+0.48)/4= 0.494	49.4 %
In2	(0.13+0.04+0.04+0.02)/4=0.045	4.5 %
In3	(0.26+0.33+0.28+0.36)/4=0.313	31.3 %
In4	(0.13+0.24+0.09+0.12)/4=0.147	14.7 %

Finally, checking the consistency of the evaluations was made using the AHP technique for checking the consistency, where the matrix will be consistent if the ratio is less than 10%, (Table 5.31 and 5.32).

Table 5.31- Example of finding ƛ.

	Consist	ƛ
In1	(0.494+0.045+0.313+0.147)/0.494	4.19
In2	(0.494+0.045+0.313+0.147)/0.045	4.03
In3	(0.494+0.045+0.313+0.147)/0.313	4.20
In4	(0.494+0.045+0.313+0.147)/0.147	4.07

Table 5.32- Example of finding CR and checking the consistency.

	CI=(ƛ-n)/(n-1)=4	CR=CI/IR, IR=0.9	CR vs 0.1
In1	(4.19-4)/(4-1)=0.06	(0.06/0.9)= 0.07	0.07<0.1
In2	(4.03-4)/(4-1)=0.01	(0.01/0.9)= 0.01	0.01<0.1
In3	(4.20-4)/(4-1)=0.07	(0.07/0.9) =0.08	0.08<0.1
In4	(4.07-4)/(4-1)=0.02	(0.02/0.9) =0.03	0.03<0.1

Note, If CR< 0.1 the ranking are consistent, If CR> 0.1 the ranking should be recalculated

With regards to calculated CR in table the results are consistent, CR values were less than 10% as well to the whole calculation.

5.4.1.3 Weighting result

This section presents the result evaluate of the questionnaires in terms of indicators for each category, categories and social dimension, where the final evaluate was the average of two groups.

It is important to indicate that it was difficult to ask the occupants about the importance of the sustainability dimensions that because normal people are not always familiar with this scientific issues. To find the sustainability dimensions weight for the occupants it was suggested to add the difference between the two groups about the social indicators to the weight of social sustainability for the experts. The average was calculated only for the respondents who think that the social indicators were the most important. It was found that social sustainability is more important for the occupants than experts in 10%.

It was possible to assign the following weights for the sustainability dimensions (Table 5.32):1 9% for social dimension; 22.5 for economic dimension; and 55.5% is the highest rate for the environmental sustainability.

Table5.33- The result of AHP evaluation for sustainability dimensions.

	Dimension	Expert Rank	occupants Rank	Average Rank
		100%	100%	100%
D.1	Environmental	62%	55%	58.5%
D.2	Social	14%	(10+14)24%	19%
D.3	Economical	24%	21%	22.5%

Table 5.34 shows that the distribution of the weight between the categories was more balanced in the occupants' valuation than in the expert's one. The indoor quality category was evaluated as the most important category according to the experts, while both cultural and safety and service quality categories were evaluated as the most importance for the occupants. In the average, the indoor quality was evaluated as the first important category. This is followed by safety and service quality. Then, cultural, health and well-being and accessibility were evaluated as the third, fourth and fifth respectively. Followed by the heritage category, and the last evaluation was for the functional category.

Table 5. 34- The result of AHP evaluation for social sustainability categories.

	category	Expert Rank	occupants Rank	Average Rank
		100%	100%	100%
C1	Cultural category indicators	14%	23%	18%
C2	Heritage category indicators	6%	5%	6%
C3	Functional category indicators	3%	4%	4%
C4	Indoor quality category indicators	40%	15%	27%
C5	Health and well-being category indicators	13%	12%	13%
C6	Safety and service quality category indicators	18%	23%	20%
C7	Accessibility category indicators	6%	18%	12%

Table 5.35 and Figure 5.18 presents the weight of each indicator, comparing the weight inside each category. From the analysis of these results, it is possible to conclude that visual privacy is the most important indicator in the cultural category. Maintenance of the heritage value of an existing facility is the most important indicator of the heritage issues. In the functional category, both the possibility to modify the house construction and provide fixed space for installing an elevator in the design indicators are considered the most important. Regarding the indoor quality, good air quality and natural ventilation is the most important one. Reducing the exposure to toxicity of finishing materials has the highest rate among the health and well-being indicators and security of the house among safety and service quality category. While, accessibility to the public transport is considered as the most important one in the accessibility issues.

However, the respondents from the both side argued that all the indicators were essential indicators, at least three out of them indicated one indicator as extremely important. 27 indicators and more two mandatory parameters is a large number of indicators for just one sustainability dimension and this can make the assessment tool not practical (Bragança, Mateus, and Koukkari, 2010). To solve that it was decided to compare the weight result of the indicators with the lowest weight given by the international tools. From the analysis of Table 5.36, it is possible to conclude that, among the present tools, the indicator with the lowest weight has a weight of 0, 4% in the overall score. It happens for the "Potential of the building's conditions for promoting the separation of solid waste" and "Waterproofing index" indicators, in the SB Tool PT-H. Therefore a list considering only the indicators that contributes 0, 4% or more to the overall sustainability is proposed.

Table 5.35- The result of AHP evaluation for social sustainability indicators.

