

**ANALYZING LIBRARY BUILDINGS ACCORDING
TO PALESTINIAN HIGHER GREEN BUILDING
COUNCIL AS ONE OF THE FACTORS OF
SUSTAINABILITY**

**A THESIS SUBMITTED TO THE
INSTITUTE OF GRADUATE STUDIES
NEAR EAST UNIVERSITY**

**By
LAYTH M.A. ARAFA**

**In Partial Fulfilment of the Requirements for
the Degree of Master of Science
in
Architecture**

NICOSIA, 2021

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ANALYZING LIBRARIES ACCORDING TO PHGBC AS A FACTOR

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FACTORS OF SUSTAINABILITY**

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that I have fully cited and referenced all material and results that are not original to this work, as required by these rules and conduct.

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To all that supported me...

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ABSTRACT

Sustainable buildings have seen a considerable amount of attention in recent time, which is due to the impending threat facing the environment and its resources. More and more projects are being built with sustainability in mind and certification bodies have been operating as authorities to ensure standards and best practices are followed to ensure sustainable buildings are designed and constructed with sustainability best practices. Socio-cultural buildings and public buildings are very good buildings which the advocacy of sustainable architecture and sustainable living can be used to communicate the importance of sustainability to a society, and one of such buildings are libraries, these thesis focuses in analyzing the performance of libraries with respect to the Palestinian Higher Green Building Council (PHGBC) checklist of sustainability certification. Two libraries were evaluated as case studies on the bases of the PHGBC checklist, the checklist includes the following points of evaluation: site sustainability, indoor environmental quality, energy consumption, materials and resources.

Keywords: Sustainable architecture; sustainable libraries; AMQF library; Near East University grand library; Palestinian Higher Green Building Council

ÖZET

Sürdürülebilir bina, son zamanlarda, çevrenin ve kaynaklarının karşı karşıya olduğu tehdit nedeniyle önemli miktarda ilgi görmüştür . Sürdürülebilirlik göz önünde bulundurularak giderek daha fazla proje inşa edilmektedir. Sürdürülebilir binaların sürdürülebilirliğinin en iyi uygulamalarıyla tasarlanmasını ve inşa edilmesini sağlamak , standartların ve en iyi uygulamaların izlenmesini sağlamak için sertifika yetkili kuruluşları olarak faaliyet gösteriyor. Sosyo-kültürel binalar ve kamu binaları, sürdürülebilir mimarinin ve sürdürülebilir yaşamın savunuculuğunun bir topluma sürdürülebilirliğinin önemini anlatmak için kullanılabilen çok iyi yapılardır, ve bu binalardan biri kütüphanelerdir, bu tez kütüphanelerin performansını analiz etmeye odaklanır. Filistin Yüksek Yeşil Bina Konseyi (PHGBC) sürdürülebilirlik sertifikası kontrol listesi alan İki kütüphane, PHGBC kontrol listesi temelinde vaka çalışmaları olarak değerlendirildi, kontrol listesi aşağıdaki değerlendirme noktalarını içerir: site sürdürülebilirliği, iç mekan çevre kalitesi, enerji tüketimi, malzemeler ve kaynaklar.

Anahtar Kelimeler: Sürdürülebilir mimari; sürdürülebilir kütüphaneler; AMQF kütüphanesi; Yakın Doğu Üniversitesi Büyük Kütüphanesi; Palestinian Higher Green Building Council

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LIST OF ABBREVIATIONS

AMQF:	Abdel Mohsen Al-Qattan Foundation
ASHRAE:	American Society of Heating, Refrigerating and Air-conditioning Engineers
BREEAM:	Building Research Establishment Environmental Assessment Method
ENSULIB:	Environment, Sustainability and Libraries Section
GECA:	Good Environmental Choice Australia
IEQ:	Indoor Environment Quality
IFLA:	International Federation of Library Associations and Institutions
ISO:	International Standard Organization
Kw:	Kilowatts
LEED:	Leadership in Energy and Environmental Buildings
NCU:	North Carolina University
NEU:	Near East University
ROI:	Return of Investment
UK:	United Kingdom
PHGBC:	Palestinian Higher Green Building Council
PV:	Photo Voltic
UNDP:	United Nations Development Program

CHAPTER 1

INTRODUCTION

1.1 Introduction

Sustainability has been a very popular term in recent times. Some have argued there is no universal definition for the term; sustainability. Sustainability can be referred to as a concept which is multi-faceted depending on the context or perspective it is viewed from. Basically, sustainability is a term which refers to the following: to keep up, to hold up, to support etc. there is a universally accepted definition of *sustainable development* which was defined in the Brundtland report (Keeble, 1988). The recent wave of environmental consciousness which has been realized by the knowledge of our very own contribution to the destruction of our planet by our ways of life which is as a result of our natural resources consumption has been helpful, the world over there have been efforts and measures put in place in attempts to remedy the damages we have done and limit further damage to the planet. And the architectural and construction industry is no exception to this movement of sustainability and sustainable development. Sustainability has seen a rise of a *movement*, this movement exists and is being driven by people who are conscious of the negative effects the traditional methods of living and industrialization is taking its toll on the planet, and are seeking ways to proffer solutions to said problems. In the past people have risen in innovations, activism, and research with regards to sustainability, people have endeavored to create whole systems to cater to sustainability, challenging traditional and conventional methods of living, challenging technologies to be better, in an attempt to better lives of people and the planet itself. Sustainability as a movement is driving us humans towards making decisions while giving equal weight to both the present and the future, considering the effects of our decisions in both short and long term; both its benefits and negativity. The importance of sustainability is not just reflected by the current state of the planet but also can be seen through history, where previous civilizations were lost in their entirety because of the lack of sustainable systems they put in place for the development of their societies (Schaltegger, 2018).

As people grow in being conscious and contributing towards sustainability, the architectural and construction discipline and industry has also seen a wide adaptation in response to the concept of sustainability. Architecture uses factors in the impacts structures and building have on both the social and environmental facets of things, sustainable architecture considers its design and development through the utilization of all factors involved in a building or structure; materials, design, spaces etc. Sustainable architecture is basically a philosophy which is driven to ensure a structure limits its negative effects in the present and the future, and at best contribute to the development and sustenance of the present and the future, sustainable architecture is moved towards limiting all detrimental decisions involved in the implementation of buildings on the ecosystem, the community and the planet as a whole. Sustainable architecture is an adaptive concept, it factors into a buildings design and implementation the ecological condition of the location and the available natural resources. Sustainable architecture has been adapted at very large scales the world over in all kinds of buildings, residential buildings, office complexes, libraries, schools, even mega structures have been adapted to be sustainable (Attia, 2018).

Sustainable libraries which are otherwise known as *green libraries* are those libraries that have been designed and built to conform with sustainability standards of architecture, besides the implementation of library buildings to go green and provide sustainability to the society and the environment, libraries are also symbols of examples to the society which include all stake holders and also educators. The International Federation of Library Associations and institutions (IFLA) have acknowledged this movement in libraries and has made significant endeavors to promote sustainability in libraries the world over and in other institutions as well, through leading by example in their sensitization of the sustainability subject. The IFLA has promoted the use of the LEED standards of sustainability by libraries that have gone green, like every other green and sustainable building project they conform to the basic demands of sustainability in a building which consist of environmentally friendly materials in building, energy efficiency, efficient use of space, and sustainable waste management. Green libraries further expand the requirements of a sustainable building with more aspects of sustainability, these include sustainable and green information services, the promotion and sensitization of people towards the sustainable movement, and engaging communities in the sustainable movement. These

factors make libraries very important factors in sustainability in architecture and sustainability at large (Pinto and Ochôa, 2018).

1.2 Aim of The Study

Architecture as a discipline and industry is a primary player in the promotion of sustainability which is necessary for our societies at this very moment due to the rising threats to the planet, and libraries have been identified to be of paramount importance in their own niche to contribute to sustainability especially when done correctly.

Palestine has a harsh climate which requires a lot of energy when using conventional methods of regulating the atmospheric temperatures within built spaces, this study will look into the effects sustainable building impacts on such factors within the context of sustainably designed and built libraries. This study is also proposed in an attempt to study the adaptability of sustainable architecture in that region of the world regarding the natural offerings of the ecosystem for designers and architects to work with to achieve sustainability, and the economic and social viability of the green and sustainable architecture in that region (Sabboubeh and Ferrell, 2017), Cyprus is a Mediterranean country which has a typical climate like other countries in this region, the Mediterranean climate is classified and characterized as a climate with dry and hot summers, with wet and cold winters, this climate type is very similar to the climate of Palestine as it is also a Mediterranean country (Yazıcı et al. 2017).

1.3 Significance of The Study

Sustainability has a reputation that is almost “misunderstood” in its simplicity, this research aims to shed light in that regard in the context of its adaptation in libraries. This study is researching sustainability in libraries in a particular region of the world; Palestine and North Cyprus. The study is driven towards assessing architectural designs and how they are evolving towards sustainability.

1.4 Research Question

Our main research question is the contribution of sustainability in library in not just the sustenance of the environment and the planet but also the efficiency of the library as a functional building adapted towards sustainability, the implementation of sustainable design in the development of libraries as a very good example of showcasing the advantages of sustainable building and the impact it has on the environment.

1.5 Methodology

This study proposed the use of qualitative research which was intended with the scope of reviewing sustainability and green buildings with regards to libraries in architecture, this will cover the methods and approaches that are been designed and implemented to achieve sustainability while focusing on the chosen case study for our analysis. The review of the case study will be done using certified standards of grading sustainable buildings to ensure proper evaluation of the case studies to enable us shed light on the aims and objectives of the study and achieve the significance of the study.

This study also chose the use of the indigenous green and sustainable building certification authority of Palestine named the Palestinian Higher Green Building Council (PHGBC), this was chosen because it is a professional body which uses the internationally recognized best practices of certification of green and sustainable buildings and the authority of green and sustainable buildings in Palestine where our primary case study is situated.

1.5.1 Palestinian Higher Green Building Council (PHGBC) Standards

The Palestinian Higher Council for Building Council (PHGBC) is an initiative of the guild of engineers in Palestine towards ensuring standardization and promotion of sustainable building in Palestine. PHGBC was set up with the primary goal of tailoring the generic sustainable building standards to suit the Palestinian context of construction, not only does the PHGBC give guidelines and ensures standards are appropriately followed with regards to sustainable buildings in Palestine but they also offer sensitization of the people towards the importance and

advantages of embracing sustainable construction and buildings, and how it can move Palestine further and strengthen their economy and general welfare of the people.

