Journal of Sustainable Construction Materials and Technologies

Sustain. Construct. Mater. Technol. 5(2) (2020) 450–466

www.eds.yildiz.edu.tr/jscmt

Evaluation of Sustainable Building Construction in the kingdom of Bahrain

Haya Alqahtani[a], Bahaaeddin Alareeni[b, *]

[a]*Ahlia University, Manama, Bahrain*
[b]*Middle East Technical University – Northren Cyprus Campus, Güzelyurt, KKTC*

Manuscript Received April 5, 2020; Accepted August 29, 2020

Abstract

Sustainable buildings revolve around the concept of sustainability – to manage limited resources in order to meet the needs of the present generation without compromising the future generations. The present research aims to evaluate both practical and theoretical application levels of sustainable building constructions in the Kingdom of Bahrain via sustainability indicators. To carry out this research, the population size is based on architects, contractors, and policy and decision makers from the Kingdom of Bahrain, this research adopted a quantitative research approach by using survey questionnaires and the data analysis was performed with the statistical software Statistical Package for Social Sciences (SPSS). Finally, the result of this study is accumulated and presented, followed by recommendations for further research. Our results revealed that the Kingdom of Bahrain weakly supports the level of sustainable building constructions, and it is important now, to integrate renewable energy into buildings, particularly after the increasing prices of fossil fuel "oil and gas".

Keywords: Sustainable building construction, integrated renewable energy, fossil-based energy sources, CO2 emission.

1. Introduction

Over the past few years, buildings constructions contributed to the development of several sectors worldwide. This leaded to the application of new concepts of environmental protection and management by individuals and the entire society. One of the most important concepts extensively used in this field is the concept of sustainability.

Nowadays, the term “sustainability” is used in various disciplines and in most countries worldwide, fluctuating from the concept of maximum sustainable yield in forestry management to the vision of a sustainable community with a steady economy (Brownet al., 1987). A suitable concept of sustainability, broadly or narrowly defined, must clearly specify the context along with the chronology and scales that are considered. The term refers to the goal in performing activities without depleting or damaging the available resources (Brundtland Commission, Our Common Future, 1987).

In the context of building constructions, sustainability consists in reducing the environmental impact during and after the construction process in order to attend the ongoing requirements and to maintain the same impact in the future.

Each year, an increasing number of buildings (shopping malls, residential and commercial properties, and

* Corresponding author. Tel.: +905338427206
E-mail address: alareeni@metu.edu.tr (B.Alareeni)
https://doi.org/10.29187/jscmt.2020.49

other landmarks) emerges in the Kingdom of Bahrain. Huge projects even generated new islands, such as Amwaj, Diyar AlMuharraq, Durrat Al Bahrain, and others (A.AlRaees, 2015). Therefore, in order to reduce the negative impacts of this built environment, we should emphasize the need for raising the level of sustainability in the building constructions of the Kingdom of Bahrain. This approach aims to reduce energy consumption, carbon and water emissions, and any other negative environmental impact.

Based on that, the government of the Kingdom of Bahrain took an initiative to work on more than 40 environmentally friendly building projects as a part of sustainability development (Al Murbati, J, 2014). The lack government support and financial justification certainly limit the construction of sustainable buildings.

Al Naser and Flanagan (2007) reported that many buildings constructed in the Kingdom of Bahrain and in the region did not consider any sustainability criteria. The construction companies used materials such as glass claddings and big openings in the design and construction of the building, thus, leading to an energy crisis as well as damaging the environment by contributing to more CO_2 emissions.

Under this scenario, the present study will evaluate the current application level of sustainable construction of buildings in the Kingdom of Bahrain. We will investigate to which extent the sustainability indicators are used and the way their application in the construction of building sector in the Kingdom of Bahrain.

2. Study Problem

The application of sustainability concept may bring prosperity of growing markets. According to Isarangkun and Pootrakool (2002), sustainability consists of the most important goal in countries that seek for growing their economic, social, and environmental sectors. Al Naser and Flanagan (2007) suggested a set of indicators for evaluating the sustainability in building constructions: (1) the possibility for on-site renewable energy generation; (2) the reduction of fossil-based energy sources used during the construction process; (3) the building of more user-friendly and less complex management systems; and, finally, (4) the presence of buildings systems that reduce CO2 emission, construction and demolition waste, and stop the pollution of indoor air. Therefore, the present study focuses on evaluating the application level of sustainable construction of buildings in the Kingdom of Bahrain. It evaluates to which extent the above-mentioned sustainability indicators are used and the way they are applied in the construction of building sector in the Kingdom of Bahrain.

3. The Purpose of the Study

The study purpose consists in to investigate the application level of sustainable strategies for buildings construction in the Kingdom of Bahrain by evaluating its sustainability indicators. It evaluates the adoption of the above-mentioned set of sustainability indicators (Naser and Flanagan, 2007), and also determine their application in the sector of building construction of the Kingdom of Bahrain. The present study might contribute to providing a clear picture for government and all interested partners regarding the application level of sustainability criteria in guiding the sector of building constructions in the Kingdom of Bahrain.

4. The Study Objective

The main objectives of this study are to use sustainability indicators to evaluate the current level of sustainability criteria that guide the construction process of buildings in the Kingdom of Bahrain. The findings expected from this research will lead to more in-depth studies for this area.

The objectives of this research are:

1. To evaluate the application level of sustainability in building constructions in the Kingdom of Bahrain.
2. To evaluate to which extent building sector in the Kingdom of Bahrain adopts and applies sustainability indicators in their construction of buildings.

5. Study Questions

The main research question of this study consists in understanding the application level of sustainable buildings construction in the Kingdom of Bahrain from the viewpoint of specialists. The following five questions were formulated by extracting important indicators from the literature review.

1. What are the possibilities to generate on-site renewable energy within building construction in the

Kingdom of Bahrain?
2. Is the consumption of fossil-based energy reduced in terms of energy embodied in materials, construction process, and energy used through the lifetime of the buildings?
3. Are the building management systems in Kingdom of Bahrain user-friendly and less complex?
4. Do such buildings reduce CO2 emission, minimize construction and demolition waste, and prevent indoor air pollution?
5. What are sustainability indicators used and how they drive in the construction processes of building sector in the Kingdom of Bahrain?

6. Research Significance

Architecture and Urbanism play a crucial role in determining the resources consumption and distribution in space. With that in mind, to achieve an equitable and sustainable design should take into account the vital role played by the design of the built environment. For example, the design of cities and buildings directly determine the carbon emissions. The built environment dominates humanity's impact on nature and contributes to climate change, resources depletion, waste, over-consumption, diminished human health, and other significant problems. Therefore, in order to sustain ourselves under a scenario of climate change crises, the best route should approach a sustainable future by building more sustainable environments with equitable carbon footprints.