	Category/Indicator	**Expert Rank**	**occupants Rank**	**Average Rank**
C1	**Cultural category indicators**	**100%**	**100%**	**100%**
In.1	Visual privacy	53.1	49.4	51.3
In.2	External views	10.4	4.5	7.5
In.3.	Access to private open space	14.8	31.0	22.9
In.4.	Easy access entrance for disabled	21.8	14.0	17.9
C2	**Heritage category indicators**	**100%**	**100%**	**100%**
In.5	Respect the cultural value and surrounding context	33.4	28.3	30.9
In.6	Use of traditional local materials and techniques	9.8	7.4	8.6
In.7	Maintenance of the heritage value of an existing facility	56.8	64.3	60.6
C3	**Functional category indicators**	**100%**	**100%**	**100%**
In.8	Availability of a user manual	33.3	14.3	23.8
In.9	Provide fixed space for installing elevator in the design	33.3	42.9	38.1
In.10	Possibility to modify the house construction	33.3	42.9	38.1
C4	**Indoor air quality category indicators**	**100%**	**100%**	**100%**
In.11	Air temperature and relative humidity	15.6	18.3	17.0
In.12	Appropriate daylight	21.9	22	22.0
In.13	Appropriate illumination	12.3	5.9	9.1
In.14	Good air quality and natural ventilation	33.8	37.8	35.8
In.15	External noise reduction	11.3	10.6	11.0
In.16	Internal noise reduction	5.1	5.4	5.3
C5	**Health and well-being category indicators**	**100%**	**100%**	**100%**
In.17	Installing mechanical extract ventilation in the kitchen and bathrooms	7.9	7.6	7.8
In.18	Reducing the exposure to airborne chemical contaminants	24.9	44.3	34.6
In.19	Reducing the exposure to toxicity of finishing materials	53.6	25.0	39.3
In.20	Nonsmoking area	13.6	23.1	18.4
C6	**Safety and service quality category indicators**	**100%**	**100%**	**100%**
In.21	Regulated building maintenance	20.0	20.0	20.0
In.22	Security of the house	60.0	20.0	40.0
In.23	Security of the neighbourhood	20.0	40.0	30.0
C7	**Accessibility category indicators**	**100%**	**100%**	**100%**
In.24	Accessibility to the public transport	48.9	43.8	46.4
In.25	Accessibility to the work place	23.5	24.6	24.1
In.26	Accessibility to exterior public spaces	13.8	7.0	10.4
In.27	Accessibility to public services	13.8	24.6	19.2

To make the comparison it was necessary to calculate the final indicators weight where equation 5.8 was used.

Indicator final weight =[percentage indicator weight * category weight) * dimension weight] 5.8

Example: In 1 final weight =[(51.3*0.18)*0.19]= 1.8

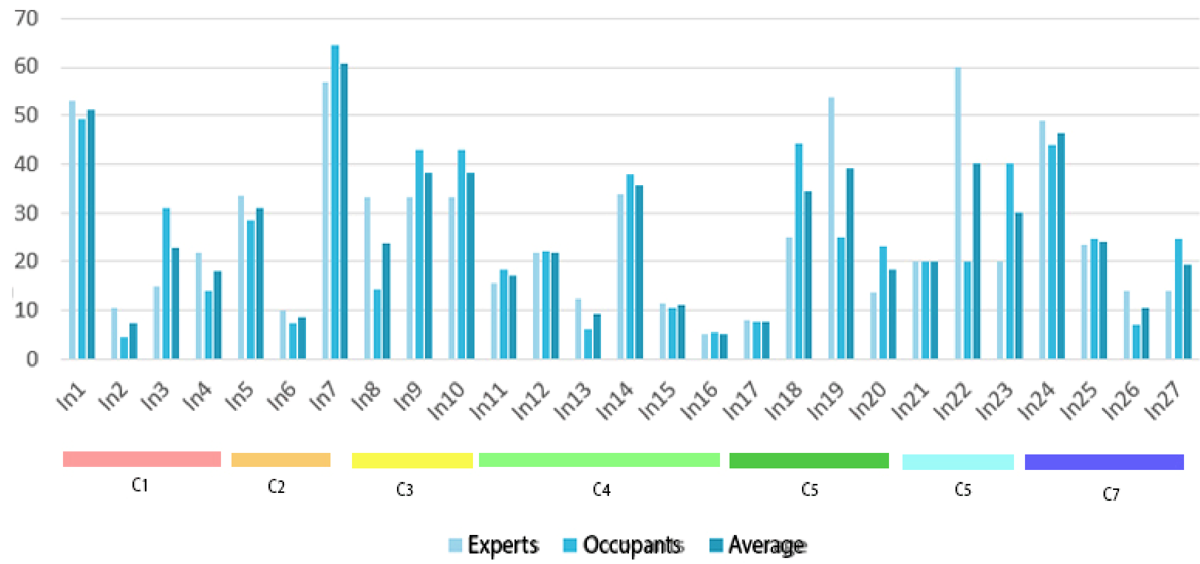


Figure 5.18- The result of AHP evaluation for social sustainability indicators.

Table 5.36- The lowest weights values in the international assessment tool.

The assessment tool	Code for Sustainable Homes	LEED for homes	SB-Tool PT	The Pearl Rating System
The lowest weight awarded	0.7%	0.9%	0.4%	0.85%

With the previous approach, the list was cut off to 19 indicators (Table 5.37) where the indicators highlighted in red at table were the excluded indicators; external views; use of traditional local materials and techniques; availability of a user manual; provide fixed space for installing elevator in the design; possibility to modify the house construction; internal noise reduction; installing mechanical extract ventilation in the kitchen and bathrooms and accessibility to exterior public spaces. It is quite understandable that the functional category was excluded from the tool.