PHGBC has an outlined grading system for sustainable buildings in order to evaluate the performance of constructed buildings in light of sustainability, our research will follow this grading system factors to evaluate the performance of our case studies. The factors evaluated by PHGBC in their scoring and evaluation sheet when grading a building are site sustainability, indoor environment quality, energy use efficiency, materials and resources, and finally innovative new technologies and integrated building design. Table 1.1 below shows the factors and their allocated percentage in the grading of a sustainable building by PHGBC (PHGBC, 2013)

Table 1 1: Palestinian High Green Building Council evaluation system

Factors	Points (%)
Site sustainability	15
Indoor environment quality	15
Energy use efficiency	30
Water use efficiency	25
Material and resources	10
Innovative new technology and integrated building design	5

a. Site sustainability

The grading of the site sustainability by the PHGBC follows standards and comprehensive evaluation of other sub factors within site sustainability as a bigger umbrella, the construction of a building to conform with sustainability standards has to start right in following the required best practices of site sustainability. Site sustainability has to follow best practices in ensuring the following are done appropriately; best practices in the selection of a site and ensuring the best use of it, providing adequate building accessibility, building responsibly, taking measures to ensure outdoor thermal comfort is considered, and lastly making sure the construction process of the building leaves little to no carbon footprint on the environment’s ecosystem.

b. Indoor environment quality

Achieving a sustainable building goes beyond using the best materials and ensuring the environment is not disrupted or at least disrupted in the barest minimum way, when all is said and done in the design and construction of a building or structure the primary goal of every building is to provide function to inhabitants or users of the building, as such the health and welfare of the people using the building is of utmost priority, hence the need for evaluation of indoor environment quality. Indoor environment quality needs to ensure there is appropriate indoor air quality which conforms to health standards set by the responsible bodies to that regard, pollution such as cigarette smoking which is detrimental to the smoker and the third parties should be properly curbed by placing appropriate measures, and materials used especially in the interior of the building such as adhesives, paints/coatings need to be selected with health consciousness as there are some with harmful chemicals in them. Pollution of any form is to be checked and ensured that it is eliminated, the pollution types include noise pollution, and the overall safety of the building is also evaluated in this section.

c. Energy use efficiency

Energy use efficiency hold the highest points in the evaluation grading system of the PGBHC sheet due to its importance in the aspect of sustainability, energy is a resource and commodity which its production takes a huge toll on the environment, as such its use is a significant aspect in any building, and sustainability highly recommends and needs energy is used efficiently to cut down on its production need which will be better for the environment. The energy efficiency use evaluation and grading of a building gives more point to buildings which are not just consumers of energy but also energy generators if possible, but the noteworthy factor is the energy generation is preferable when it is done in a sustainable way that does not harm the environment such as solar energy and wind energy generation. Appliances used in buildings are evaluated based on how much energy they consume, and how much of such fittings and appliances a building needs to function properly and efficiently.

d. Water use efficiency

Water use efficiency of a building is the second highest point factor on the PGBHC sustainable building grading and evaluation sheet, water is a resource which also needs to be used efficiently

without waste, a proper sustainable building needs to be able to efficiently manage its water use through techniques of consumption minimization and recycling and reuse of water. This grading factor check a building's amenities with regards to characteristics such as harvesting and usage of rain water, recycling and reuse of gray water produced in and around the building. The evaluation of water use efficiency by the PGBHC follows and adheres to some very important world-renowned international standards such as the ASHRAE green guide, international green construction code, international plumbing code 2012, and NSF international.

e. Materials and resources

The evaluation and grading of materials and resources by the PGBHC follows a strict adherence to its code like all other factors on the scoring sheet, the evaluation of sustainable buildings by the PGBHC has a mandatory requirement of two factors which are the proper construction of a building using the required waste management protocols, and the total elimination of hazardous materials during the construction and management of the building, when this two are checked and found satisfying then other factors are checked and allocated points accordingly.

f. Innovation, new technologies and building integrated design

This aspect of the grading and evaluation of sustainable buildings by the PGBHC is one which evaluates a building based on the innovation and the creativity which the designers and builders of the building took on as the approach to achieve the required result of sustainability. Innovation in design is highly.

CHAPTER 2

LITERATURE REVIEW

2.1 Green/Sustainable Buildings

It is very important to understand what the general definition of sustainable architecture in order to efficiently discuss what sustainable library should be or are, over the years there have been several interpretations of the term sustainable building, all the interpretations settle over some common design elements in their definition consideration, other factors playing into the definition of what sustainable building is are factors such as selection of site, the conservation of water and other energy sources, the reduction of waste in the building, the quality of the indoor environment, and lastly the design innovation of the building (Andriamirado, 2018). The general definition of a sustainable building otherwise known as green building are the use or the practice that involves the building of structures with environmental responsibilities by being resource efficient, these factors are considered during the entire life cycle of the structure which include the construction, maintenance, the operations within the structure, and even the deconstruction of the structure at the end of its life cycle. This definition applies to any kind of structure that is intended to be sustainable, be it a residential complex, a commercial complex, library or any other structure (Awadh, 2017).

The world has reached a tipping point regarding the awareness of the world's consumption, there is an alarming rate of human consumption of the world's resources, these alarming consumptions entail the use of unhealthy products, which are often produced through unhealthy process that damage the human health and the global conditions generally. These kinds of consumptions eventually take their toll on the economy, the people and the world because of their unsustainable characteristics. The jeopardization of the global health through the unsustainable ways of consumption of humans is shown in reports that seem to show it growing at an alarming rate (Lakatos et al. 2018). The very ecosystem that is needed to sustain life on earth is in jeopardy and needs conscious decisions to be made in order to avert the resource dilapidation, the decisions to be taken need to reflect an effort towards embracing sustainable

living, and in the context of architecture this means being involved in sustainable buildings and architecture, this is necessary because the ultimate fate of the world rests in these decisions which if not taken will result into an irreversible stage in the world's ecology. Green building and architecture have the general goal of producing structures that will lead to minimal or zero damage to the world's ecosystem, these can only be achieved if the structure or building is intended with such purpose and start its contribution towards sustainability from the stages of conceptualization and design process to the construction stages, and the general structure maintenance will benefit from the sustainable concept and design of the building. Doing so will ensure the building consumes less in natural resources or rather in wasting natural resources which means damaging the earth's health to source such resources, the building will reduce pollution during its life cycle, the building may generate its own energy through sustainable means, all these eventually mean there will be less or no environmental degradation because of the construction or the maintenance of the structure or building, in some cases the sustainable building actually contributes to the sustainable ecosystem of the earth by giving more beyond what it needs from its own sustainable design (Alvarado and Toledo, 2017). A green or sustainable building is a building which beyond the sustainability if the ecosystem also factors in the health wellbeing of the occupants of the structure itself, these health factors are addressed through aspects such as lighting quality in the building, air flow quality in the building, and other factors that may enhance healthy living for the dwellers and occupants of the structure. Cost effective structures and buildings are developed when sustainable factors are considered in the design and construction of a building and its entire life cycle up till the point of demolishing the building, such sustainable design aspects have also been argued to extend the life cycle of a building besides just being environmentally conscious and protective. Sustainable building is a key factor that contribute to humanity in so many aspects, they do not only contribute to an economy like any other building but they also have a long-term effect and impact on the economy and health of the people and the global ecosystem. Following these aspect of building; green and sustainable building will help the society and the world design and build sustainable libraries that will proffer healthy library operations, flexible library structures that will seamlessly fit into the natural conditions of their locality without disrupting the natural

ecosystem of the surrounding, this will not only affect the general well-being of the planet but will also impact on the enrichment of library traditions in a society by adding continuity of quality living (Doan et al., 2017).

2.1.1 Green and sustainable buildings in Palestine

It has been estimated that the population will reach 9 billion in the year 2050, this rise in population will have a direct influence on the demand of resources; water and other natural resources. The rise in population which implies the surge in natural resource demand means the ecosystem will experience a more exhaustive exploration by the human race which will inevitably worsen the ecosystem eventually. The United Nations has for the past 20 years sounded alarm on the state of the global ecosystem with the intention of setting up measures that will ensure the healing of the ecosystem and providing sustainable alternatives to natural resources usage around the world. This called to the definition of sustainability in 1987 by the Portland committee which defined sustainability as the meeting of the current demands and needs of humans without jeopardizing the demands and the needs of the future human generations (Meiboudi et al., 2019). The global population right now have an estimate of its 50% living in the cities and this has been projected to produce the 60% population growth expected till the year 2030. It is however ironic where less than 1% of the worlds surface is housing 50% of the world population and it is also responsible for most of the climate changes the world is going through. Cities around the world have been generally considered by environmental scientists as the black holes of the world's resources as they are known to consume up to 75% of the total energy consumed around the world and are also the world's most greenhouse gas emitters. The ways that have been proposed by researchers to reduce the effect of the human consumption on the planet point to half of the solutions being inside buildings, and the solution is the use of alternative energy in the form of green buildings or construction to effectively reduce the carbon emissions. The major contributor to the emission of greenhouse gasses has been noted to be the construction industry, two thirds of the global carbon emissions have been said to be from the construction sector because the consumption occurs within buildings, the environment program of the United Nations; United Nations

Environment Program reported that can be used as an opportunity to use resources in an effective manner towards a sustainable development concept, and to do so the green building endeavor has been noted to be a very efficient solution in that regard (Shan et al., 2017). The economic perspective has to be factored into the sustainability movement and it has in fact become one of the fundamental aspects of green building and sustainable building design.

The concept of building based on the Stockholm conference has argued that there is up to 70% energy conservation using the concept in green buildings, there is a trend all over the world on the adoption and implementation of green and sustainable buildings but it is still noteworthy that there is not enough awareness about the sustainable movement around the world, among building owners and occupants (Al-Hudayri and Halem, 2018). There is also insufficient attention being given to the cost of operation of buildings by owners, and this is a major factor that hinders the speedy growth and development of green and sustainable buildings around the world. Increased productivity through low resource consumption is a definite advantage of green and sustainable buildings. Dwaikat and Ali (2018) have said aspects such as waste recycling and waste disposal have to be properly taken in to account in the construction of a green and sustainable building. Countries around the world have made up tools and proper systems with regard to standardization and evaluation of green and sustainable buildings, there are no world unified bodies or standards in this regard but there are two authorities in this field those are very much regarded as such, The British Research Establishment Environmental Assessment Method (BREEAM) and the American Leadership in Energy and Environmental Buildings (LEED) (Dwaikat and Ali, 2018).