All development and conservation planning should consider sustainability as its foundation. The future of human health and well-being and the health of our planet as a whole largely depend on the adoption of sustainable practices. This highlights the importance of sustainability in the built environment as the conventional human habitation dramatically altered the environment with serious and cumulative impacts.

Sustainability should be taken into account in all the phases: planning, design, construction, and preservation of the built environment. It helps these activities to reflect multiple values and considerations. Traditionally, the arts and sciences of the built environment seek to integrate values and foster creative expression. All these capabilities can and should lead a sustainable movement, especially considering that society seeks for ways to live in an equilibrium, balancing its own diverse needs and the natural world. Given the growing environmental impact of building environments, the search for sustainability will not succeed without taking into account the need for finding this balance.

Sustainable built environments require a planning that goes beyond individual disciplines. It is crucial to consider the variety of economic, social, and environmental impacts of our long-term decisions. A decision to build environmental-friendly residences in an isolated location may pass some of the tests of sustainability like reduction in storm water runoff, energy-efficiency, and ecological sustainability in the building but it may fail to be sustainable from a transportation perspective. The sustainability challenge in the built environment should not be limited to only one area of knowledge but to become multi-disciplinary and trans-disciplinary in our teaching and learning.

7. Construction Industry of Bahrain

As illustrated in 2.6 below, the kingdom of Bahrain has witnessed a prompt population increase alongside a continuous growth of cities. The result is an increased pressure on the overall construction sector in addition to provision of social facilities for the benefit of the present growth demands and certifies continued provision of equal and better facilities for the future needs. In addition to that, Ahmed (2013) has underlined that the sector of edifice represents continuing sensation resulting from the revolution of economy and the rapid growth of people equally lead to the pledgee the sustainable building since the last years and was applied during the crisis that led to depletion of oil and environmental challenges. Previously, the base to the establishment of 'green construction' rules and regulations followed the enforcement of policy on oil depletion. To that effect, the subsequent sections in the introduction chapter offers a discussion on the current efforts as well as related challenges arising in Bahrain on this issue besides giving facts in relation to green design launch and significance.

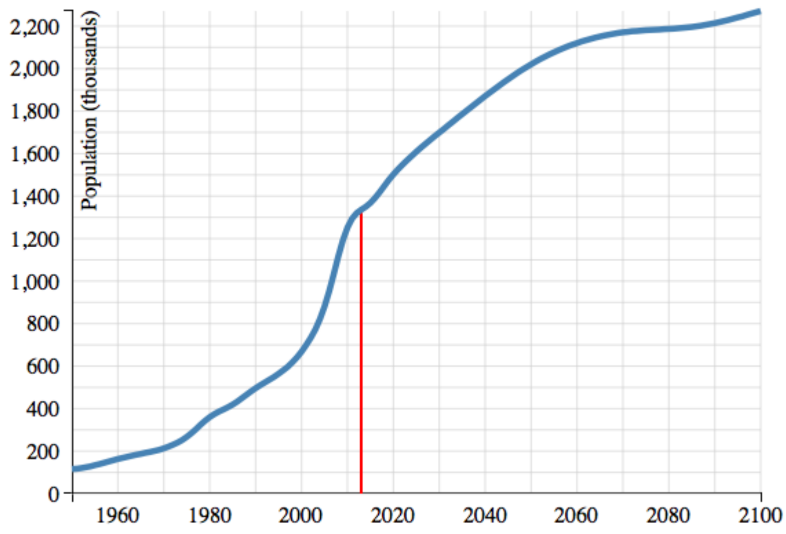

Figure 2.6: Population of *Bahrain* (Source: World Population Review, 2014)

The initiatives adopted by the kingdom of Bahrain through the Economic Vision 2030 launched by His Majesty King Hamad bin Isa Al-Khalifa in October 2013 in an effort to present a holistic and ambitious vision focused on the shaping of society, economy, environment, and the government around the foundations of fairness, sustainability, and affordability. The vision of economy offers the Bahrain régime with specific principles to develop the economy in every dimension and at the same time ensures an improvement in the living standards of citizens to a global height. Together with the economic vision 2030, the liberal population increase, the country has beheld a noteworthy stress on construction marketplace stemming from the function of buildings to provide somewhere to stay varied purposes and amenities in unity with the prescribed policy standards. However, the scarcity allied with availability of quality land parcel for expansion of current urban buildings has prompted government consultants to secure expansion through land retrieval. The program has focused on providing a suitable quality of land along with an area for the necessitated development of new urban houses. Thus, the aim is to build new cities in line with the basic infrastructure and numerous structures to serve citizens. Of note, any economic development demands the provisions of buildings, for instance, commercial, residential, industrial or recreational. According to Cooker and Lazzeretti (2008), Economic development founded on any aspect should provide the government, private sector, local communities, and non-profit organizations the prospect of interacting and working together as composite unity geared towards improving the local economy.

Fundamentally speaking, a number of factors are in line to consideration in an effort to allow Bahrain as a country enhances her local economy. The superseding factor mentions the reduction of undesirable influences of the building improvement on the ecosystem besides increasing the wellbeing of users. In fact, it is significant to hearten bearable growth in every dimension for promoting a vigorous public. To that end, the writer accurately indicates that raising economy of a country requires a concurrent investment in high quality buildings that are in uniformity with related laws and regulations.

8. Indicators of Sustainable Building

According to Ferreira (2016), The concept of sustainable building construction has been acknowledged as a construction or design system of evaluation of robustness of building, comfort, and efficacy of energy from an overall point of view. To that end, the concept covers design, site of construction, and the envelope resources geared towards meeting the objectives of inhabitants for a healthy life. A number of worldwide and national eco-friendly rating system of constructions focuses on the establishment of sustainable built environment intended to limit the impacts that damage the environment. Environmentalists have achieved the goal through the development of a set of performance-based standards directed towards realizing exclusive desires of a country or region and its atmosphere. Additionally, the assessments of constructions remain elastic and are applicable in different building typologies.

The indicators of sustainable construction reflect the immediate section of the principal emphasis in this study, particularly the designing of the rating systems to evaluate the construction sector based in a united approach with the socioeconomic and environmental. Further, the characteristics of supportable and sensible framework founded on a substitutable and cooperative slant among varied participants. In addition to that, the said systems of rating expose architects, builders, and users to significant challenges in terms of developing and building structure that satisfy the requirements of sustainable building and benchmarks, including water and energy conservation, use of strong and ecological resources that focus on a vigorous and conform indoor settings.

Al Naser and Flanagan (2007) suggested a set of indicators for evaluating the sustainability in building constructions, there are many indicators for sustainable building design. Among these:

1. Identifying opportunities to generate on-site renewable electricity, i.e. like Building-Integrating Photovoltaic (BIPV).
2. Minimizing the use of fossil-based energy in terms of energy embodied in the material, transport and construction process and energy used during the lifetime of the building.
3. Ensuring that building management systems are user friendly and not over-complex.
4. Among the guidance for the design of government policies to address the environmental issues related to sustainable building is reducing of CO2 emission, minimizing of construction and demolition waste, and prevention of indoor air pollution.