Based on the AHP procedure the weights for the rest indicators and categories was recalculated using the same intervals to find the final weights. Table 5.38 shows the final weighting of social sustainability assessment tool.

By analyzing the final weights, the indoor quality was ranked the most important factor in the social sustainability and accounts 28% of the social area. This supports the findings of Hall (2011) that states that the most important housing priority, from the point view of residents, is the good quality of the living environment. Individually, good air quality and natural ventilation were ranked as the most important variable under the indoor quality category. While cultural category has ranked the second most important category for house building design. Individually, the highest rate was 59% for the visual privacy, which means that it is the most important indicator at the whole tool. The third category that should be considered in the sustainable housing design is safety and service quality, and the house security was the most important variable under this category. Furthermore, the fourth-ranked category was health and well-being, closely followed by the accessibility category. Reducing the exposure to toxicity of finishing materials in health and well-being category was the highest score, and in accessibility category, the accessibility to the public transport was the most important. Finally, 7% was the least category weighted for social dimension and with the lowest number of indicators, heritage category.

Table 5.37- The final weights of the social sustainability indicators.

	Category/Indicator	Indicator weight	
C1	**Cultural category indicators**		
In.1	Visual privacy	1.8	
In.2	External views	0.3	<0.4
In.3.	Access to private open space	0.8	
In.4.	Easy access entrance for disabled	0.6	
C2	**Heritage category indicators**		
In.5	Respect the cultural value and surrounding context	0.4	
In.6	Use of traditional local materials and techniques	0.1	<0.4
In.7	Maintenance of the heritage value of an existing facility	0.7	
C3	**Functional category indicators**		
In.8	Availability of a user manual	0.2	<0.4
In.9	Provide fixed space for installing elevator in the design	0.3	<0.4
In.10	Possibility to modify the house construction	0.3	<0.4
C4	**Indoor air quality category indicators**		
In.11	Air temperature and relative humidity	0.9	
In.12	Appropriate daylight	1.1	
In.13	Appropriate illumination	0.5	
In.14	Good air quality and natural ventilation	1.8	
In.15	External noise reduction	0.6	
In.16	Internal noise reduction	0.3	<0.4
C5	**Health and well-being category indicators**		
In.17	Installing mechanical extract ventilation in the kitchen and bathrooms	0.2	<0.4
In.18	Reducing the exposure to airborne chemical contaminants	0.9	
In.19	Reducing the exposure to toxicity of finishing materials	1.0	
In.20	Nonsmoking area	0.5	
C6	**Safety and service quality category indicators**		
In.21	Regulated building maintenance	0.8	
In.22	Security of the house	1.5	
In.23	Security of the neighbourhood	1.1	
C7	**Accessibility category indicators**		
In.24	Accessibility to the public transport	1.1	
In.25	Accessibility to the work place	0.5	
In.26	Accessibility to exterior public spaces	0.2	<0.4
In.27	Accessibility to public services	0.4	

Table 5.38- The result weights of the social sustainability assessment tool.

Dimension		**Dimension weight%**	
Social dimension		**19**	
Category	**Indicator**	**Indicator weight%**	**Category weight%**
C1. Cultural category indicators	1.Visual privacy	**59**	**23**
	2.Access to private open space	**23**	
	3.Easy access entrance for disabled	**18**	
C2.Heritage category indicators	4.Respect the cultural value and surrounding context	**29**	**7**
	5.Maintenance of the heritage value of an existing facility	**71**	

Table 5.38- The result weights of the social sustainability assessment tool.

Category	Indicator	Indicator weight%	Category weight%
C3.Indoor quality category indicators	6.Air temperature and relative humidity	**17**	**28**
	7.Appropriate daylight	**23**	
	8.Appropriate illumination	**9**	
	9.Good air quality and natural ventilation	**40**	
	10.External noise reduction	**11**	
C4.Health and well-being category indicators	11.Reducing the exposure to airborne chemical contaminants	**37**	**13**
	12.Reducing the exposure to toxicity of finishing materials	**44**	
	13.Nonsmoking area	**19**	
C5.Safety and service quality category indicators	14.Safety from fire	**M**	**18**
	15.Safety from earthquake	**M**	
	16.Regulated building maintenance	**20**	
	17.Security of the house	**50**	
	18.Security of the neighbourhood	**30**	
C6. Accessibility category indicators	19.Accessibility to the public transport	**54**	**11**
	20.Accessibility to the work place	**25**	
	21.Accessibility to public services	**20**	

5.5 COMPARISON OF INDICATOR BETWEEN INTERNATIONAL AND SUSTAINABILITY ASSESSMENT METHODS AND THE PROPOSED METHOD.

Analyzing Table 5.39, it is possible to conclude that the developing assessment tool for West Bank residential building includes the highest number of indicators the SB Tool master list. This indicates how much the social sustainability issues are important to the West Bank residential buildings. It is also possible to conclude that the proposed assessment method at least shares four indicators with the other lists. However, the highest overlap percentage was only 65% for the SB-Tool global list, followed by 40-45% of the ISO 21929-1 criteria, LEED for Homes and SB Tool PT-H. From this analysis it is possible to conclude that Code for Sustainable Homes has only 20% of its indicators overlapping the proposed indicators, which means that it is the less suitable method for the West Bank residential building conditions. Availability of home user guide and the possibility to adapt the construction to meet future occupant's needs indicators were covered at least in two lists, unfortunately, they were not taken into account in the proposed method, respective the perspective of the expert's panel. Nevertheless, the availability of a home user guide is considered as one of the most important indicators in the social sustainability assessment because it helps the residents to operate their house efficiently. Furthermore, the accessibility to the workplace indicator was the indicator that is covered only by the assessment tool proposed for the West Bank and that is due to the movement restrictions in the West Bank because of the occupation. In conclusion, there is a relative difference between the shared indicators in the proposed method and the other lists which show that each place is a special case and requires a special sustainability assessment method.