Palestine has two geographic parts which are apart with no feasible or existing communication link between the two regions due to sociopolitical factors, according to the Bureau of statistics of Palestine the two geographical regions have the following populations; West Bank: 2,881,687 and Gaza Strip: 1,899,291 with densities of 794 people per kilometer. The political instability in Palestine has an obvious impact on all the sectors in Palestine with the inclusion of the energy sector, the control of water and other energy sources have been complicated by the sociopolitical factors, these factors have brought about the growth in the interest of green and sustainable

buildings in Palestine as it seems to be a viable solution to the energy resources predicament (Alatawneh, 2015). Despite the availability of renewable energy sources in Palestine there has been a very low exploitation of such sources of energy, this in turn increases the cost of building construction and operation in Palestine. Despite the unspecified date to mark the beginning of the interests of sustainable and green buildings in Palestine, there are some research literatures that point to as far back as 2010 where Alatawneh discussed the adoption of the courtyard concept in Palestinian homes towards the contribution to sustainable living and construction which he argued is a traditional way of sustainability in the Palestinian architecture which suits both the culture and environment of Palestine (Alatawneh et al. 2015). A focus on walls of buildings in Palestine as an energy conservation element in building design of Palestinian architecture was discussed by Salameh (2012), stating that the use of walls of building as envelopes could lead to energy conservation which will in turn make buildings efficiently sustainable and has to be properly adopted by Palestinian designers, architects and builders. The necessity and possibilities of sustainable buildings in Palestine have been highlighted by Abdel Hadi in 2013 where she mentions the residential buildings in Palestine should be considered using renewable energy sources in order to help the buildings provide cooler atmospheres from within to stabilize the hot Palestinian atmosphere, she furthered a study which finds ways to harmonize the traditional Palestinian architecture with modern ways in an attempt to improve the sustainability factors of buildings which led her to recommend the fabrication of materials with better characteristics towards sustainability than what is currently available in the market (Alsamamra and Said, 2019). In 2016 Haj Hussein et al. carried out a research to study and evaluate the performance of Palestinian architecture with regard to energy performance, their primary target was the study of schools precisely. The research concluded that schools in Palestine are very much far from desired green and sustainable architecture, there is still room to improve on minimizing the energy consumption by buildings in Palestine (Haj Hussein et al. 2016). A Ph.D. research carried out by Al Atawneh et al. in 2015 studied the challenges facing the growth and adoption of green and sustainable buildings in Palestine and other developing nations, the research arrived at two categories of challenges; technical and organizational challenges. Another author sort to investigate the actual performance of buildings and the

theoretical expectations of the performance of buildings, the case study to such performance evaluation was the study of the first green certified school in Palestine; the school of Aqqaba which received a gold class certification from the Supreme council of the Palestinian Green Building, the author compared the performance of this school against other schools in the region regarding the consumption of power and water (Al-Hudayri and Halem, 2018).

2.2 International Sustainability

The rise in interest in green and sustainable buildings across the globe has led to also the rise in the methods of achieving such buildings and structures, and with these growing numbers in methods there is also the growth in the ways and manner in which these methods of developing sustainable buildings are evaluated. The evaluation methods are mostly regional or country specific as standards put in place by the authorities for adherence in the quality of buildings, some of the most widely accepted and famous evaluation standards of structures is the Leadership in Energy and Environmental Design also referred to as LEED (Uğur and Leblebici, 2018). LEED is an international evaluation system which is a certification base system, LEED uses points in its certification process and has certified projects in more than 30 countries around the world, LEED factors in issues that are regional specific to the location of a building in carrying out its certification procedure of a building, LEED works hand in hand with the building authorities where the building is based in order to carry out the certification process. LEED is known for the provision of third party verifications for design and construction of buildings, LEED has four levels to their certifications of buildings, the four certification levels depict the buildings performance on measurements of key areas of the building, the four level of certification for LEED are certified, silver, gold and the platinum certification, the certification levels listed are in the order of ascension with the certified being the lowest level and platinum being the highest level of evaluation, the measured aspects of the building during the evaluation for the building certification are ranging from the selection of the site of the building, awareness around the building and the environment and the entire system of the building (Uğur and Leblebici, 2018). Besides LEED being a very widely accepted and famous green building assessment body, another outstanding and famous green building evaluation

organization is BREEAM which is an abbreviation for Building Research Establishment Environment Assessment Method, BREEAM has been around as an assessment and certification system for over 20 years, BREEAM unlike LEED does not have four levels of evaluation but five, BREEAM has a level of evaluation that starts as Pass as the lowest possible level to Outstanding which is the highest possible evaluation level. Generally, LEED and BREEAM have been noted to differ in the way they carry out their evaluation of green buildings but they remain the two most recognized standard bodies of assessment and verification of green buildings around the world (Awadh, 2017).

2.3 Green/Sustainable Libraries

When the awareness of sustainability started as a movement in the 1970s, there was a debate which was happening as to whether libraries should carry on the responsibility of becoming leaders of the ecological sustainability movement by showing or leading by example in their functions and their structures to deliver library services. It has been noted that the development of functions and structures in line with the suggested notion of libraries to be the leaders of the ecological sustainability movement has been rather slow over the years but it is also noteworthy that there have been tremendous efforts made with the mechanisms put in place by libraries over the years, the efforts and mechanisms point to libraries finally taking the center stage in taking a leading role in the movement for sustainable living, with aspects such as sustainable service delivery, green library building, and general responsibility in sensitizing the public towards sustainability (Darko and Chan, 2017) Countries that have shown progress in developing and maintaining green libraries are the United States of America, Australia, China, Russia, Germany, Croatia to mention a few. The green library movement has been fostered over the years by bodies such as the Group of Environmental Sustainability and Libraries and the International Federation of Library Associations, these are some of the well known international organizations that have pushed for sustainable libraries in light of the ecological sustainability movement around the world, there are other local bodies in several countries that also push the same agenda within their own country for the same purpose (Trojak and Hauke, 2017).

2.4 Libraries as Environmental Consumers

It is a known and established fact that libraries are a very huge energy consuming buildings around the world, energy is being used by libraries to deliver comfort to users and for the creation and preservation of contents. Libraries are known for their enormous waste production especially in the use of water, computers, paper, and other electronic equipment. There has been a report from the environmental Trends and climate impacts which showed findings from the book industries in the united states of America being responsible for cutting over 30 million trees every year to enable them meet up with their production demand for books, and this demand for books are only for the demand of books to be sold in the united states of America alone (Hauke, 2017). In a world that is constantly threatened by the dilapidation of its natural resources, this is a very alarming report, and libraries are known to be one of the highest consumers of books around the world which implies conventional and traditional libraries are very much guilty for the dilapidation of the world resources; especially in the form of tree felling in this regard. It is also reported that about 600 pounds of paper is used by the average American every year, the copying machine giant Xerox has been known to report that about 44.5% of all paper printed documents are printed for only a one-time use, and about 25% of paper printed documents get recycled in the same day they are printed. A research institute by the name of Lyra estimated there is about 15.2 trillion pages of documents being printed across the globe annually, and the estimated this figure is approaching a 30% growth over the next decade, and in light of finances going to the public libraries in the united states alone, Donella Meadows have reported the average citizen of America pays about \$20 annually in taxes which go to the public libraries, which she argued could go a long way in saving resources if the average American would consider borrowing a book from the library instead of buying a book for themselves which will eventually contribute to the constant felling of trees (Jankowski & Marcum, 2010). When a book gets loaned by a library at least ten times, it is estimated that the paper use has been averagely cut down by at least a factor of ten, while libraries usually opt for recycling it is not enough to curtail the problem of unsustainable consumption of resources. The

consistent growth of libraries across the world equals to the consistent of the carbon foot print across the world, this calls for the reduction of the operational costs of libraries and environmental waste with a proper sustainable plan for the future, which if not properly managed will have a subsequent long term effect on the environment, the consistent development of libraries and the expansion of library book collections could eventually go against what the intended purpose for the process is; to provide information to more people. Other hazardous wastes such as electronic wastes are also growing at an alarming rate, and libraries are also known to be major consumers of electronic equipment in their service delivery, the rise of electronic equipment on the contrary were celebrated by most to be a progressive solution towards sustainability because they meant the reduction of use of paper as reading mediums, however the constant production of electronics have also taken a toll on the environment and it keeps doing so. Libraries across the globe are known to have shipping rooms that are constantly receiving new books for their collections, and most libraries do not opt for recycling measures, they instead resort to disposing the books they consider out of shape for use, and any other document they may have in the stated condition (Bhat, 2018). To challenge and solve the issue of unsustainability by libraries, most of them have resorted to electronic mediums, by going into digital projects and with networked functions to provide services to users even from home in some cases, but as these digital solutions are being implemented and adopted, while they create solutions, they also create problems; the problem of more energy consumption, and recycling of digital equipment such as compact disks, digital drives and computers. As the cost of paper on the environment is being reduced and another cost on the environment is being created by the libraries, and some will argue the seeming solution is even making it worse than it was. This calls for a method of measurement to know how much damage or consumption libraries are causing, the measurement should be in the form of indicators for the materials used; water, ink, paper, computers and electricity. However, these indicators or measurement methods have not been created or adopted yet, such measurement methods will enable libraries and other institutions to track their sustainability and environmental impact which will in turn help the global environmental issues and the economy of the institutions and the world. These indicators will be capable of providing data that will be very important in not

just tracking their usage but also in studies that are targeted at the impact of global resources consumption, the developed indicators should be able to provide the following data (Li et al. 2020):

- Library water consumption for any specified period of time,
- The amount of generated waste for every category of waste; hazardous or non-hazardous type of waste,
- Tracking of cost reduction in any adopted solution, whether it's the substitution of paper with electronics, or the reduction of paper consumption,
- The number of shipments received by the library on materials to do with their collections, paper or electronic equipment,
- The library's consumption of paper and electronic equipment. And the recycling adoption,
- The amount of energy used by every individual and the library as a whole,
- The library's use of eco-friendly materials; cleaning materials, or other materials,
- The cost incurred by the library for printing and other services the library may offer,
- The ecological foot prints the library contributes on the average,
- The social and economic performance of the library; at least annually. (Li et al., 2020)

2.5 What is a Green/Sustainable Library?

The definition of what a green or sustainable library is should conform to a checklist like every other green structure should, this checklist is a cumulation factors which are considered to be necessary for achieving a green or sustainable building. The importance of sustainability is a growing aspect of living as time passes it becomes clearer to us as to how paramount it is for us to conform to sustainable living standards; this has made the prioritization of green buildings especially in public buildings across the world. Most libraries in recent years are expected to be sustainable or "green", the checklist for conformity may not be a complete list but it provides a general outline for the topics and aspects for conforming to sustainable standards. The checklist for guiding conformity towards a green or sustainable building or green libraries specifically in general is as follows:

- Project planning and finances; with regards to green and sustainable plans,
- Tendering; this applies especially to public buildings, public buildings should have a role modelling aspect to them, it is advisable it is done at the very beginning of the building project,
- Location choice of the building, the ecological aspect of the site location is very crucial to building a green and sustainable building, this ensures there is no contamination of location or altering the ecology of the place which will ultimately defeat the purpose of the building,
- Construction standards; the construction methods carried out in building the structure must conform to standards that are suitable to sustainable libraries, for example the facades, energy supply of the process, and other materials used,
- Interior design and materials, the interior of the building must adhere to using materials that enable sustainability and should provide a green atmosphere within the building.
- “Green Technology”; the building needs to indulge the use of sustainable technology especially regarding information technology,
- Services for adaptation should also be more sustainable approaches, such as the use of scan instead of the use of printing,
- The library management also needs to be planned towards sustainable management,
- A focus on green methods to achieve tasks that a library usually carries out should also be done, tasks such as shipping and archiving of materials, also the daily maintenance services within the library such as the cleaning of the building need to be “green”,
- The public marketing and press release to be done for the library should also be planned to conform to “green” methods,
- Public awareness; all the plans and the goal of the proposed library should also be efficiently communicated to the public; this will ensure the building goes beyond being a structural figure in the community but it will also become a source of orientation to the public about the importance and benefits of living sustainably (Shurab et al., 2019).