These above indicators are used in the present study to focus on evaluating the application level of sustainable construction of buildings in the Kingdom of Bahrain, and to evaluate to which extent they are used and the way they are applied in the construction of building sector in the Kingdom of Bahrain.

9. Research Method

In order to reach the research objectives, this study adopted a quantitative research approach by using survey questionnaires to collect and analyze data of sustainable building constructions in the Kingdom of Bahrain. To measure the main factors of the research, the survey consisted of 4 sections and each section contains from 2 to 3 close-ended questions and 20 factors obtained from sustainability factors to find the obstacles, problems and any recommendation for the construction of sustainable buildings.

10. Study Hypotheses

The purpose of following hypothesis is to study and evaluate the application level of sustainable building construction in Bahrain, the researcher developed these hypotheses based on the literature review. That is to assess the application level of sustainable construction of buildings in the Kingdom of Bahrain. The following part highlights the study hypothesis:

H1: There are possibilities to generate on-site renewable energy within building construction in Bahrain.
H2: Fossil-based energy consumption is reduced in terms of energy embodied in materials, construction process, and energy used through the lifetime of the buildings in Bahrain.
H3: The building management systems in Bahrain are user-friendly and less complex.
H4: Buildings construction in Bahrain reduces CO2 emission, minimize construction and demolition waste, and prevent indoor air pollution.

11. Data Collection and Study Sample

Data was collected from the selected sample for the study; research tools, the survey was distributed within the project period to allow an appropriate analysis of the data. Beyond the data gathered from the survey, the study also includes as data source academic textbooks and notes, scientific journals, conference publications, governmental publications, newspapers, the Internet.

The study adopts a random sampling to choose the set of architects, contractors, and policy and decision makers from the Kingdom of Bahrain to answer the questionnaire. The list of engineers is extracted from the council for regulating the practice of engineering professions. The population size of engineers was extracted on June 2018; the population size was around 1,500 in private and governmental sector. An annual report from the Council for Regulating the Practice of Engineering Professions was used for extracting a sample based on the various sectors in the kingdom of Bahrain. According to the report, an available sampling size at 95% confidence interval for the population size of 1500 is 309 respondents.

Questionnaires used for this research contain questions in the theoretical framework appropriated for analysis with the help of statistical analysis. The questionnaire is based on five sections defined in conceptual framework: generate on-site renewable energy in construction, fossil-based energy consumption & buildings materials, building management systems, co^2 emission in the construction, and sustainable factors. The questionnaire exhibits 'criteria validity' as it revolves around finding the main research objective to evaluating the application level of sustainable buildings in construction. The questionnaire adopted the Likert 5-point scale, ranging from strongly disagree to strongly agree.

12. Analysis and Results

12.1 Reliability of Data:

The Reliability Test contributes to check the internal reliability of the questions under analysis. The Cronbach's alpha was used in measuring the internal consistency, especially because multiple Likert questions in the questionnaire used a 5-point scale and thus, the scale is determined if reliable. According to the reliability statistics output (Table 4.1), the Cronbach's Alpha is 0.912 suggesting a high level of internal consistency for the scale. Therefore, the scaling questions is pass the reliability test.

Table 1: Result of the reliability test

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	# of Items
.912	.916	23

12.2 Viability of Data:

In order to test the validity, all the questions in this survey confirmed. On top of that, the validity tested through a pilot test by distributing the survey to four neutral and experienced participants in the educational field. Adjustments made to the survey based on their comments to ensure the accuracy and clarity of the questions.

12.3 Testing of normality:

Table 4.2: Result of the normality test

	Questions	*Shapiro-Wilk*		
		Statistic	df	Sig.
1	Generate on-site renewable energy in construction	0.844	309	0.000
2	Fossil-based energy consumption & building materials	0.861	309	0.000
3	Building management systems	0.887	309	0.000
4	CO2 emission in the construction	0.883	309	0.000
5	Sustainable factors	0.830	309	0.000

Testing normality is used to identify the method that is used in the study and to determine whether it is parametric of non-parametric test. Table 4.2 summarize the results, as Shapiro- Wilk test is used. As shown in the table, all p-values are less than 5%. Based on these results, the parametric tests are used in this study.

12.4 Hypotheses Testing:

Table 4.3 shows the significant value of each question used in the test. At 95% level of confidence, the test is significant for "evaluate the level of sustainable buildings" by showing a mean significantly bigger than 3 ($p<0.05$, T-test > +1.96), with a standard deviation smaller that one. Overall, the results point out the building construction sector take into account the level of sustainability in the building.

Table 4.3: Hypotheses Testing

	Questions	*N*	*Mean*	*Std. Deviation*	*T-test*	*Sig. (2-tailed)*
1	Generate on-site renewable energy in construction	309	3.2597	0.082567	5.529	0.000
2	Fossil-based energy consumption & building materials	309	3.7961	0.076586	18.273	0.000
3	Building management systems	309	3.2597	0.74341	6.141	0.000
4	CO2 emission in the construction	309	3.2848	0.67003	7.472	0.000
5	Sustainable factors	309	3.9252	0.53635	30.324	0.000

12.5 Descriptive Analysis:

The questionnaire gathered information from participants through many statements; the following table summarizes the answer frequencies and percentage along.

Table 4.4: Frequency table for questioner answers

No.	***Question***		***Answers***				
			Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
	Generate on-site Renewable Energy in Construction						
1	Building construction is designed to use the renewable energy in Bahrain.	No. of responses	42	84	69	75	39
		(%)	13.6%	27.2%	22.3%	24.3%	12.6%
2	The wind energy is used in building construction in Bahrain.	No. of responses	60	108	63	63	15
		(%)	19.4%	35.0%	20.4%	20.4%	4.9%
3	The solar energy is used in building construction in Bahrain.	No. of responses	42	87	51	75	54
		(%)	13.6%	28.2%	16.5%	24.3%	17.5%
4	It is important now, to integrate renewable energy into buildings, particularly after the increasing price of fossil-fuel "Oil and gas".	No. of responses	3	3	15	108	180
		(%)	1%	1%	4.9%	35%	58.3%
	Fossil-based energy consumption & building materials						
1	The consumption of fossil-based energy "Oil and gas" is reduced in terms of energy embodied in materials, construction process, and energy used through the lifetime of the buildings.	No. of responses	3	24	117	108	57
		(%)	1%	7.8%	37.9%	35%	18.4%
2	With the industry's drive towards sustainability, the designers generally are paying more attention to materials used in the construction process, to ensure the most efficient products are used.	No. of responses	3	21	51	141	93
		(%)	1%	6.8%	16.5%	45.6%	30.1%
	Building management systems						
1	Designers are using the Building Management System "BMS" in Bahrain.	No. of responses	6	39	117	117	30
		(%)	1.9%	12.6%	37.9%	37.9%	9.7%
2	The Building Management Systems "BMS" in the Kingdom of Bahrain are user-friendly and less complex.	No. of responses	12	24	102	144	27