Table 5.39- Comparison of indicator between international and sustainability assessment methods and the proposed one

Social indicator	ISO 21929-1	SB-Tool master list	Code for Sustainable Homes	LEED for Homes	SB- tool PT-H	Proposed method
Cultural indicators						
Visual privacy in dwelling units		■				■
Views		■				
Universal access on site and within the building	■	■				
Ease access for disabled	■	■				■
Access to private open space	■	■	■			■
Provide drying space			■			
Provide home office			■			
Heritage indicators						
Maintenance the architectural heritage	■	■				■
Use the local materials and techniques		■				
Compatibility of the design with local cultural values		■		■		■
Functional indicators						
Availability of home user guide			■		■	
Efficiency of vertical or horizontal systems		■				
Spatial efficiency		■				
Possibility to adaptable the construction to meet future occupants needs		■	■			
Functionality of layout		■				
Indoor air quality indicators						
Thermal comfort		■		■	■	■
Indoor air quality and ventilation	■	■			■	■
Efficiency of mechanical ventilation		■		■		
Appropriate daylighting		■	■		■	■
Illumination		■		■	■	■
Reduce outdoor noise	■	■	■	■	■	■
Reduce indoor noise		■				
Health and well-being indicators						
Free smoking area				■		■
Minimizing the exposure of building occupants to indoor air pollutants				■		■
Installing Mechanical Ventilation and air Filtering in the kitchens				■		
Social indicator	**ISO 21929-1**	**SB-Tool master list**	**Code for Sustainable Homes**	**LEED for Homes**	**SB- tool PT-H**	**Proposed method**
Limiting the leakage of combustion gases				■		
Reducing exposure to airborne chemical contaminants	■			■	■	■
Safety indicators						
Building maintenance	■	■				■
Safety from fire		■				■
Safety from flooding		■				
Safety from earthquake		■				■
Providing security			■			■
Accessibility indicators						

Table 5.39- Comparison of indicator between international and sustainability assessment methods and the proposed one

Social indicator	**ISO 21929-1**	**SB-Tool master list**	**Code for Sustainable Homes**	**LEED for Homes**	**SB- tool PT-H**	**Proposed method**
Access by public transport						
Access to bicycle traffic						
Access to user basic services						
Access to green and open spaces						
Accessibility to the work place						

6 CONCLUSION AND RECOMMENDATION

Social sustainability in the residential buildings is considered to be a very important issue for developing countries and since the sustainability assessment methods are considered important to promote sustainable building, as a first step a social sustainability assessment method for residential building in West Bank, Palestine, was proposed. The proposed method comprises categories and indicators and requires their weights. Social indicators were first aggregated from the international values due to the lack of the national social sustainability principle and then some indicators were added and other modified or omitted with respect to the national context using the building codes in West bank and the interviews to the Palestinian professionals.

The weight of social sustainability dimension, categories and indicators values were obtained by applying the AHP on the data collected from two surveys conducted to the specialists in the architecture and construction sector in Nablus, West Bank and the building's occupants in the same city.

The outcome is a framework that highlights the most important societal aspects, when designing a new or retrofitted building in West Bank, Palestine. This framework consists of twenty-one indicators distributed among five categories, namely, cultural category, heritage, indoor quality, health and well-being category, safety and accessibility. The Palestinian specialists recommend this case study as a very important issue for improving the residential building sector. It is also considered as a powerful assessment framework because it is based on scientific research and gathers the opinion of both experts and non-experts in the field of building stakeholders. Moreover, the final social indicators and categories suit the local context and the culture of the West Bank.

Although the analysis of the methods that already exist in the market shows some similarity in the sustainability categories, from this work it is possible to conclude that there are some differences both in the indicators that belong to each category and the weight assigned to each indicator, when approaches from developed and developing countries are compared. As an example, the visual privacy is considered the most important societal indicator in this case study but it is not considered in any of the three analyses assessment methods for residential buildings: LEED for Homes, SB Tool PT-H and Code for Homes.

While the framework of the related work fulfils the primary objectives of the study, in order to achieve the secondary objectives, a survey study included questions to give a better understanding of the behavior and the satisfaction of building occupants to match them with the final list of indicators and provide sufficient recommendations.

This study suggest a number of recommendation:

- For developing a social sustainability assessment tool in general: devolving such assessment framework should be based on scientific research and understand well the human behavior in the building; the building experts from different fields must participate as well as the building occupants and the final result should be balanced between them which increase the potential effectiveness of the tool; the final assessment tool should reflect the local context with respect to the international values and the proposed assessment tool is not an individual work and it should base on a discussion with different parties.