The checklist for ensuring a green library is just a general overview type of guide, a green and sustainable library transcends the summation of what is on the checklist, a green library is

ultimately the summation of the factors on the list and the eventual sustainable maintenance and services the library will provide over the course of its lifecycle as a building and a place of delivering services. The provided checklist is a tool to guide and orient library stakeholders to embrace sustainable methods of constructing and running a library in order to promote and achieve a better ecological system for the world at large (Shurab et al., 2019).

The checklist of a green library as outlined has its similarities and also has its differences with respect to the checklist of green building certifications, green building checklists ensures the factors required in building a sustainable building are achieved at possible best optimum, by ensuring the functional aspects of a building or structure are met, as can be seen with the sustainable building checklist of PHGBC when juxtaposed with the checklist of green and sustainable libraries, the core requirements of building a sustainable buildings as structures are seen in both checklists, such as construction standards, technologies involved, site sustainability, but what is lacking in sustainable building checklist but is present in the sustainable libraries checklist are the socio-cultural significant factors such as the public awareness, and the factor of being not just a sustainable structure but a building which will have a social impact in orienting people towards adapting sustainability by seeing the advantages of it through its implementation on the sustainable library (PHGBC, 2013).

2.6 Green/Sustainable Library International Initiatives

There have been worldwide initiatives internationally with regards to green and sustainable libraries development and maintenance since the year 2000, this was the era which the green library movement was developed (Vertakova and Plotnikov, 2017). Sustainable living communities such as the American Sustainable communities were the frontiers in inspiring the green library movement which was adopted across the world (Meher and Parabhoi, 2017), ecological sustainability efforts have seen more focus through themes such as “a new century in public library architecture” which was an initiative meant to drive libraries across the world to adopt sustainability in light of the deteriorating ecology of the world (Manolis and Manoli, 2020). The promotion of green and sustainable libraries has been promoted through initiatives that increase awareness and orient librarians with aspects of ecological sustainability, these

initiatives have been in form of conferences and journal publications or books (Fedorowicz-Kruszewska, 2019). Organizations and associations of library communities such as the special library communities are becoming more aware of green library for sustainability through the organization of conferences in that regard to meet and share ideas and ways or methods to achieve the ecological sustainability movement, other initiatives also came in the form of formation of groups and associations such as the Australian library and information association was formed in the year 2010, green themed conferences such as the green conference organized by the Library Buildings in Europe group of architects in 2011 in Prague (Sommer and Feldsien, 2012). There has been documentation that have shown the involvement of the American library association's involvement in the green library movement towards sustainability since the 90s, and the year 2013 they actually started and forwarded a petition to hold a round table for sustainability to create and enable the fostering and advancement of practices that are sustainable.

The International Federation of Library Associations and Institutions held their 75th anniversary which saw to the implementation of sustainable issues of publications by the IFLA, the publication was titled "Statement on Libraries and Sustainable Development" which was published in 2002. As reported by the IFLA section 3 in the buildings and equipment issue picked up a directive on the matter of sustainable development guidelines (Wagner et al., 2007). During the 2009 congress titled the 75th IFLA world library and information congress which was held in Milan, Italy saw the formation of a special interest group for sustainability of libraries named Environmental Sustainability and Libraries Special Interest Group acronymized ENSULIB. Articles of sustainability of the environments and libraries were published in the international preservation news from 2009 onwards, the publication was done by the international preservation news (IPN), at the 2011 77th IFLA conference which took place in San Juan, in Puerto Rico, the IFLA hosted the library buildings and equipment section conference titled "sustainability issues in the design of libraries" which was used to stress and emphasize the importance attached to creating libraries that are environmentally responsible as spaces and facilities to be used in the 21st century. Another initiative towards green libraries is that which resulted from book project of a student from the school of library and information

science in Berlin, the IFLA publication volume 161 in 2013 published a book titled “The Green Library” (Hauke et al., 2013), it was written by various experts in the field of library and architecture from the world over, the book covered several subjects regarding the subject of green libraries and sustainability and their best practices, the book covered how to efficiently go green with libraries for sustainability.

2.7 Promoting Green/Sustainable Libraries

Educating and orienting people and the general public on ecology and sustainability of the ecology has been carried out by several libraries across the world, where endeavors such as the design of databases which are populated with information regarding the sustainability if ecology is populated with it, however most of these endeavors do not get advertised as projects and their set goals. It was pointed out how the sustainability of the ecosystem is often not given the necessary value and attention it deserves from the general public and the stakeholders, but the topic of ecological sustainability is actually a very critical topic that has more impact than most people actually realize, the impact of ecological sustainability on stakeholders and people has been called upon by organizations that promote the topic worldwide, attention of bot library users and the stakeholders have been called upon because of the seeming equal impact this issue has on both parties, this call is regarding the provision of green identity by the libraries and also the imbibing of these green identities by the library users and the public at large. The need for ecological sustainability to be promoted and marketed to the public is a strategy which should be emphasized on as a social responsibility to the world by the library service providers, not so radical steps and methods will as well go a long way in providing a green image and impacting on the ecological sustainability of the world (Hauke and Werner, 2013). There seems to be a lot of marketing potentials regarding green libraries and ecological sustainability that has not been tapped into, and these potentials seem infinite in what they can offer and impact positively. Through such promotions and orientation to the general public and other stake holders there will be an immense achievement in the green library movement and libraries will have the impact on the ecological sustainability movement they intend to have and should have on the world (Dias, 2017). The creation of an image that reflects the green movement endeavors is a critical

and important task that should be prioritized accordingly and should also play a very big role in strategies or marketing and orientation of green and sustainable libraries across the world as seen in Finland and Croatia; as to how much impact was seen with their promotion approaches of green and sustainable libraries (Sahavirta, 2013)

The economic and cost implications of green and sustainable buildings have reached a maturity level in today's world that it is starting to become a traditional way of building to some professionals and individuals, however some parts of the professional world are still not accepting it as it should be accepted and most of them use the cost implications as a reason of not adopting sustainable building design and construction (Zhang et al. 2018). Regarding sustainable buildings context is very important, it is noteworthy to know a sustainable aspect of a building in a certain country may not be as sustainable in another country or even another society in the same country, in countries like the united states the average energy consumption may be higher than in a country which is a developing country, measurements of return of investments (ROI) have to be taken into account to gauge the level of profitability in the decision to use sustainable design in a building, ROI calculation in a building project is also a relative aspect to many countries, ROI in European countries is calculated in returns that stretch over the span of 30 years to 40 years, but in a country like the united states of America ROI is considered on a period of 3 years on the average (Dwaikat and Ali, 2018). The determination of ROI on a building is a desirable process for most people, having an ROI evaluated for a proposed design will enable a client see the management advantages that a sustainable design can offer them. Usually, the long-term economic impact of a sustainable design is essential in giving a positive economic evaluation of constructing a green building, because maintenance costs is drastically cut down when sustainable design is adapted in a building, and not even the seemingly feasible cost when spent over the maintenance activities but also it cuts down on the required time for maintenance activities which as we know subsequently takes a toll in the economy of a building or organization. Sustainable buildings factor in every aspect of maintenance of a building, such as generation and consumption of energy, decisions made for purchases required for the maintenance, cleaning activities, renovation activities, the facilitation of utility individuals that are used in maintaining a building also requires adaptation and

reprogramming of the usual schedules of activities in a building. An integrated design which is seen in most sustainable designed buildings has an input process which engages maintenance facilitation in a very less disruptive way in the context of scheduling and programming, these integrated methods of maintenance in sustainable building come with immense benefits to the economic management of a building. Such advantages in a sustainable building serve as not just economic advantages but also serve as means of educating professionals and individuals alike regarding both the economic and ecological benefits of going green in a building design, such implementations will lead to consensus among people to further study and research more optimal ways to improve the already beneficial aspect of sustainable buildings (Zhang et al., 2019).

2.8 Cost of Green/Sustainable Building

The question of the cost of building sustainable or green buildings has always been asked among people, most people are of the opinion that the cost of building a sustainable structure or green building is more expensive than building a traditional structure. As of a decade ago the cost of building a sustainable structure is definitely a more expensive way of building when actual cost of construction is considered, but in today's world with the immense progress industries have made in making materials which are fabricated for sustainable living the cost of building a green building is definitely not as expensive as it used to be and will actually compete in having less cost compared to traditional and conventional construction and design methods, it has been duly noted that to build a green building that adheres to sustainable ecological movement with an average of a silver certification of LEED is definitely cheaper than building a traditional and conventional building, however the cost increases when certification rating of LEED gold standards are considered or aimed for in a green building then the cost of building such a sustainable building becomes a bit more expensive because of the premium standards being set (Uğur, and Leblebici, 2018).

2.9 Green and Sustainable Libraries

Libraries have been noted to being involved in the United Nations 2030 agenda for SDGs, and part if the progressive movement carried out by libraries is the implementations of sustainable

principles which have been developed and implemented actively since the 1990s, this is when the definition of sustainability in architecture itself matured reasonably. There is a definition of sustainability and green buildings called the ISO 26000; a standard set in 2010, this standard defines sustainability and green buildings as a development in a form of meeting people's social and economic needs without making compromises to the people of the future being able to meet their own needs too. According to the ISO 26000, sustainability is a developmental aspect that caters to three distinct factors which are: social, economic, and environmental aspects (Basdeikidou, 2017). Libraries in the context of sustainability has been developed in light of ecological protection and sustainability with terms such as “*green library*” and “*sustainable library*”, the two terms have been generally been seen as synonyms but these two cannot be accepted as synonyms, he argued that green libraries are libraries designed with a goal of achieving minimization of the building on the ecosystem around it and maximizing environmental quality the building contributes to, this can be achieved by the selection of building materials for the library carefully, ensuring the materials are biodegradable, and the conservation of energy has to be factored into the design of the library, and the library has to be designed to have a responsible waste management (Reitz, 2017). As green libraries are focused towards the sustainability of the natural atmosphere, sustainability is defined to cater to social, economic and environmental quality, these three factors are the driving forces for sustainable libraries, trying to find a balance for all three needs without compromises. A sustainable library is defined as a library that caters to environmental sustainability through its design materials and maintenance, caters to the social needs with the intended functions being fulfilled, and having an economic sustainability by making the library a profitable institution by having a very good return on investment (Engström and Rivano, 2019).