		(%)	3.9%	7.8%	33%	46.6 %	8.7%
3	It is easy to implement a project with the installation of solar and wind energy to generate power in building construction.	No. of responses	12	78	81	99	39
		(%)	3.9%	25.2%	26.2%	32%	12.6%
4	There is enough being done to apply a new sustainable construction industry.	No. of responses	21	108	81	78	21
		(%)	6.8%	35%	26.2%	25.2 %	6.8%
CO_2 emission in the construction							
1	The buildings in Bahrain reduce CO_2 emission, minimize construction and demolition waste, and prevent indoor air pollution.	No. of responses	18	102	78	81	30
		(%)	5.8%	33%	25.2%	26.2 %	9.7%
2	Around 52% of the Bahrain CO_2 emissions are created by the construction and usage of buildings and many personnel within the construction industry are aware of this fact.	No. of responses	21	78	99	96	15
		(%)	6.8%	25.2%	32%	31.1 %	4.9%
3	Sustainable construction methods can significantly reduce CO_2 emissions and waste, and that use of these methods generally results in increased capital costs.	No. of responses	6	12	75	153	63
		(%)	1.9%	3.9%	24.3%	49.5 %	20.4%

- **Generate on-site Renewable Energy in Construction**

1. Building construction is designed to use the renewable energy in Bahrain.

Concerning if building construction is designed to use the renewable energy in Bahrain, the respondents rated this factor on a scale of 1-5, whereby 1 represented a strong disagreement and 5 a strong agreement. According to the table 4.4, the majority of the respondents, 27.2% disagreed with this statement, 24.3% and 22.3% agreed or were neutral, respectively. Moreover, regarding the extreme options, 12.6% of the respondents agreed strongly and 13.6% disagreed strongly.

2. The wind energy is used in building construction in Bahrain

When the respondents confronted the statement of the wind energy usage in building construction in Bahrain, most of them disagreed (35%) or strongly disagreed (19.4%). However, 20.4% were neutral, 20.4% agreed, and 4.9% strongly agreed, thus suggesting that the majority of the sample do think that Bahrain building constructions make use of the wind energy (Table 4.4).

3. The solar energy is used in building construction in Bahrain.

We also observed the same pattern regarding the usage of solar energy. The relative proportion of respondents disagreed (28.2%) or strongly disagreed (13.6%) to the statement. However, when we take into account the total number of respondents we found that the majority of them remained neutral (16.5%), agreed (24.3%) or strongly agreed (17.5%) as shown in table 4.4.

4. It is important now, to integrate renewable energy into buildings, particularly after the increasing prices of fossil-fuel "Oil and gas"

Concerning the importance of integrating renewable energy in buildings, particularly after an increase of fossil-fuel prices, the majority of respondents (58.3%) strongly agreed or agreed (35%) on the need to integrate renewable energy into buildings. Only 4.9% of the respondents remained neutral, 1% disagreed and another 1% strongly disagreed (Table 4.4).

- **H1:** There are possibilities to generate on-site renewable energy within building construction in Bahrain.

As the above table (table 4.4) illustrate, there are no possibilities to generate on-site renewable energy within building construction in Bahrain. This result does not support H1, and therefore, H1 is rejected.

- **Fossil-based energy consumption & building materials**

1. The consumption of fossil-based energy "Oil and gas" is reduced in terms of energy embodied in materials, construction process, and energy used through the lifetime of the buildings

When confronted with the statement regarding the reduction of fossil-based energy consumption in the process of construction, energy embodied in the material, and maintenance of buildings construction, we report that 37.9% presented a neutral position to this statement, whereas 35% and 18.4% agreed and strongly agreed, respectively. Only a few minorities disagree (7.8%) or strongly disagree (1%) with the statement as shown in table 4.4.

2. With the industry's drive towards sustainability, the designers generally are paying more attention to materials used in the construction process, to ensure the most efficient products are used.

According to the table 4.4, the respondents agreed (45.6%) or strongly agreed (30.1%) with the statement that the industry drives towards sustainability and the designers are more concerned with developing new sustainable and more efficient materials to apply in the construction process. Part of the respondents remained neutral (16.5%) and only a few disagreed (6.8%) or strongly disagreed (1%) with this statement.

- **H2:** Fossil-based energy consumption are reduced in terms of energy embodied in materials, construction process, and energy used through the lifetime of the buildings in Bahrain.

As the above table (table 4.4) illustrate, Fossil-based energy consumption are not reduced in terms of energy embodied in materials, construction process, and energy used through the lifetime of the buildings in Bahrain. This result does not support H2, and thus H2 is rejected.

- **Building management systems**

1. Designers are using the Building Management System "BMS" in Bahrain

Concerning the building management systems, the issue of the designers being used to manage buildings in Bahrain, our results in table 4.4 shows that although 37.9% remained neutral to the issue, 37.9% of the respondents agreed and 9.7% strongly agreed with the statement. Only, 12.6% and 1.9% disagreed and strongly disagreed, respectively.

2. The Building Management Systems "BMS" in the Kingdom of Bahrain are user-friendly and less complex

Concerning the usability and complexity of the Building Management Systems "BMS" in the Kingdom of Bahrain, the majority of the respondents agreed (46.6%) or strongly agreed (8.7%) that the BMS consists of a user-friendly and less complex system. However, 33% remained neutral, and 7.8% and 3.9% respectively disagreed and strongly disagreed as revealed in table 4.4.

3. It is easy to implement a project with the installation of solar and wind energy to generate power in building construction

The third factor on building management systems discuss the reliability of using renewable energy sources to generate power for the building construction. Our results showed that 32% of the respondents agreed that it is easy to implement this kind of project and 12.6% strongly agreed. On the other hand, 26.2% remained neutral, 25.2% disagreed and 3.9% strongly disagreed, thus suggesting some difficulties in trying to implement new sources of energy in the building sector (Table 4.4).

4. There is enough being done to apply a new sustainable construction industry

This statement concerns about what is being done in order to foster new sustainable construction industry. The table 4.4 shows that 35% disagreed and 6.8% strongly disagree with the statement. Neutral answers corresponded to 26.2% of the respondents. We also observed that 25.2% agreed with the statement followed by a strong agreement of 6.8%. Therefore, according to the opinion of the professionals in the construction building sector, what is currently done in the sector might not foster a new sustainable construction industry.

- **H3:** The building management systems in Bahrain are user-friendly and less complex.

As the above table (table 4.4) illustrates, the building management systems in Bahrain are user-friendly and less complex. This result supports hypothesis 3, therefore H3 is accepted.