- For the West Bank housing sector: merging the building assessment tool with local legislation will improve the social sustainability. However, this cannot be enough because each building is a unique case requiring full understanding of the building occupants needs prior to the design. This means that the building stakeholders have to increase their knowledge about sustainability and all relative issues with it and they also must work in increasing the local awareness about sustainability.

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APPENDIXS

6.1 APPENDIX (A)

6.1.1 1. The interviewees

Dear Engineer..,

My name is Nisreen Ardda, Master's student in the Department of Civil Engineering and I am conducting a study titled "**Developing Assessment Tool for New and Retrofit Residential Building in West Bank, Palestine** " to obtain the Master's degree University of Minho– Portugal.

I kindly ask you to participate in Skype interview. Your response to this interview is highly appreciated where your answers helps to define the first social draft list that influence the Palestinian house design. Please be informed that all personal information supplied is a top confidential issue.

Thank you very much for your time and cooperation,

Sincerely,
Nisreen Ardda

A.1 **Dr. Muhannad Haj Hussein,** Head of Department of Building Engineering, An-Najah National University and Research Associate at GRECAU laboratory, ENSAP-Box, France.

A.2 **Dr. Mohammed Atmeh**, Assistant Professor at Architecture Engineering Department, An-Najah National University and Head of Atmeh Office for Engineering and construction.

A.3 **MSc. Dua Mallah,** Research Assistant at Architecture Engineering Department, An-Najah National University.

A.4 **Arch. Refa Sukker,** Research Assistant at Architecture Engineering Department, An-Najah National University.

C.1 **Abed Al-Jabbar Adel Mosa,** Structural Consultant, Head of Al-Asas Engineer office.

G.1 **Dr. Loai Abu-Raida,** Assistant Professor at department of Geography, An-Najah National University.

6.1.2 The interview questions format

1. What are the barriers to implementing sustainability in West Bank construction industry?
2. How do you feel about West Bank residential building according to the social and cultural aspects?
3. In what ways could engineering and architectural firms take a step for sustainable residential building?
4. What is your opinion on developing sustainable residential building assessment tool?

5. Which of the following global social indicators could help in assessing the social sustainability in West Bank residential building, and why?

Cultural issues		
1.Visual privacy	**2**.Ease access for disabled	**3**.Views
4.Provide drying space, and home office	**5**.Universal access on site and within the building	**6**.Access to private open space
Heritage issues		
1.Maintenance the architectural heritage	**2.**Compatibility of the design with local cultural values	**3.**Use the local materials and techniques
Functional issues		
1.Availability of home user guide	**2.**Spatial efficiency	**3.**Functionality of layout
4.Efficiency of vertical or horizontal systems	**5.**Possibility to adaptable the house construction	
Indoor air quality issues		
1.Thermal comfort	**2.**Indoor air quality and ventilation	**3.**Appropriate daylighting
4.Efficiency of mechanical ventilation	**5.**Reduce outdoor noise, and indoor noise	**6.**Illumination
Health and well-being issues		
1.Installing Mechanical Ventilation and air Filtering	**2.**Minimizing the exposure of building occupants to indoor air pollutants	**3.**Free smoking area
4.Reducing exposure to airborne chemical contaminants	**5.**Limiting the leakage of combustion gases	
Safety issues		
1.Building maintenance	**2.**Safety from flooding	**3.**Providing security
Accessibility issues		
1.Access by public transport	**2.**Access to user basic Services and green and open spaces	**3.**Access to bicycle traffic

6. What are the social and cultural issues that should be added to the list in your opinion?
7. Please, do you have any comment/s?

6.2 Appendix (B)

1 **Dr. Muhannad Haj Hussein,** Head of Department of Building Engineering , An-Najah National University and Research Associate at GRECAU laboratory, ENSAP-Bx, France.

2 **Dr. Ricardo Mateus,** Assistant Professor at Department of Civil Engineering, University of Minho

3 **Dr. Mohammed Atmeh**, Assistant Professor at Architecture Engineering Department, An-Najah National University and Head of Atmeh Office for Engineering and construction.

4 **Arch. Refa Sukker,** Research Assistant at Architecture Engineering Department, An-Najah National University.

5 **Eng. Muna Arda,** Civil Engineer at Al-Asas Engineer office

6 **Eng. Sura Almaleh,** Electrical Engineer, Master student at university of Minho, Department of Electronic Engineer

7 **MSc. Rasha Abbadi,** Assistant Professor at Economics Department, Arab American University PhD Student at university of Minho, Finance

8 **MSc. Laura Dumuje,** PhD Student at university of Minho, Human Resources Management

9 **BA. Safa Arda,** a bachelor's degree in Economics and Political Science, An-Najah National University

10 **Arch. Israa Jayousi,** Master student at An-Najah National University, department of urban and regional planning

6.3 APPENDIX (C)

Escola de Engenharia
Universidade do Minho

Campus de Azurém

4800-058 Guimarães

PORTUGAL

WEST BANK HOUSE DESIGN PRIORITIES LIST SURVEY

Dear Engineer..,

My name is Nisreen Ardda, Master's student in the Department of Civil Engineering and I am conducting a study titled "**Developing Assessment Tool for New and Retrofit Residential Building in West Bank, Palestine** " to obtain the Master's degree University of Minho– Portugal.

I kindly ask you to participate in a brief survey. Your response to this survey helps to define the priorities list of the team that influence the Palestinian house design.