We will be presenting examples of a green library and sustainable libraries to further explain and distinguish between the definitions of what green libraries are and what sustainable libraries are. Libraries have evolved into the acquisition of competency skills especially in the realm of public buildings, this competency skills entail raising awareness of the public and mastering knowledge in several professional areas, in sustainable libraries there is a goal set to be achieved; which is the consistent implementation of set goals for progressive sustainability, in the design

of the libraries and the activities carried out in the libraries as well. The Hunt Library in North Carolina University (NCU) in the United States is an exemplification of sustainable development on the part of public libraries, the LEED certification awarded the library building a silver level certification with regards to its sustainability achievement, the library has been optimally equipped with solar energy generation panels, and the library has also been efficiently designed to cut down the loss of water, and it is also equipped with a green roof in light of making the building green. The NCU library was built with recyclable material which gave it the certification of wood from the Forest Stewardship Council, the recyclable materials used in the construction of the library make up 82% of the total materials used in the construction of the NCU library (Peterson et al., 2014).

The Macquarie University library has been referred to as a library with a multifaceted approach to sustainability, this library has been awarded the green star by the Australian green construction certification body, the library is equipped with energy storing capabilities from thermal sources, this capability makes it reduce emission of greenhouse gases by up to 25%. The library has also been designed to collect water from rain sources which is utilized for purposes such as toilet flushing and plant watering, the roof of the library is a garden planted to add to the ecological sustainability of the place and also provide insulation from heat to the interior of the building. Most of the design and construction materials of the library are certified for their recycling origin, they were certified by the Good Environmental Choice Australia (GECA) (Fedorowicz-Kruszewska, 2019). The library is a hub for research, teaching and learning, this has earned it the name "*Living Lab*". The Macquarie University library is a library which contributes to the education of its community regarding green living and sustainability, and also development of sustainability, the library went further to spend 79% of its collection expenditure on electronic based collections which conforms to the finding which states electronic library collections are way more sustainable than card collections because of the 0 carbon footprint creation, the library also has a café which is taking responsibility in the services it offers by making sure they conform to green living and sustainability in the form of product packaging and the minimization of energy consumption in the café. In Europe there is an example of a library which adheres to the green building principles exceptionally; The

University of Reims's Robert de Sorbon Library, this library has a reputation of being of the pioneering libraries across the world to adhere to the stringent requirements of the environment, the requirements include the use of natural light in lighting the interior, the provision of acoustic comfort in the library, stabilizing the temperature of the interior in winter or summer without the use of conventional air conditioning, the use of rain water in the library toilets (Fedorowicz-Kruszewska, 2019). The McClay library in Belfast also adheres to sustainable development principles, the design of the library was done by the engineers to adopt five key points of sustainability, the five key areas include: energy supply use efficiency, reduction of energy consumption, power saving through the reduction of equipment use time, adoption of eco and user-friendly solutions in the library, and passive systems which support adjustment of the environment. (Latimer, 2013) (Touboulic and McCarthy, 2019).

Sustainable libraries have also seen implementations in Asia, one of such examples is the Eco-library in Kasetsart University in Thailand, the library was established in 2012. This eco-library was established to function as a library for the promotion of education through the creation of an interior design that is environmentally friendly, by doing so they hoped to orient people about the necessities of taking actions in their day to day lives that are environmentally friendly. The library was built to have two sections; the first section is the library itself, and the second section is the architecture faculty's scrap lab, the scrap lab is used by engineers to design eco-friendly products which are then fabricated from waste and refuse materials collected from all over the city of Bangkok in Thailand (Kassim et al., 2019). The scrap lab works with other scrap labs in companies to collaborate and advise them on how to acquire materials and process them accordingly to ensure minimal negative impact on the environment. The two sections of the Eco-library are targeted to ultimately achieve a single goal with the underlying idea of green and sustainable living, they do that by reducing the immense consumerism behavior especially through energy consumption and promoting the use of substitute energy sources and also promoting recycling. The scrap laboratory section has produced interesting products such as lampshades, bank staff uniforms etc. (Kassim et al., 2019). Another sustainable library implemented in Asia is the library in the Chinese university in Hong Kong, this library provides one of the best sustainable solutions through the provision of resources to users of the library

facilities which save a lot of power, the library roof is made of a garden where vegetables are farmed unlike other libraries that only make their roofs into ornamental gardens, all farming processes in the garden are done using natural methods that are not dangerous to the environment, this library is known to have promoted both sustainable living practices and improved inter personal relationships (Jones and Newsome, 2015). Another interesting library which is the first of its kind and happen to be in Asia is the My Tree House library in Singapore, this library is a children library commissioned in 2013 as part of an initiative of the Singapore central public library. The children library was designed and constructed following the principles of green building, the designers installed only lighting that are considered energy efficient, the book shelves in the library are all refurbished and recycled old book shelves, all carpets installed in the library are eco-friendly carpets, a very significant aspect of the children's library is the canopy installed at the center of the library which was constructed with a total of three thousand recycled plastic bottles, they called the center piece "A Three With a Crown". Further harmonization was ensured with the library's book collection, the main themes of the book collection are environmental, plants, animals, climate change and recycling, classes are also offered to children in the library which are all devoted to the sustainability of the environment (Siva et al., 2017) Each library mentioned in this section plays a very great role regarding the green and sustainable libraries movement, all the libraries play a role in offering services that are targeted at creating the awareness on environmental sustainability and the effect of reckless living that most traditional or conventional methods offer. The united nations has pushed for the involvement of sustainable libraries to incorporate services that will work with it to achieve the SDG goals it set out to achieve in the near future, they argued the libraries can be very paramount in this regard to offer services that will ensure the rise in competence of digital awareness among people, job search involvement in the society, the inclusion of people which is not hindered by any form of social barriers, acquisition of financial resources, the promotion of human rights especially to do with women and girls right (Garcia et al., 2017).

The world has seen a rise in interest by libraries in the movement for sustainable development, the endeavors carried out by the libraries vary in different ways but with the same focus and goal, some of the libraries are in the sustainable movement with exclusive focus on

environmental issues, while other libraries have tried to adapt other complementary approaches in their sustainable movement promotion and adaptation, such as issues that involve the growth of the economy and social inclusion. The variation in their methods does not matter as much as the common goal they seek to achieve matters, the goal being ensuring a world where the planet's resources are being used responsibly to avoid a world going into a stage no one will want to see; a world which starves, a world that could possibly be inhabitable due to the harm that has been done to it by dilapidating its resources and atmosphere. In a nutshell sustainable library are a key aspect of the movement of protecting the world's ecosystem from harm, the integration of sustainability in the design and architecture of libraries across the globe is a necessity which demands more priority than it sees at the moment because of the clear impact it has done so far from the few adoption it has seen. Some researchers argue the adoption of green and sustainable libraries is a moral obligation of the world, because sustainable libraries can be used to gain the society's trust, and for a public institution to stand as a public moral compass in regard to sustainable living practices compliance of stated ways to sustain the planet and its resources (Ghorbani, 2017).

2.10 Palestine Climate

In 2002, the ministry of local government in Palestine and the applied research institute of Jerusalem reached an agreement with the support of the United Nations Development Program (UNDP) in an effort to adopt the code of energy saving and sustainable buildings in Palestine. With the goal in mind the division of climate in Palestine constructed codes of energy saving in buildings, the codes were classified in different aspects such as the yearly temperature, annual precipitation, and the humidity of the region. As green and sustainable buildings are generally targeted towards efficient energy consumption and generation, the analysis of climate is paramount to this endeavor. Palestine is categorized as having a Mediterranean climate with a very long summer season and a very cold winter season, between these two seasons are the transitional periods of autumn and spring. The climate division of Palestine came up with seven zones of climates in the regions of Palestine, where every zone has been specified with its average climatic conditions throughout the year to help in guiding the standards of green and

sustainable buildings in Palestine. It is evident that in as much as Palestine has a generally categorized climate as Mediterranean, it is also noteworthy that in every zone there are distinct differences in climate that require different methods of green or sustainable building adoption and implementation and this factor can be a challenge to the growth of green and sustainable buildings in Palestine because each climate zone as categorized requires its own building and construction model for efficient output, and again it is also noteworthy to know that the majority of the designers, architects and builders in Palestine do not give enough consideration to the varying climatic zones in Palestine which will eventually take its toll on the efficiency of their buildings (Mizyed, 2018).

2.10.1 Energy in Palestine

The ugly reality of the energy in Palestine is as it is in the majority of the world, energy is deteriorating. The energy availability and consumption in Palestine is hugely influenced by the sociopolitical situation of Palestine and Israel, where noncompetitive prices are imposed by Israel on Palestine on energy resources which in turn cripples the energy sector of Palestine towards development, this makes the adoption of renewable energy sources by Palestine a very much radical alternative energy source. It has been noted by Abu Hamed et al. (2017) that Palestine pays more for energy in comparison to their neighboring nations, a comparative study was done between the energy availability in Palestine between the year 2007 and the year 2012 and there was not improvement in the level of its availability and cost in Palestine, as the cost and availability fail to grow the demand of energy has seen a surge in this period thanks to the inevitable population increase in Palestine. The main pillars of energy in Palestine are balanced petroleum products generated energy and renewable energy generated source. The research gave an energy consumption analysis; where commercial and residential sectors emerged the highest energy consumers with 58.2% of the total energy consumption and the transport sector consumed 36.5% of the energy. The most efficient use of renewable energy in Palestine is seen in the heating of water in homes, where solar energy has 65% of the water heating energy source in Palestine (Abu Hamed et al., 2017).

2.10.2 Renewable energy in Palestine

The presence of high indicators to the source of renewable energy in Palestine and the socioeconomic impact from Israel on fossil fuel availability to Palestine has led Palestine to focus more on renewable energy source, and the main renewable energy source focused on in Palestine is solar energy where Palestine has been noted to have an annual sunshine of more than 3000 hours. With a variation of 5.4 kW per square meters per day to 6kW per square meters per day, the solar energy utilization as an alternative and sustainable energy source is very promising especially if it is compared to other countries and regions in the world. A presentation on the review of Palestine energy review where the authors explained renewable energy can play a critical role in Palestinian sustainable development, and they referred to it as “*The Magic Solution*” for Palestinian energy demand and independence, solar energy has been praised as the most reliable source of renewable energy for Palestine but that should not make the nation ignore other source of renewable energy; wind energy, geothermal energy, and biomass energy sources. The exploitation of renewable energy sources has been limited to only water heating demands in Palestine. There is a need of sensitizing people on the importance of renewable energy in promoting sustainability in a nation and ultimately the whole word, renewable energy such as solar energy has the capability to make Palestine establish an efficient sustainability platform and carbon emissions reduction in the nation which will contribute to the world sustainability movement (Juiadi et al., 2016).

2.10.3 Construction sector in Palestine

In 2010, the Palestinian statistics bureau reported the highest growth in the construction sector of the nation at 36% increase, which compared to 2009 has given more 22% more employment to construction workers (PCBS, 2017). Construction as an industry has been recognized worldwide as a source of destruction of the worlds ecosystem when not being done with sustainability in mind; depletion of resources with not replacement. This is also widely seen in Palestine because of the habit a lot of Palestinians have of resolving to build homes or other structures without the consultations of the appropriate professionals; architects and engineers.