- **CO_2 emission in the construction**

The emission of carbon dioxide in the construction was one of the major concerns for the study. The following analysis shows that the buildings in Bahrain reduce CO2 emission, minimize construction and demolition waste, and prevent indoor air pollution. We also showed that many personnel in the construction industry are aware of the fact that nearly 52% of the Bahrain CO2 emissions originated from the construction. In fact, sustainable construction methods may significantly reduce CO2 emissions and waste, however, these methods generally result in increased capital costs, a new issue to this sub-factor.

1. The buildings in Bahrain reduce CO2 emission, minimize construction and demolition waste, and prevent indoor air pollution

According to the table 4.4, a major part of the respondents disagreed (33%) or strongly disagreed (5.8%) pointing to the issue of CO_2 emissions in the construction sector of Bahrain. However, 25.2% of the respondents remained neutral, 26.2% agreed and 9.7% strongly agreed with the statement. Therefore, we found a lack of consensus concerning the environmental problems.

2. Around 52% of the Bahrain CO_2 emissions are created by the construction and usage of buildings and many personnel within the construction industry are aware of this fact.

Concerning the awareness of the personnel in the construction industry, we found that 32% of the respondents were neutral, but a total of 36.0% agreed (31.1%) or strongly agreed (4.9%) that the personnel in the construction industry are aware of the fact the nearly 52% of Bahrain CO_2 emissions originated from the construction and usage of buildings. However, 25.2% of the respondents disagreed with the statement and 6.8% strongly disagree, thus revealing that many professionals in this field might not be aware of the contribution of the construction industry in the country CO_2 emissions.

3. Sustainable construction methods can significantly reduce CO_2 emissions and waste, and the use of these methods generally results in increased capital costs.

Our results in Table 4.4 demonstrated that 49.5% of the respondents agreed in the increased costs that sustainable method might bring to the building constructions. Moreover, 20.4% strongly agreed with the statement, thus composing the majority of answers (69.9%). Neutral answers corresponded to 24.3% of the interviewed sample and a small proportion disagreed (3.9%) or strongly disagreed (1.9%) with the statement.

- **H4:** Buildings construction in Bahrain reduces CO_2 emission, minimize construction and demolition waste, and prevent indoor air pollution.

As the above table (table 4.4), Buildings construction in Bahrain not reduces CO_2 emission, minimize construction and demolition waste, and prevent indoor air pollution. This result not support hypothesis 4, and we reject H4.

Table 4.5: Frequency table of sustainable factors

No.	***Factor***		***Answers***				
			Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Economic factors							
1	Ownership cos (Depreciation – insurance – license- registration and taxes – finance charges)	No. of responses	3	18	93	150	45
		(%)	1%	5.8%	30.1%	48.5 %	14.6%
2	Cost of equipment	No. of responses	6	15	66	162	69
		(%)	1.9%	4.9%	21.4%	52.4 %	19.4%
3	Operational cost in building	No. of responses	3	18	63	165	60

		(%)	1%	5.8%	20.4%	53.4 %	19.4%
Environmental factors							
1	Reduce building gases emissions	No. of responses	6	18	66	147	72
		(%)	1.9%	5.8%	21.4%	47.6 %	23.3%
2	Fossil fuel consumption	No. of responses	9	21	75	159	45
		(%)	2.9%	6.8%	24.3%	51.5 %	14.6%
3	Energy saving	No. of responses	0	15	36	132	126
		(%)	0%	4.9%	11.7%	42.7 %	40.8%
4	Noise control	No. of responses	0	18	42	147	102
		(%)	0%	5.8%	13.6%	47.6 %	33%
5	Vibration control	No. of responses	3	12	69	156	69
		(%)	1%	3.9%	22.3%	50.5 %	22.3%
6	Quality of equipment	No. of responses	0	6	48	162	93
		(%)	0%	1.9%	15.5%	52.4 %	30.1%
7	Oil/Lube leakage control	No. of responses	3	15	54	162	75
		(%)	1%	4.9%	17.5%	52.4 %	24.3%
8	Use of sustainable fuels	No. of responses	3	6	69	159	72
		(%)	1%	1.9%	22.3%	51.5 %	23.3%
9	Use of biodegradable lubricants and hydraulic oil	No. of responses	3	9	105	144	48
		(%)	1%	2.5%	34%	46.6 %	15.5%
10	Reduce pollution and waste	No. of responses	6	3	24	153	123
		(%)	1.9%	1%	7.8%	49.5 %	39.8%
Human and social factors							
1	Availability of local skilled engineers/ operator	No. of responses	0	30	45	147	87
		(%)	0%	9.7%	14.6%	47.6 %	28.2%
2	Availability of healthy environment	No. of responses	6	15	54	138	96
		(%)	1.9%	4.9%	17.5%	44.7 %	31.1%
3	Availability of operator view and comfort	No. of responses	0	18	69	168	54
		(%)	0%	5.8%	22.3%	54.4 %	17.5%
4	Availability of safety features	No. of responses	0	15	42	159	93
		(%)	0%	4.9%	13.6%	51.5 %	30.1%
5	Availability of operator proficiency	No. of responses	0	15	66	162	66
		(%)	0%	4.9%	21.4%	52.4 %	21.4%
6	Availability of training needs for operator	No. of responses	9	21	54	147	78
		(%)	2.9%	6.8%	17.5%	47.6 %	25.2%
7	Availability of relationship with dealer/ supplier	No. of responses	6	18	48	165	72
		(%)	1.9%	5.8%	15.5%	53.4 %	23.3%

o **Factors are importance in the selection of onsite equipment and in relation to the sustainable buildings.**

1. Economic factors

Some of the important factors in the selection of onsite equipment and in the relation to the sustainable buildings included: Ownership cost (Depreciation – insurance – license- registration and taxes – finance charges), Cost of equipment, and Operational cost in building.

- Ownership cost (Depreciation – insurance – license- registration and taxes – finance charges)

According to the table 4.5, 48.5% agreed and 14.6% strongly agreed that ownership cost (Depreciation – insurance – license- registration and taxes – finance charges) consists of one of the economic factors for selecting onsite equipment related to the sustainable buildings. A relevant proportion of respondents did choose the neutral option (30.1%) and only a small proportion disagreed (5.8%) or strongly disagreed (1%) with the statement.

- Cost of equipment

Concerning the economic impact of the equipment costs, we observed that, out of the 309 respondents, 52.4% agreed and 19.4% strongly agreed on the importance of costs in driving the selection of onsite equipment related to the sustainable buildings. Another relevant part (21.4%) remained neutral to the suggestion, but 4.9% and 1.9% disagreed and strongly disagreed, respectively, to the suggestion as shown in table 4.5.