The survey is brief and will only take 10 minutes to complete.

Your participation will be voluntary and all your responses will be confidential.

Thank you very much for your time and cooperation,

Sincerely,
Nisreen Ardda

Questionnaire/Survey NO. : ----------------

A. Sustainable construction

1. The following statements are barriers to implementing sustainability in the construction industry, agree or disagree?

(Select 1 to 5 scale: **1** if you **strongly disagree** with the sentence and **5** if you **strongly agree**)		**1**	**2**	**3**	**4**	**5**	**No opinion**
1.1	Limited data about sustainability	□	□	□	□	□	□
1.2	Lack of knowledge and training among professionals	□	□	□	□	□	□
1.3	Lack of legal aspects concerning sustainability	□	□	□	□	□	□
1.4	Lack of financial incentives	□	□	□	□	□	□
1.5	Tendency to use traditional design and construction methods	□	□	□	□	□	□
1.6	Fear of implementing sustainability due to the risk factor	□	□	□	□	□	□

2. The following statements about residential building industry.

(Select 1 to 5 scale: **1** if you **strongly disagree** with the sentence and **5** if you **strongly agree**)		**1**	**2**	**3**	**4**	**5**	**No opinion**
2.1	The current residential building industry respect the social and cultural aspects	□	□	□	□	□	□
2.2	There is a necessity to develop a sustainable residential building assessment tool	□	□	□	□	□	□
2.3	There is a necessity to merge the sustainability with the municipalities code	□	□	□	□	□	□

3. What is your opinion about the importance of sustainability dimensions in residential building?

(Select 1 to 5 scale: **1** if the sentence is **extremely not important** and **5** if it is **extremely important**)		**1**	**2**	**3**	**4**	**5**
3.1	Environmental issues	□	□	□	□	□
3.2	Socio-cultural issues	□	□	□	□	□
3.3	Economic issues	□	□	□	□	□

B. Socio-cultural architecture house issues

1. What is your opinion about the importance of <u>Socio-Cultural Architecture</u> house issues? (Select 1 to 5 scale: **1** if the sentence is **extremely not important** and **5** if it is **extremely important**):

1.1 Social issues		**1**	**2**	**3**	**4**	**5**
1.1.1	Visual privacy	□	□	□	□	□
1.1.2	External views	□	□	□	□	□
1.1.3	Access to private open space (e.g. balcony, garden, terraces, etc.)	□	□	□	□	□
1.1.4	Easy access entrance for disabled persons	□	□	□	□	□

1.2 Cultural and heritage issues		**1**	**2**	**3**	**4**	**5**
1.2.1	Respect the cultural value and surrounding context (city heritage or nearby)	□	□	□	□	□
1.2.2	Use of traditional local materials and techniques	□	□	□	□	□
1.2.3	Maintenance of the heritage value of an existing facility	□	□	□	□	□

1.3 Functional issues		**1**	**2**	**3**	**4**	**5**
1.3.1	Availability of a user manual for the building performance and how it works	□	□	□	□	□
1.3.2	Provide fixed space for installing elevator in the house design	□	□	□	□	□

		1	2	3	4	5
1.3.3	Possibility to modify the house construction (e.g. horizontal and vertical extension, changes in the house use or design... etc.)	□	□	□	□	□

1.4 Indoor air quality		1	2	3	4	5
1.4.1	Air temperature and relative humidity	□	□	□	□	□
1.4.2	Appropriate daylight	□	□	□	□	□
1.4.3	Appropriate illumination	□	□	□	□	□
1.4.4	Good air quality and natural ventilation	□	□	□	□	□
1.4.5	External noise reduction	□	□	□	□	□
1.4.6	Internal noise reduction	□	□	□	□	□

1.5 Health and well-being issues		1	2	3	4	5
1.5.1	Installing mechanical extract ventilation in the kitchen and bathrooms	□	□	□	□	□
1.5.2	Reducing the exposure to airborne chemical contaminants	□	□	□	□	□
1.5.3	Reducing the exposure to toxicity of finishing materials	□	□	□	□	□
1.5.4	Nonsmoking area	□	□	□	□	□

1.6 Safety and service quality issues		1	2	3	4	5
1.6.1	Regulated building maintenance	□	□	□	□	□
1.6.2	Security of the house	□	□	□	□	□
1.6.3	Security of the neighbourhood	□	□	□	□	□

1.7 Accessibility issues		1	2	3	4	5
1.7.1	Accessibility to the public transport	□	□	□	□	□
1.7.2	Accessibility to the work place	□	□	□	□	□
1.7.3	Accessibility to exterior public spaces (e.g. coffee, playground, etc.)	□	□	□	□	□
1.7.4	Accessibility to public services (e.g. Bank, pharmacy, school, shopping...etc.)	□	□	□	□	□

C. Personal information

1. Gender? 1.1 Male 1.2 Female

2. Age?

2.1 23-29 2.2 30-39 2.3 40-49 2.4 50-59 2.5 60-69

3. What is your speciality?

3.1 Architectural Engineering 3.2 Building Engineering 3.3 Civil Engineering
3.4 Electrical Engineering 3.5 Mechanical Engineering 3.6 Urban Planning Engineering

4. Level of education?

4.1 Bachelor’s degree 4.2 Master’s degree 4.3 Doctorate degree 4.4 Post-doctorate degree

5. Please, do you have any comment/s about the questionnaire?

THANK YOU

6.4 APPENDIX (D)

Escola de Engenharia
Universidade do Minho

Campus de Azurém

4800-058 Guimarães

PORTUGAL

HOUSE PRIORITIES LIST SURVEY

Dear Residents of Nablus,

My name is Nisreen Ardda, Master's student in the Department of Civil Engineering and I am conducting a study titled "**Developing Assessment Tool for New and Retrofit Residential Building in West Bank, Palestine** " to obtain the Master's degree from University of Minho– Portugal.