The average Palestinian is known to regard a structure or building as a facility rather than a living space which requires a lot more consideration (Alatawneh et al., 2015). The Palestinian public are known to engage construction with the materials and elements they see fit for their geographic location, and the most prevalent dominant building material are stones, when considering heat insulation, the average Palestinian does not consider insulation adaptation in a home due to the economic implication of such endeavor and this takes a toll in the later required energy to cool the resulting hot living space they have which goes against sustainable living with regard to energy consumption. Salameh (2011) stated the lack of accountability of sustainability in the way most Palestinians indulge in construction which in turn increases the cost of the long-term maintenance of a building because most Palestinians sort to reduce the cost of initial construction of the buildings. She also pointed out the poor choices of some professionals which defeats the purpose of sustainability in their construction methods; where they choose materials, which promote sustainability in another region but are not suitable for their own region in which they construct using it. There is a diverse variety of construction materials in Palestine, and these materials have played key roles in both traditional and modern architecture in Palestine, the traditional Palestinian architecture has been known to take advantage of the materials found in Palestine to build efficient buildings to compliment the climatic nature of their regions which some professionals to be even more of a sustainable endeavor than most modern construction in Palestine (Sabboubeh et al., 2019) The traditional architecture of Palestine has been known to use clay as insulation for their buildings to provide efficient cooling without needing other source of energy to provide cooling, they built their structure with thick walls to provide insulation against winter seasons which usually get freezing cold, and they desisted from over crowing buildings at the coastal regions of the country to provide good ventilation across the buildings (Jankowska et al., 2016) hence it is safe to say the traditional architecture of Palestine has been synonymous with energy saving (Aghimien et al., 2019).

2.11 Climate of Cyprus

Cyprus is a Mediterranean country and the third largest island in the Mediterranean Sea, like every other country or region the climate of Cyprus is determined by the variation in elements and how they interact with one another, such as wind speed, precipitation, humidity, temperature and long wave radiation. The temperature zone of Cyprus is that of the Mediterranean temperature zone, Cyprus has an average summer temperature of 37.2 degrees and a high temperature that sometimes hits 40 degrees Celsius in the months of July. The winter months season of Cyprus is categorized as mild, cool, and wet with an average temperature of 15.5 degrees Celsius and a sub 5 degrees Celsius when the temperature goes really low in the months of January which is the coldest month of the year (Mesda, 2012). The climate of Cyprus has a range of 15 to 25 degrees Celsius between day time and night time temperatures and an average humidity between 40% to 60% in most part of the island (Atiyat et al., 2015).

The climatic thermal comfort in Cyprus which is dependent and determined by people based variables has been determined by studies to be around the limits of 19.5 to 29 degrees Celsius, and the generally accepted humidity relative to the comfort zone of Cyprus is around 20% to 75%(10). The months recorded to have the best thermal months are April, May, October and November, as these months need lesser heating and cooling for thermal comfort (Al-Din et al., 2017).

2.11.1 Energy in Cyprus

Cyprus has an energy system which is primarily dependent on fossil fuel for the generation of energy, and the country has a relatively low share of renewable energy of 10% as stipulated by the European Union energy targets and regulation. The electrical grid system of Cyprus is an isolated system with no interconnection to any neighboring countries systems and a 91% fossil fuel electricity generation as of 2018, and only 9% of the energy consumed was powered by renewable energy sources, the transportation sector of Cyprus has a 3% share of the total transport sector energy consumption which puts it at a very low mark when compared to the 10% target placed by the European Union energy targets and that puts Cyprus a position where it needs to heavily invest and diversify its energy generation into renewable sources, however

the economy of Cyprus is relatively small economy with a relatively low energy output which puts forward the question whether it is viable financially to impose the burden on the economy and its energy model (Taliotis et al., 2020).

2.11.2 Renewable energy in Cyprus

The energy infrastructure of Cyprus is faced with significant challenges due to its dependency on fossil fuel which is a nonrenewable source of energy, fossil fuel in takes its toll on Cyprus in two ways, the degradation of the environment and the cost inefficiency attached to it due to its high cost of import to the island. Cyprus has made attempts and set up policies to reduce the cost of renewable energy to enable the country reduce its dependency on fossil fuel for energy (Taliotis et al., 2017). The complete isolation of the power grid of Cyprus makes it really economically expensive which is added to the preexisting issue of environmental degradation it contributes to on the planet, Cyprus needs to overcome the challenges of fossil fuel importation and rely on the local resources it can harness to obtain renewable energy, Cyprus as a country has been noted to have a huge potential for solar energy generation due to its geographic placement and the exposure it gives it to solar radiation, with an annual exposure rate of 2700 hours to 3500 hours of sunshine, Cyprus has both factors which are known to lead to efficient solar energy harnessing and generation which are the horizontal irradiation and considerable high air temperature, with an average global horizontal irradiation of 1900kWh/m² to 2100kWh/m², and an average air temperature of 20 degrees Celsius to 24 degrees Celsius (Kassem et al. 2020).

2.11.3 Construction sector in Cyprus

The construction sector in Cyprus is one of its most developing and growing sectors, in fact it has been registered as the leading sector in Cyprus with its success credited to the rapid growth in tourism in the country, the construction sector of Cyprus has an annual growth rate of 7%, however the construction sector like most parts of the developing world has challenges of unsustainable construction practices, and needs strengthening and enhancing. Due to lack of policies by the government on construction with regards to sustainability practices the real estate developers are majorly bound to traditional and conventional ways of construction, and due to

the established link between the developers and possibly sustainable and cost-efficient alternatives sustainable construction still faces significant challenges with regards to its best practices (Elmualim & Alp, 2016).

2.12 Palestine Higher Green Building Council (PHGBC)

Palestinian Higher Green Building Council (PHGBC) is a non-governmental organization, it has the cooperation from engineers and architects in Palestine and other stake holder organizations of the construction industry in Palestine, the organization is geared with the orientation to engage in issues of standardization of environmental and sustainability goals in construction. It has the following objectives as an organization: sensitizing the public on issues of green and sustainable building, support research communities to proffer breakthroughs in sustainable and green construction, acts as an organization for guidance on sustainable construction, provision of green and sustainable construction guidelines suitable for the Palestinian geography and climate (Said & Alsamara, 2019). The engineer's association in Palestine collaborated with green buildings supreme council issued a green buildings guidebook for Palestine. This guidebook enabled the green and sustainable construction efforts of Palestine, the guide book primarily encourages the energy saving in buildings, use and integration of energy systems considered clean and harmless to the environment, natural lighting and ventilation. The guide book was written to enable buildings achieve harmony for the people dwelling in them and the environment in which they are building. PHGBC has a rating system for buildings which they give as points and then the total point a building scores across some factors determines the certification the building gets, the total points that could be achieved in the PHGBC rating is 200 points and the 200 points are spread across some factors as percentages and they are as follows; 15% for construction site sustainability, 30% for energy efficiency, 15% for internal environment quality, 10% for resources and materials used in the building's construction, and 5% for innovation in the building's design. And of this 200 points a building after grading can fall in three categories, 160 points or more gets a building the Diamond class certification, 140 points to 159 points gets a building the Silver category certification, and 100 points to 119 points earns a building the Bronze category certification. However, before a

building gets the privilege of being evaluated by the organization it has to fulfil some requirements; the building must have undergone a minimum of twelve months operation, the safety standards of the building must comply with both local and international safety regulations (PHGBC, 2013).

CHAPTER 3

CASE STUDIES

3.1 Introduction

In this chapter of our study, we will cover the case studies chosen with regards to the subject title of the research which is concerned with sustainable libraries. This study has concluded in choosing two case studies to review and analyze. The two chose case studies for the purpose of this study are the A M Qattan Foundation Library (AMQF) in Palestine and the Near East University Grand Library in North Cyprus. AMQF was chosen because it is a library which have been built with the sustainability in the design and construction objective, and it was chosen to be evaluated under the Palestinian Higher Green Building checklist for sustainability evaluation to that regard, the Near East University Grand Library was chosen as a case study in light of it also being a state of the art library, and also a sustainable conscious library, the grand library of near east university has some really commendable features which conform to sustainability standards.

3.2 Case Study 1: A M Qattan Foundation Library (AMQF), Ramallah, Palestine

The A M Qattan Foundation library building is considered a pace setter in Palestine, this is a project which checks a lot of boxes with regards to this research and its aims and objective, the A M Qattan Foundation is not only a public library but also a library which was built as a pillar of socio-cultural center for the Palestinian community. This building is situated in the city of Palestine in Ramallah, covering an area size of 7730- square meters, this is the first project in Palestine which is registered under the governing body of sustainable buildings in Palestine which is known as the Palestinian Higher Green Building Council (PHGBC), this implies the building was designed and constructed with the intention of establishing a certified sustainable building which adheres to established standards to that regard. The A M Qattan Foundation building is a building which was proposed and designed to serve as a communal beacon of

progress and knowledge considering the socio-political challenges the Palestine faces (AMQF, 2013).

The design and construction of this building started off with a competition exhibition with the intention to attract and stimulate the best design for a project of this kind, the competition was started off to pull in entries of architectural designs which will also involve the community in the choice of the winning design, where community members were given the platform to vote and give comments on their preferred building design entry (AMQF, 2012). The competition for the design of the proposed building attracted entries from our internationally acclaimed architectural offices which are Mangado Arquitectos, Donaire Arquitectos, UK and Pesquera Ulargui Arquitectos and MRJ Rundell & Associates. The design entries were adjudicated by a set up panel which is made up of the board members of the foundation's trustees and internationally acclaimed architectural design experts, the design competition was opened with the following description to guide the competition entries: a building which will serve as an architectural landmark to its community, a socio-cultural building design, an environmentally conscious building design specific to the chosen site of the construction of the building, a building to engage its community. The AMQF building was proposed with the intention of becoming a beacon to the people of its community, establishing a landmark which is not just a landmark with respect to architecture but also a landmark in socio cultural and community engagement, a hub for the community to be themselves freely, a hub for knowledge and interaction/sharing, this proposal is what the AMQF stands for as a foundation and they projected it on the building, the building was proposed to capture the past, the present , the rich complexities of the community and also provide a source of awareness to the hope and possibilities of improving the quality of socio-cultural and economic aspects of the community through the perspective of fabrics of design ("A.M. Qattan Foundation Bulding Winning Proposal / Donaire Arquitectos", 2013).