- Operational cost in building

According to the table 4.5, 53.4% agreed on the importance of operational cost for the selection of onsite equipment related to more sustainable buildings, and more 19.4% strongly agreed on this. We also report a considerable proportion of neutral opinions (20.4%). On the other hand, only a small proportion of the respondents disagreed (5.8%) or strongly disagreed (1%) with this statement as proposed in the questionnaire.

2. Environmental factors

On environmental factors affecting the selection of onsite equipment and in the relation to the sustainable buildings, we reported the following issues:

- Reduce building gases emissions

According to the table 4.5, 47.6% and 23.3% agreed and strongly agreed on the significance of reducing the building gases emissions during the selection of onsite equipment for implementing more sustainable buildings. Neutral answer corresponded to 21.4% of the respondents, while 5.8% disagreed and 1.9% strongly disagreed with the need for reducing gases emissions.

- Fossil fuel consumption

We found a similar pattern regarding the fossil fuel consumption: 51.5% agreed and 14.6% strongly agreed that the selection of onsite equipment and the relation to the building sustainability. Another relevant proportion corresponded to the neutral answer (24.3%). Here, again, only a few respondents either disagreed (6.8%) or strongly disagreed (2.9%) regarding the fossil fuel consumption.

- Energy Saving

Energy saving is one of the major environmental factor considered in the selection of onsite equipment, and, consequently, relates to the building's sustainability. Our results showed (Table 4.5) that 42.7% agreed and 40.8% strongly agreed to this statement. A small proportion did choose a neutral answer (11.7%) and a diminished amount of respondents disagreed (4.9%). No respondent strongly disagreed (0%) with the statement.

- Noise control

Noise control is a major environmental concern for the respondents whereby 47.6% agreed and 33% strongly agreed on the importance of this environmental factor in the selection of onsite equipment and in the relation to the sustainable buildings. Others 13.6% remained neutral and 5.85% disagreed on the importance of noise control. Here again, no respondent strongly disagreed with the statement.

- Vibration control

According to the table 4.5, a total of 72.8% respondents considered vibration control important, 22.3% of which strongly supported this idea. Moreover, neutral answers corresponded to 22.3% of the sampling group. Finally, respondents who disagreed or strongly disagreed do not comprise a relevant proportion of the population corresponding to 3.9% and 1%, respectively.

- Quality of equipment

The large majority of the respondents (83.5%) also considered the importance of equipment's quality as a major environmental factor related to buildings sustainability. Table 4.5 shows that 52.4% and 30.1% are agreed and strongly agreed with the statement and 15.5% choose a neutral answer. However, 1.9% did disagree and no responded presented a strong disagreement regarding this factor.

- Oil/ lube leakage control

Respondents considered oil or lube leakage control a decisive factor in the selection of onsite equipment and in relation to the sustainable building. In total, 52.4% agreed with the proposed statement and 24.3% strongly agreed (Table 4.5). Neutral answers corresponded to 17.5% of respondents, and only a small proportion of the answer pointed to a disagreement (4.9% disagreed and 1.0% strongly disagreed).

- Use of sustainable fuels

Another important environmental factor refers to the use of sustainable fuels guiding the selection of onsite equipment and its relation to the sustainable buildings. Table 4.5 shows that 51.5% and 23.3% of the respondents agreed and strongly agreed with the statement, respectively. Another relevant proportion (22.3%) remained neutral. Interestingly, only a diminished part of respondents disagreed (1.9%) or strongly disagreed (1.0%). Thus, the large majority of sampled individuals understand the relevance of sustainable fuels for the construction of sustainable buildings.

- Use of biodegradable lubricants and hydraulic oil

According to the table 4.5, most of the respondents (46.6%) agreed that the use of biodegradable lubricants and hydraulic oil is one of the environment factors for selecting onsite equipment and in relation to the sustainable buildings, and 15.5% even strongly agreed with this statement. Neutral answers corresponded to 34.0% of the sampled population. We also highlight the small percentage of respondents that disagreed (2.9%) or strongly disagreed (1.0%) to the evaluated statement.

- Reduce pollution and waste

Regarding the importance of reduced pollution and waste, 49.5% of our respondents agreed and 39.8% strongly agreed that these environmental factors play an important in the selection of onsite equipment and in relation to the sustainable buildings. Interestingly, only 7.8% chose a neutral answer and an even small percentage disagreed (1%) or strongly disagreed (1.9%) to the statement.

3. Human and social factors

In order to check the importance of human factor in selecting onsite equipment and in the relation to the sustainable buildings, the following items investigate the opinion of our sampled population regarding this issues.

- Availability of local skilled engineers/ operator

According to the analysis of the human and social indicators, the availability of local and skilled engineers/operators consists of an important factor for 75.8% of the respondents (47.6% agreed and 28.2%

strongly agreed) in determining the selection of onsite equipment and in relation to the sustainable buildings. Neutral answers corresponded to 14.6%. However, 9.7% disagreed with the statement as shown in table 4.5

- Availability of a healthy environment

The respondents rated the importance of an available healthy environment: 44.7% agreed and 31.1% strongly agreed on that human factor as an important element in determining the selection of onsite equipment and in the relation to the sustainable buildings; neutral answer comprised 17.5% of the individuals; and those who disagree and strongly disagree corresponded to 4.9% and 1.9%, respectively (Table 4.5).

- Availability of operator view and comfort

Our results also revealed that the majority of respondents agreed (54.4%) or strongly agreed (17.5%) on the importance of operator comfort (Table 4.5). Another relevant proportion of responded chose a neutral answer (22.3%), but only a small part of them (5.8%) disagreed with the statement. For this factor, no respondent strongly disagreed.

- Availability of safety features

Similarly to the others social indicators, the majority of respondents agreed (51.5%) and strongly agreed (30.1%) on the importance of available safety features in sustainable buildings. The neutral answer also corresponded to a relevant proportion of the respondents' opinion (13.6%). Once again a small fraction of the respondents disagreed (4.9%) with no strong disagreement regarding the statement (Table 4.5).

- Availability of operator proficiency

According to the table 4.5, when asked about the importance of available operator proficiency the large majority of responded agreed (52.4%) or even strongly agreed (21.4%), while other showed a neutral opinion (21.4%). Interestingly, a small proportion (4.9%) of the respondents disagreed, thus considering the operator proficiency less significant for the selection of onsite equipment and in the relation to the sustainable buildings.

- Availability of training needs for operator

Availability of training needs for the operator is a major social and human concern. Therefore, a large proportion of our respondents agreed (47.6%) or strongly agreed (25.2%) that the selection of onsite equipment and in the relation to the sustainable buildings should take into account the operator training needs. Neutral answer corresponded to 17.5% of the sampled individuals. Finally, the rest of respondents disagreed (6.8%) or strongly disagreed (2.9%) with the statement, but these individuals corresponded to no more than 9.7% of the total interviewed sample (Table 4.5).