I kindly ask you to participate in a brief survey. Your response to this survey will help in define a list of priorities that will be used by the design team to satisfy the user expectations.

The survey is brief and will only take 10 minutes to complete.

Your participation will be voluntary and all your responses will be kept confidential.

Thank you very much for your time and cooperation,

Sincerely,
Nisreen Ardda

Questionnaire/Survey NO.: ----------------

A. Culture-heriatege Architecture issues

1. Your house location?

1.1 In the city   1.2 In the village   1.3 In the old city

2. Your house type?

2.1 Apartment   2.2 Single family home   2.3 Raw house   2.4 Villa

3. Please, if your house is an apartment answer the following:

A. At which floor is your apartment?

A.1 Ground floor   A.2 First floor   A.3 Second floor   A.4 Third floor   A.5 Fourth floor
A.6 Fifth floor   A.7 Sixth floor   A.8 Seventh floor   A.9 Eighth floor   A.10 Over the 8th floor

B. What is your apartment orientation? (More than one option is possible)

B.1 North   B.2 East   B.3 West   B.4 South

C. How many apartments on each floor in your building?

4. What is the exterior wall material of your house? (More than one option is possible)

4.1 Stone   4.2 Concrete   4.3 hollow block cement

5. What is the total area of your house in m^2?

5.1 Less than 100   5.2 Between 100 and 149   5.3 Between 150 and 180   5.4 More than 180

6. How many people live in your house?

7. How many years have you lived in your house?

8. In a typical day, how many hours do you spend in your house?

9. About your house, how satisfied are you with the followings:

(Select 1 to 5 scale: **1** if the statement is **extremely dissatisfied** and **5** if it is **extremely satisfied**)		1	2	3	4	5
9.1	House layout	□	□	□	□	□
9.2	Space that required for each function	□	□	□	□	□
9.3	Percentage area that allocated for you in your house	□	□	□	□	□

10. What is your opinion about the importance of <u>functional house issues</u>?

(Select 1 to 5 scale: **1** if the sentence is **extremely not important** and 5 if it is **extremely important**)		1	2	3	4	5
10.1	Availability of a user manual for the building performance and how it works	□	□	□	□	□
10.2	Provide fixed space for installing elevator in the house design	□	□	□	□	□
10.3	Possibility to modify the house construction (e.g. horizontal and vertical extension, changes in the house use or design... etc.)	□	□	□	□	□

11. Who participated in your house design? (More one option is possible)

11.1	Your family	11.2	The house owner	11.3	The designer	11.4	The contractor	11.5	No idea

12. Have you been carried out any of the following change in your house?

12.1 Changes in space use 12.2 Physical changes (additional room, ..) 12.3 Decorative changes

13. What was the main reason for this change?

13.1	Cultural issues (privacy,..)	13.2	Changes in family size	13.3	Improve the indoor quality	13.4	Luxury

14. What is your opinion about the importance of <u>cultural and heritage</u> house issues?

(Select 1 to 5 scale: **1** if the sentence is **extremely not important** and **5** if it is **extremely important**)		1	2	3	4	5
14.1	Respect the cultural value and surrounding context (city heritage or nearby)	□	□	□	□	□
14.2	Use of traditional local materials and techniques	□	□	□	□	□
14.3	Maintenance of the heritage value of an existing facility	□	□	□	□	□

15. What is your opinion about the importance of <u>social house</u> issues?

(Select 1 to 5 scale: **1** if the sentence is **extremely not important** and **5** if it is **extremely important**)		1	2	3	4	5
15.1	Visual privacy	□	□	□	□	□
15.2	External views	□	□	□	□	□
15.3	Access to private open space (e.g. balcony, garden, terraces, etc.)	□	□	□	□	□
15.4	Easy access entrance for disabled persons	□	□	□	□	□

16. About your house social issues, please answer the following questions:

		Yes	No	No idea
16.1	Do you have direct sunlight access to your living area	□	□	□
16.2	Do you have visual privacy	□	□	□
16.3	Do you have external views	□	□	□
16.4	Do you have access to private open space (e.g. balcony, garden, terraces,.. etc.) from the house	□	□	□
16.5	Do you have easy access entrance for disabled persons	□	□	□

<u>B.Indoor quality</u>

1. In hot weather, which of the following do you use to adjust the temperature in your house? (More than on option is possible)

1.1 Windows 1.2 Fan 1.3 Door to interior space 1.4 Conditioning unit

2. In cold weather, which of the following do you use to adjust the temperature in your house? (More than on option is possible)