The AMQF after due considerations and oversight by the adjudicating committee chose the competition entry by Donaire Arquitectos as the winning entry. The chosen design was a concept which presented a design which perceived the proposed building as a beacon or a

lighthouse of enlightenment to the people of Palestine, with a proper presentation of the resilience of the people as a flagship of their socio-cultural and political endurance. The architects describe their design as a light at the top of a mountain which can be seen from all angles of the community, built from the materials found at the site in the community, the very earth and stone of the community, whilst they designed it with targeting local and international audiences inclusive, they made sure the building at its core speaks the local vernacular of the community. A noteworthy critical aspect of the building design is the ensuring of the building being in harmony with its environment, and this was achieved by taking total advantage of the environment in the core design of the building.

The AMQF building was designed with the main body conceptualized from a stone plinth, which is carved out from the natural environment's soil as terraces, this enables the enhancement of the building's exterior to relate with the interior of the building due to the utilization of permeable screens made of natural stones and lattices. The design was able to achieve its concept of a lighthouse sitting atop a mountain through the use of local stones not clad the entirety of the seeming tall transparent structure which gives it a glittering look at the top of the hill of the site which it is built on (Donaire, 2013). Figure 3.1 below shows the front view of the AMQF building.



Figure 3. 1: Front view of the AMQF building (Photo: L, Arafa, 2021)

The AMQF library is a well-rounded library facility, it is equipped with state-of-the-art library facilities to meet the requirement of any world standard library. The library is made up of several sections which the administrations of the library call departments, the sections and facilities in the library include the reception areas which is where the reception staff of the library are stationed, then the management offices where the rest of the administration staff of the library are also stationed, all floors of the library are accessible with elevators which were equipped to ease access for physically challenged visitors of the library. There are also meeting rooms in the library which are all sound proof rooms in order to retain the quiet atmosphere needed in a library even when meetings are going on in the meeting rooms, there is also a reception area which houses sitting areas for people who may need a break and refreshments. The library is also equipped with multimedia studios for people who may need to use a multimedia room, this multimedia studio is also well equipped and properly sound proofed to ensure the multimedia activities going on in the room does not interfere with the needed quiet atmosphere of the library,

the library also houses computers for public use and on these computers people can also access the digital library of the facility, the digital library is highly developed, maintained and encouraged by the library foundation in an attempt to promote the sustainability theme of the entire facility. Despite the library being in an Arab country, the book shelves of the library are stocked for a diverse international visitor use, the library shelves are stacked with Arabic, English and French books, the library also has a kid's section in it which houses children friendly content, also the library is well equipped with rest rooms for adults, children, all genders, and physically disabled users.



Figure 3. 2: AMQF library reception area (Photo: L, Arafa, 2021)

3.2.1 Site sustainability

Site sustainability is a very critical and paramount aspect of sustainable and green buildings, site sustainability is the taking into account or consideration the impact a building or structure will have on its immediate environment and the people who will subsequently use the building or structure. It is best practice to design and construction of a building especially a building which is intended to be a sustainable building to consider the following factors: local climate, history of development, current infrastructure, natural habitat, intended function and logistics for users of the building. The design, construction and management of the AMQF library has seen a comprehensive and careful design, planning and execution of a carefully planned site sustainability approach which adheres to best practices in that regard, the design and construction of the library has been carefully executed to contribute and adapt to the reduction of greenhouse gases and decrease the effects of climate change in the best possible ways it can. The site sustainability of AMQF library includes a conscious design by the architects to adapt to the environment it is meant to be constructed in without disrupting the ecological balance of the site beyond what is necessary

- ***Building with responsibility:*** The AMQF library building was from inception propose and designed to be a sustainable building, and part of the objectives of a green and sustainable building is the consciousness of responsible development to have little negative impact on the environment and the planet at large. The AMQF building was built responsibly with respect to ensuring the site preparation was done in such a way that the construction process took into consideration the local climate, the natural habitat around the construction site, appropriate logistics for the process of construction. the first and foremost aspect of site sustainability to which was done for this building is the conscious site selection of situating the building on a hilltop which was done to promote the idea of providing a socio-cultural beacon to the people of Palestine, the hill choice as a site to construct this building ensures the natural topography of the place elevates the building which significantly reduces cost and environmental effects of if this was to be done by other means of construction,

the AMQF library building was ensured to blend into the environment which follows the traditional and cultural practices of Palestine, two of the significant endeavors done in this regard is the reuse of the sand and stone excavated from the site which was done with the intention of reusing the material of the site itself, the second endeavor is the careful removal of all tree which were in the way of the building construction and replanted after the building was completed; more native trees and other plants were used to populate the natural habitat around the building.

- ***Ensuring outdoor thermal comfort:*** The AMQF building is incorporated with terraces that have been equipped with gardens which have been carefully designed and implemented to seamlessly get intertwined with the main building and the natural environment, these gardens have orchards of olive trees which can also be used to host outdoor activities, the courtyards are designed to adhere to 20th century Palestinian domestic gardening and architecture, these implementations ensures the celebration of the traditions and culture of the people in light of the socio-cultural impact the building is intended to have and also have an aesthetic sensibility that respects and promotes the sustainability of the site and global sustainability. The host of strategic placements of plantation of gardens and orchards in and around the building also follows active endeavors which were carried out to regulate and provide for a comfortable outdoor thermal comfort and also reduce the sometimes-severe urban heat effect of Palestine.
- ***Proper management of urban heat effect:*** The measures taken by the AMQF library building design and construction to ensure outdoor thermal comfort was the careful removal of all trees which were in the way of the building construction and replanted after the building was completed; more native trees and other plants were used to populate the natural habitat around the building. The AMQF building was designed and constructed with several courtyards in and around it which are managed and well taken care of by gardeners who have specialist green certificate, this is to ensure the management of the plants and fauna in and around the building is done in accordance of best practices of sustainability.
- ***Efficient storm water design:*** The storm water design of the AMQF building was implemented efficiently and incorporated to seamlessly work with the central storm water collection system of Ramallah where it was built. The design of the storm water management was also incorporated with the system of the rain water harvesting.
- ***Adequate reduction of pollution due to construction:*** The process involved in the construction and development of a building is a process which is often associated with

several forms of pollution, some of which are noise pollution due to the banging and movement of construction implements and machinery, and air pollution which could be from the dust raised due to excavation and other such soil related activities on the building site. The AMQF library building process saw to the active measures in reducing the pollution as a result of the construction process by the use of water sprinklers to subdue the dust on the construction site.

Table 3. 1: Site sustainability features of AMQF library

Site Sustainability Features	Presence	Description
Building responsibly	Yes	Replanting of trees, strategic site selection, use of vernacular architecture.
Outdoor thermal comfort	Yes	Garden equipped terraces, presence of courtyards and orchards.
Urban effect management	Yes	Repopulating the plant and fauna around the building with indigenous plants, certified specialist gardeners.
Storm water design	Yes	Central water collection, reservoir for rain water harvesting.
Construction pollution	Yes	Water sprinklers to reduce dust on construction site.



Figure 3. 3: A view of AMQF surrounded by replanted trees (Photo: L, Arafa, 2021)



Figure 3. 4: Indigenous shrubs and flowers planted around AMQF (Photo: L, Arafa, 2021)

3.4.2 Indoor environment quality

Indoor environment quality of a building is a very critical aspect of a building, all buildings are required to adhere to best practices or indoor environmental quality in order to provide a conducive experience to people who use the space, there are standards and best practices which have been put in place to this regard. Indoor environmental quality goes beyond the best practices of ensuring a sustainable buildings and structures, this is an issue which relates to both

long- and short-term health of the people who use a building especially does who frequent a building. The AMQF library has been designed to carry put efficient indoor environment quality with respect to adhering to sustainability best practices, the two best known and most effective methods of improving indoor environment quality have been carefully implemented in the AMQF library; proper ventilation and reduction of pollution.

Known factors under the indoor environmental quality topic are as follows: IAQ performance, healthy and efficient ventilation systems, smoking control. These three mentioned factors have been properly acknowledged and managed appropriately in the design and construction of the AMQF library building, the ventilation of the AMQF library has been majorly designed to use efficient natural ventilation with the implementation of a central void at the center of the building which is strategically designed and implemented to provide appropriate ventilation to the entire building, this is complimented with air-conditioning systems which are barely needed in most days of the year due to the efficiency of the natural ventilation system of the building. Smoking in the AMQF library building is highly discouraged and even prohibited in its entirety, the prohibition of smoking was taken so serious with regards to providing a very good indoor environment quality that smoking in the building was prohibited from the beginning of the construction of the building, as such even construction workers were not allowed to smoke on the construction site, and even after the construction and opening of the library smoking is prohibited and all smokers are required to step out of the buildings premises if they insist on having a smoke. The indoor environment quality of the AMFQ library follows standards which conform to the international standards of ensuring a building has the best possible indoor environment quality, the standards which the AMFQ library building conform to include the world health organization's guidelines of air quality, the particulate matter PM10 standard from ASHRAE which is a guideline for acceptable indoor air quality with regards to appropriate ventilation for a building, thermal comfort standards as stipulated by the Palestine green buildings regulatory body and more.



Figure 3. 5: A view of the central void in AMQF building (Photo: L, Arafa, 2021)

The indoor noise quality for the AMFQ building is a critical aspect of the building which is subject to been considered with utmost care due to the available infrastructure the library has, such as the conference rooms and multimedia rooms, such facilities are known to disrupt the atmosphere required in a library even though they are comfortable enough for a public building, such facilities which are susceptible to create or generate noise that may interfere with the needed ambience in a library are designed and constructed with materials which make them sound proof to their exterior.

3.2.3 Energy use efficiency

The AMQF library building has at its core the consideration for energy use efficiency at its core, the issue of energy in Palestine is a very critical issue due to it not being in abundance as in most parts of the world, energy in Palestine has a very high demand and a very low supply which makes it a very expensive resource. The AMQF library being a sustainable building project was designed and constructed to cater to solving the issue of energy in the management of the building, the proposed solution of the building in its design and construction is the minimization of energy use and considerable contribution to the generation of energy as part of the functions of the building. In any building two of the most energy consuming functions of a building are lighting and ventilation/air conditioning, the AMQF building has been designed to considerably depend on its environment for the most part of its ventilation and lighting without the need for energy to be used to achieve those functions in the building.

The lighting of the AMQF library building has majority of the lighting from the natural lighting of the environment, through the use of permeable material as the façade of the building which allows for light penetration into the building, also the building's central void designed for central ventilation into the building also serves the building with a function of lighting, the central void also allows considerable lighting into the building, the front façade of the building has been the main source of lighting into the building as intended by design of the building, this is significantly complimented by the central void and the rear courtyard of the building, the courtyard and central void are linked diagonally within a plinth. This design was inspired by the effective Palestinian vernacular architecture which the people have used for generations and has always worked for them with respect to air conditioning and lighting of their homes and scenery which are usually done via the use of courtyards and atria in towers to allow lighting and ventilation into a building or structure, such methods are known to significantly cut energy requirement to run and manage a building hence cutting costs and helps in the reduction of the carbon footprint the building creates.