- Availability of relationship with dealer/ supplier

Our questionnaire also determined how important our sampled individuals consider the availability of relationship with dealer/supplier regarding the onsite equipment and relating to the sustainable buildings. The Table 4.5 shows that those who agreed and strongly agreed accounted, respectively, for 53.4% and 23.3% of the total sampled population. Neutral answer composed 15.5% of the remained individuals. Once again, no more than 7.7% of respondents disagreed (5.8%) or strongly disagreed (1.9%) the statement that availability of relationship with dealer/supplier consists of an important selection of onsite equipment and in the relation to the sustainable buildings.

Conclusion

Building and constructions, as well as their sustainability, constitute the major pillars of substantial growth and development of a region. We analyzed the key issues that included (i) the generation of an on-site renewable energy in construction, (ii) fossil-based energy consumption and building materials, (iii) building management systems, (iv) CO2 emissions in the construction, and (v) important factors in the selection of onsite equipment and in relation to the sustainable buildings (economic, environmental, and human factors).

The findings in chapter 4 revealed that, in the kingdom of Bahrain, most of the designs adopted in building constructions do not use renewable energy. The use of wind energy and/or solar energy in building construction was weakly supported and used. Finally, we suggest the importance of integrating renewable energy in buildings, particularly after the increases in fossil fuel prices (oil and gas).

Concerning fossil-based energy consumption & building materials, we observed a lack of consensus on this reduction in terms of energy embodied in materials, construction process, and energy used through the lifetime of the buildings. However, with the industry moving towards sustainability, the designers, in general, start to pay more attention to materials used in the construction process, in order to ensure the selection of the most efficient products.

Moreover, regarding the building management systems (BMS), the designer generally used BMS in Bahrain mainly due to its characteristics of less complexity and user-friendly. BMS facilitates to implement a project with the installation of solar and wind energy to power the building construction and there is enough being done to apply a new sustainable construction industry. Finally, the sustainable factors (environment, economic and social factors) concerns the majority of personnel involved in building constructions and their sustainability in the Kingdom of Bahrain.

Recommendation for future

The Kingdom of Bahrain should start to promote more sustainable buildings in order to generate more clean energy, reduce CO2 emission and onsite waste and use solar panels in the complex buildings and other buildings to generate significant energy. In addition, they should facilitate the adoption of methods that use renewable energy sources in buildings. Further, they should use HVAC system and natural materials to help reduce the energy consumption for heating in the building.

References

1. Ahmed, R. (2013). Promoting Sustainable and Green Construction. Almohandis Magazine, Issue 57, p. 16 .[Retrieved from 21/9/2017]
2. Akbari, K. (2013) . What is the impact of buildings on our environment? Almohandis Magazine, Issue 57, p. 21. [Retrieved from 21/9/2017]
3. Al Motawa, M. (2016). Green, sustainable buildings support national economy. Bahrain News Agency [Online]. [Retrieved from 4/9/2017]. Available at: http://www.bna.bh/portal/en/news/727038.
4. Al Murbati,J. (2014). Bahrain unit for sustainable energy. UNDP in the Kingdom of Bahrain. [Online]. [Retrieved from 4/9/2017] Available at:
5. Al Naser, N and Flanagan, R (2007). The need of sustainable buildings construction in the kingdom of Bahrain. Building and Environment, 42 (1), 495-506.[Online]. [Retrieved from 15/9/2017] Available at: http://www.sciencedirect.com/science/article/pii/S0360132305003616
6. Al Raees, A. (2015). Sustainability, Fairness and Competitiveness. The Real Estate Market and the 2030 Economic Vision of Bahrain. [Online]. [Retrieved from 13/9/2017]. Available at: http://www.grin.com/en/e-book/343202/sustainability-fairness-and-competitiveness-the-real-estate-market-and
7. Alnaser, N.W. (2008) Towards Sustainable Buildings in Bahrain, Kuwait and United Arab Emirates. The Open Construction and Building Technology Journal, Vol 2, pp 7-21.
8. AlOrrayedh, E. (2014). Interviewed by M. Al-Saffar for Dissertation. British University in Dubai. [Retrieved from 21/9/2017]
9. Alrashed, F and Asif, M (2015). Analysis of critical climate related factors for the application of zero- energy homes in Saudi Arabia. Renewable and Sustainable Energy Reviews Vol. 41, 1395-1403 [Online]. [Retrieved from 15/9/2017]. Available at: http://www.sciencedirect.com/science/article/pii/S1364032114008041
10. Bergman, D. (2012). Sustainable Design: A Critical Guide. Architecture Breiefs. Princeton Architectural Press.
11. Brown, B. J., Hanson, M. E., Liverman, D. M., & Merideth, R. W. (1987). Global sustainability: toward definition. Environmental management, 11(6), 713-719. [Online]. [Retrieved from 9/9/2017]. Available at:
12. Chan, H & Riiat, S - Zhu, J . (2010). Review of passive solar heating and cooling technologies. Renewable and sustainable energy reviews [Online]. 14(2), 781-789. [Retrieved from 12/9/2017] Available at:
13. Cooke, P. and Lazzeretti, L. (2008). Creative Cities, Cultural Clusters and Local Economic Development. UK: Edward Elgar Publishing Limited, 39(4), 677-686 [Online]. [Retrieved from 15/9/2017]. Available at:
14. Creswell, J. W (1994), Research design: qualitative and quantitative approaches, age Publications, Thousand Oaks.
15. Dear, R., Nicol, F., Roaf, S. (2013). The wicked problem of designing for comfort in a rapidly changing world. Architectural Science Review, 56(1). [Retrieved from 10/9/2017].Available at: http://www.tandfonline.com/doi/abs/10.1080/00038628.2012.753783
16. Elain, NGL. M. (2013). Impact of green buildings on value of property. Bartlett school of graduate studies. Retrieved from:
17. Elgendy, K. (2014). Two trends of energy and carbon emissions in the Arab world [Online]. [Retrieved from 19/9/2017]. Available at: http://www.carboun.com/category/carbon-emissions/
18. Ferreira, J.F (2016). Sustainability indicators in construction companies. Instituto Superior Técnico, Lisboa, Portugal. [Online]. [Retrieved from 15/9/2017]. Available at:

https://fenix.tecnico.ulisboa.pt/downloadFile/281870113703376/Extended%20Abstract%20-%20Jose%20Fernando%20de%20Carvalho%20Ferreira.pdf
19. GORD (2013). Gulf Organisation for Research & Development: (GSAS) Global Sustainablity Assessment System. [Online]. [Retrieved from 19/9/2017]. Available at: http://www.gord.qa/uploads/formsnew/GSAS_Overview_07_for_web.pdf
20. Hegger, M. (2008). Energy Manual (Construction Manuals). Switzerland: Birkhäuser GmbH.
21. Hernandez (2011). Control of Indoor Environments: General Principles [Online]. [Retrieved from 21/9/2017]. Available at: http://www.iloencyclopaedia.org/part-vi-16255/indoor-environmental-control/45/control-of-indoor-environments-general-principles
22. Herzog, T. (2008). Energy Manual (Construction Manuals). Switzerland: Birkhäuser GmbH.
23. Horn, R. (2009). Research & writing dissertation: A complete Guide for business and management students. The chartered institute of personnel and development. London. UK.
24. Houghoton, J. (2009). Global warming, climate change and sustainability [Online]. [Retrieved from 8/9/2017]. Available at:
25. http://onlinelibrary.wiley.com/doi/10.1111/j.1468-2257.2008.00451.x/abstract
26. http://www.bh.undp.org/content/bahrain/en/home/presscenter/pressreleases/2014/11/Bahrain-Unit-for-Sustainable-Energy.html
27. http://www.jri.org.uk/brief/Briefing_14_3rd_edition.pdf
28. http://www.sciencedirect.com/science/article/pii/S0360132307002090
29. http://www.sciencedirect.com/science/article/pii/S0360544208003216
30. http://www.sciencedirect.com/science/article/pii/S1364032109002615
31. http://www.tandfonline.com/doi/full/10.1080/01944360802380290?scroll=top&needAccess=true
32. http://www.ucl.ac.uk/Bartlett/environmental-design/programmes/postgraduate/mscdiploma-facility-environmrnt-management/documents/Elaine_L_M_Ng_82161_assignsubmission_file_FEM-Dissertation-ENg-Submission-1Sep13.pdf
33. https://books.google.com.bh/books?hl=en&lr=&id=qB3v3gYofSUC&oi=fnd&pg=PR9&dq=Lyle,+J.(1994).+Regenerative+Design+for+sustainable+development.+New+york:+wiley.&ots=Dc9egmcIbi&sig=HPBP--3rWaOvuxEwUeaRdPw-1fk&redir_esc=y#v=onepage&q&f=false.
34. https://link.springer.com/article/10.1007/BF01867238
35. https://www.informedesign.org/_news/sustain01_06.pdf
36. https://www.researchgate.net/publication/237533815_A_Comparative_Evaluation_of_the_Importance_of_Thermal_Mass_of_Traditional_Architecture_in_Hot_and_Dry_Region_in_Turkey?ev=prf_high
37. Isarangkun, C. and Pootrakool, P. (2002) Sustainable economic development through the sufficiency economy philosophy. [Retrieved from 8/9/2017]. Available at: http://v-reform.org/wp-content/uploads/2012/06/SUSTAINABLE-ECONOMIC-DEVELOPMENT.pdf
38. Kallet, R. H. (2004). How to write the methods section of a research paper. Respiratory care, 49(10), 1229-1232.
39. Kang, M. (2013). Defining Sustainable Design. Implications: A Newsletter by Informed Design. Vol. 1(6). [Online]. [Retrieved from 14/9/2017]Available at:
40. Lyle, J. (1994). Regenerative Design for sustainable development. New York: Wiley. [Online]. [Retrieved from 6/9/2017] .Available at:
41. Mahajan, B. (2012). Building Construction & Climate Change: An Indian Perspective. Introduction to climate change. [Online]. [Retrieved from 18/9/2017] Available at: https://www.academia.edu/2319654/Building_Construction_and_Climate_Change
42. Malhorta. N. K. (2007) Marketing research: An Applied orientation (5th ed). Pearson education LTD. New Jersey, USA.
43. Manioglu, G & Yilmaz, Y. (2007).A Comparative Evaluation of the Importance of Thermal Mass of Traditional Architecture in Hot and Dry Region in Turkey. [Online]. [Retrieved from 15/9/2017]. Available at:
44. Mazria, E. (2003). It's the Architecture, Stupid!: Who really holds the key to the global thermostat?. Solar Today. pp. 48 – 51 [Online]. [Retrieved from 17/9/2017]. Available at: http://www.mazria.com/publications.html
45. McLennan, J. (2004). The Phhilosophy of Sustainable Design. Kansas City, Missouri. Jason F. McLennan
46. Ochoa, C. E and Capeluto, I. G. (2008). Strategic decision-making for intelligent buildings: Comparative impact of passive design strategies and active features in hot climate. Building and Environment, 43(11), 1829-1839. [Online]. [Retrieved from 20/9/2017]. Available at:
47. Radhi, H. (2009 a). Evaluating the potential impact of global warming on the UAE residential buildings - A contribution to reduce the CO2 emissions. Building and Environment Journal. 44(12), 2451-2462. [Retrieved from 16/9/2017]. Available at: http://www.sciencedirect.com/science/article/pii/S0360132309001024
48. Radhi, H. (2009 b). Can envelop codes reduce electricity and CO2 emissions in different types of buildings in the hot climate of Bahrain. Energy Journal. 34(2), 205-215. [Retrieved from 9/9/2017]. Available at:
49. Ralegoankar, R. V. & Gupta, R. (2010). Review of intelligent building construction: A passive solar architecture approach. Renewable and sustainable energy reviews. 14(8), 2238-2242. [Online]. [Retrieved from 16/9/2017]. Available at: http://www.sciencedirect.com/science/article/pii/S1364032110001279
50. Retzlaff, R.C (2008). Green Building Assessment Systems: A Framework and Comparison for Planners. Journal of the American Planning .74(4), 505-519. [Online]. [Retrieved from 11/9/2017]. Available at:
51. Ruiz, M.C. & Romero, E. (2011). Energy saving in the conventional design of a Spanish house using thermal simulation. Energy and buildings Journal. 43(11), 3226-3235. [Online]. [Retrieved from 13/9/2017] Available at: http://www.sciencedirect.com/science/article/pii/S0378778811003720
52. Schucking, H. (2013). Banking in Coal: urgewald, BankTrack, CEE Bankwatch Network and Polska Zielona Siec. [Online]. [Retrieved from 17/9/2017] Available at:

https://www.banktrack.org/download/banking_on_coal/banking_on_coal_updated.pdf
53. Shaka, H. (2013). Sustainability in Qatar: QSAS/GSAS and beyond. [Online]. [Retrieved from 20/9/2017]. Available at: http://www.ice.org.uk/ice_web_portal/media/middleeasst/arup-sustainabilitypresentation.pdf
54. Stevanovic, S. (2013). Optimization of passive solar design strategies: A review. Renewable and Sustainable Energy Review. Vol. 25. pp 177-196. [Online]. [Retrieved from 11/9/2017]. Available at: http://www.sciencedirect.com/science/article/pii/S1364032113002803
55. Yin, R. (2003), Case study research, design and methods, 3rd ed., vol. 5, Sage Publications, Thousand Oaks.
56. Yin, R. K (1994), Case Study Research: Design and Methods, Sage Publications, London.
57. Zikmund, W. G, Babin, B. J and Griffin, M (2012), Business research methods, 9th ed., South-Western College Publishing.