2.1 Windows 2.2 Fireplace (firewood, coal) 2.3 Heater (gas, electricity,oil) 2.4 Central heating

3. Which of the followings cause discomfort for you inside your house? (More than on option is possible)

3.1	Noise from your neighbours	3.2	Noise from traffic	3.3	Noise from the house machines (TV,)

4. What is your opinion about the importance of <u>indoor quality</u> house issues?

(Select 1 to 5 scale: **1** if the sentence is **extremely not important** and **5** if it is **extremely important**)		1	2	3	4	5
4.1	Air temperature and relative humidity	◻	◻	◻	◻	◻
4.2	Appropriate daylight	◻	◻	◻	◻	◻
4.3	Appropriate illumination	◻	◻	◻	◻	◻
4.4	Good air quality and natural ventilation	◻	◻	◻	◻	◻
4.5	External noise reduction	◻	◻	◻	◻	◻
4.6	Internal noise reduction	◻	◻	◻	◻	◻

5. About your house environmental comfort issues, how satisfied are you with the following:

(Select 1 to 5 scale: **1** if the statement is **extremely dissatisfied** and **5** if it is **extremely satisfied**)		1	2	3	4	5
5.1	Air temperature and relative humidity	◻	◻	◻	◻	◻
5.2	Appropriate daylight quality	◻	◻	◻	◻	◻
5.3	Appropriate artificial light	◻	◻	◻	◻	◻
5.4	Good indoor air quality and natural ventilation	◻	◻	◻	◻	◻
5.5	External noise reduction	◻	◻	◻	◻	◻
5.6	internal noise reduction	◻	◻	◻	◻	◻

<u>C.Health and well-being</u>

1. Do you have any of this building deterioration in your house? (More than one option is possible)

1.1	Degradation of house equipment (taps, drainage pipes...)	1.2	Detachment of coatings
1.3	Parasite vegetation problems	1.4	Moisture and dampness problems
1.5	Cracks (nonstructural)	1.6	Structural problems or collapse

2. If one of your previous answers is the structural problems or collapse, what was the main reason? (More than one option is possible)

2.1	Problems in structural design	2.2	Earthquake	2.3	The house was old	2.4	Other

3. What is your opinion about the importance of <u>health and well-being</u> house issues?

(Select 1 to 5 scale: **1** if the sentence is **extremely not important** and **5** if it is **extremely important**)		1	2	3	4	5
3.1	Installing mechanical extract ventilation in the kitchen and bathrooms	◻	◻	◻	◻	◻
3.2	Reducing the exposure to airborne chemical contaminants	◻	◻	◻	◻	◻
3.3	Reducing the exposure to toxicity of finishing materials	◻	◻	◻	◻	◻
3.4	Nonsmoking area	◻	◻	◻	◻	◻

4. About your house health and well-being issues, please answer the following questions:

	Yes	No	No idea

4.1	Do you have a mechanical extract ventilation in the kitchen /bathrooms	□	□	□
4.2	Do you exposed to air pollution (dust, emissions from factories, cars,)	□	□	□
4.3	Do you use any of toxicity finishing materials like (VOCs)	□	□	□
4.4	Do you allow smoking in your house	□	□	□

D.Safety and services issues

1. What is your opinion about the importance of Safety and service quality house issues?

(Select 1 to 5 scale: **1** if the sentence is **extremely not important** and **5** if it is **extremely important**)		1	2	3	4	5
1.1	Regulated building maintenance	□	□	□	□	□
1.2	Security of the house	□	□	□	□	□
1.3	Security of the neighbourhood	□	□	□	□	□

2. About your house safety and service quality issues, how satisfied are you with the followings:

(Select 1 to 5 scale: **1** if the statement is **extremely dissatisfied** and **5** if it is **extremely satisfied**)		1	2	3	4	5
1.1	Regulated building maintenance	□	□	□	□	□
1.2	Security of the house	□	□	□	□	□
1.3	Security of the neighbourhood	□	□	□	□	□

E.Accessibility house issues

1. What is your opinion about the importance of accessibility house issues?

(Select 1 to 5 scale: **1** if the sentence is **extremely not important** and **5** if it is **extremely important**)		1	2	3	4	5
1.1	Accessibility to the public transport	□	□	□	□	□
1.2	Accessibility to the work place	□	□	□	□	□
1.3	Accessibility to exterior public spaces (e.g. coffee, playground, etc.)	□	□	□	□	□
1.4	Accessibility to public services (e.g. Bank, pharmacy, school, shopping...etc.)					

2. About your house accessibility issues, how satisfied are you with the followings:

(Select 1 to 5 scale: **1** if the statement is **extremely dissatisfied** and **5** if it is **extremely satisfied**)		1	2	3	4	5
2.1	Accessibility to the public tra2n1s2p2o2r1t1 1	□	□	□	□	□
2.2	Accessibility to the work place	□	□	□	□	□
2.3	Accessibility to exterior public spaces (e.g. coffee, playground, etc.)	□	□	□	□	□
2.4	Accessibility to public services (e.g. Bank, pharmacy, school, shopping...etc.)					

Personal information

1. Gender? **1.1** Male **1.2** Female

2. Age?

2.1 20-29 **2.2** 30-39 **2.3** 40-49 **2.4** 50-59 **2.5** 60-69

3 . Level of education?

3.1	No schooling completed	3.2	High school	3.3	College/ Technical training
3.4	Bachelor's degree	3.5	Master's degree	3.6	Doctorate degree

4. Average monthly income?

4.1	Less than 1500NIS	4.2	Between 1500-2500NIS	4.3	Between 3000-6000NIS	4.4	More than 6500 NIS

Thank You