Electrical appliance which have become necessary such as complimentary lighting bulbs and panels have been selected based on energy requirements of power, the most minimal energy requiring appliances, most of which are sensor enabled, the sensors of this devices ensures the

appliances are activated only when there is the need, such as twilight sensors to detect when it is dark enough for them to be activated and human sensors to detect when someone is in the vicinity and the powering of the appliances is required at the specific moment.

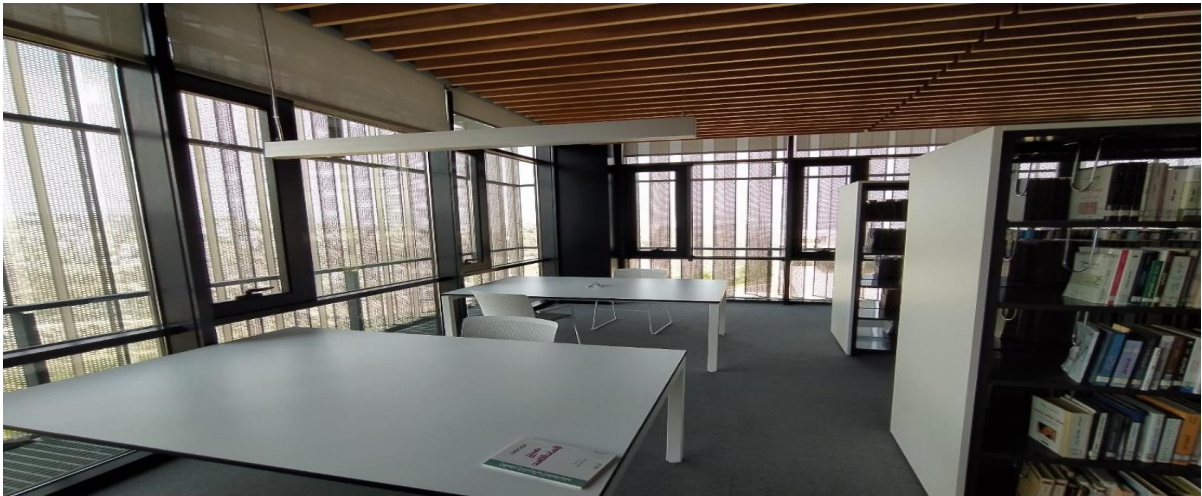


Figure 3. 6: A view of a properly lit interior of the AMQF building from natural lighting
(Photo: L, Arafa, 2021)

The AMQF library building is also equipped with PV panel fitting on the roof of the building which makes the building not just an energy consumer but also an energy generator, the energy generated by the PV panels is used to compliment the electricity which is supplied by the community electricity supply grid which is used by the building.



Figure 3. 7: Photo Voltic panels for solar energy generation on the roof of AMQF building
(Photo: L, Arafa, 2021)

3.2.4 Water use efficiency

Green and sustainable buildings are buildings which are designed, constructed and managed with the sole purpose of being environmentally friendly, that is managing the environment and the natural resources efficiently preferably through the contribution of its sustenance. The efficiency of water use in a building is paramount to ensuring a building adheres to sustainability requirements, ecofriendly water use in a building is an utmost requirement to that regard. There have been several technologies which have been developed over the years to aid in the implementation of efficient water use, and the AMQF building has taken a great deal of advantage of such technologies in ensuring the building conforms to sustainability standards in the context of efficient water use.

- ***Rain water harvesting and usage:*** Despite the Palestinian region not being a heavy rainfall seeing region, there has been a facility put in place to harvest and collect rain water whenever it rains so it can be used, rain water is collected in the AMQF building rooftop and run down a reservoir, the rain water harvesting system is part of the storm water design system which was carefully designed and also incorporated with the Ramallah municipal sewage

system which handles the disposal of the excess rain water after the reservoir of the AMQF library filled up to its capacity.

- ***Water/gray water reuse:*** the building is properly equipped with facilities which enable its re use grey water in other areas where water is needed and not necessarily sanitized water. The used water in the building is collected and reused in the management of the orchards and gardens in and around the building, the restroom facilities are also equipped with hand washing basins which collect the water which is subsequently used in flushing the toilets after they are used.

- ***Overall water system management:*** technologies have been used in the AMQF library building to efficiently reduce the quantity of water used, these technologies include the low plumbing fixtures which include the faucets and the toilets used in the building's restrooms, these chosen appliances have been carefully selected due to their utmost efficiency while using the barest minimum quantity of water in their functions, the AMQF building also uses pressure reduction or pressure moderation valves to ensure the water pressure in and around the building stays at exactly the required pressure for the water appliances to work efficiently without wasting too much water when the pressure of running water is otherwise not regulated, the pressure regulation valves ensure water is supplied at required pressures for every part of the building without an unnecessary uniform pressure been used for the entire building, this pressure moderation also extends the life cycle of the entire plumbing system if the building which implies cost efficiency in the long term management of the building, rain water and grey water are recycled in the AMQF library building especially in the area of managing and landscaping of the orchards and the gardens in the building, the recycled grey water is never used in the building in any form to be ingested even though it is treated before use because it is unhygienic to do so.

Table 3. 2: Water use efficiency in AMQF library

Efficient Water Use Features	Presence	Description
Rain water harvesting	Yes	Rain water collection reservoir, excess gets passed to the central drainage system.
Water/gray water reuse	Yes	Use of collected gray water on the gardens and orchards.
Overall water management	Yes	Sensor equipped faucets, water pressure regulation, water reuse.



Figure 3. 8: Sustainable restroom fittings in the AMQF building (Photo: L, Arafa, 2021)

3.2.5 Materials and resources

The building design competition which was put in place for the selection of an architectural design to be constructed as the new AMQF building had a clear requirement in the competition guidelines, and it was the requirement of designing and constructing the building using the best practices which will be an example to its nation as a sustainable architecture being the way forward in its future, the sustainability goal was clearly stated to use building materials that are locally available and preferably within the immediate environment of where the building was to be constructed. This clear requirement stated made it mandatory task to be carried upon with

utmost care, the building materials chosen for the construction of the building had to ensure the physical setting and environment of the building is fully taken advantage of, in order to have a complete harmony between the interior, exterior and the environment of the building, these materials also had to ensure functions such as ventilation and illumination are properly implemented.

- ***The use of non-polluting materials in the building:*** the construction and development of the AMQF library saw the use of considerably nonpolluting materials in its construction, these careful measures were taken in the process of choosing materials to be used especially in the interior of the building, ensuring coatings and adhesives were in line with sustainability standards of international green construction codes.
- ***The use of locally sourced building materials in the construction:*** Part of the sustainability endeavors in building and construction is making optimal use of the local resources in and around the construction site and incorporate it in the building, being that the AMQF library was designed based on the Palestinian vernacular architecture it was easier to utilize the locally available materials, the construction of the building utilized the locally sourced natural limestone which makes up about 80% of the building's exterior, the use of limestone achieved the intended design of the building to blend in seamlessly into the environment, painted ceramic tiles where the stones were deemed unusable in some minor areas. The choice of limestone as a material was done with regards to a significant reduction of carbon footprint left by the building.
- ***The use of recycled and recyclable materials in the building:*** The AMQF library has utilized the use of materials which are recyclable in and around the building, with furnishing materials and building materials, one of the significant use of recyclable material done in the construction and development of the building is the use of aluminum material for the façade of the entire building, aluminum is one of the most sustainable materials in the construction industry and this is so because of its immense recyclability, the entire light permitting façade of the AMQF building is made up of aluminum. Within the interior of the building a lot of materials were used most of which are synthetic materials,

however the construction of the building was mandated with the use of fittings and appliances which were produced from recycled materials, and cases where organic substitute were available to the synthetic materials, the organic materials were used.

- ***The durability of the materials used to stand the test of time thereby cost cutting:*** The use of long lasting and durable materials can be seen in and around the AMQF building, the use of materials such as limestone and aluminum in the exterior where fast deterioration of materials is common is an example of good durable material choices, these materials are very good materials which stand the test of time.

Table 3. 3: Sustainable materials and resources in AMQF library

Sustainable Materials and Resources	Presence	Description
Nonpolluting materials	Yes	Coating and adhesives conforming to green construction codes.
Local materials	Yes	80% of building exterior made up of locally sourced limestone.
Recycled/recyclable materials	Yes	Aluminum facades



Figure 3. 9: AMQF exterior made of natural limestone (Photo: L, Arafa, 2021)



Figure 3. 10: AMQF facade made of aluminum material (Photo: L, Arafa, 2021)

3.3 Case Study 2: Near East University Grand Library, North Cyprus

The Near East University grand library is a library situated in Near East University, this university was completed and launched in the year 2005, this library was designed and built to be a world class library facility, the entire library building boasts of 15,000 square meters of indoor space with an estimate 1.5 million books in its collections, over 150 million electronic books and other resources, an indoor cafeteria which has a 350 person seating capacity The Near East University Grand Library is not just accessible to the students of the university but to the entire general public.

The design and construction of the Grand Library was carried out with environmental consciousness and sustainability factored into it. Its environmental consciousness and sustainability efforts can be seen across the facilities in some of its most renowned and obvious sustainability features such as the energy use efficiency when it comes to lighting and water use efficiency in its rest rooms which use state of the art facilities to that regard. The grand library has features in its design and construction which enable it have a proper and efficient ventilation and cooling, the design and constructed to suit the need of the university and the entire Turkish Cypriot community after it drew several inspirations from the world over, the university was

designed to symbolize peace, hence its combination of different architectural styles in its design (Tumer, 2006). A view of the near east university grand library can be seen in figure 3.11 below.



Figure 3. 11: Near East University Grand Library front view (Photo: L, Arafa, 2021)

3.3.1 Site sustainability

Site sustainability is as discussed earlier is a very critical aspect of designing and building a green and sustainable building because it is the first step of actually considering the environment and ecosystem around a building as to how the building to be constructed inside it will disrupt it or compliment it. The near east university grand library has checked some boxes in this regard but in some aspect, it does not perform so well.

- ***Building with responsibility:*** The chosen positioning of the library construction in the university campus was however done strategically to provide easy access to the university people by strategically positioning it in the middle of the university campus, the library has also taken into consideration logistics for physically challenged people to have easy access to use the library facilities by placement of ramps within the library as

can be seen in figure 3.12 and also for exit and entry into the building through the use of a separate entry and exit point

- ***Outdoor thermal comfort:*** The outdoor thermal comfort of the grand library has a lot to improve on, there have been no efforts or endeavors made to provide any form of green and natural landscaping, all trees and fauna found on the site prior to construction were discarded and not replanted. the library has a vast space in front of it which could have been consciously utilized in green landscaping or building of court yards and gardens, but instead it is completely tiled.
- ***Proper management of urban heat effect:*** The grand library was designed to utilize and maximize the day light for its interior lighting which it has done so exceptionally, however it has failed to provide any form of shading against the harshness of excess sunlight, there is neither natural nor artificial shading against the harshness of sunlight which makes the library users exposed to this natural element's harshness whenever the sun is harsh.
- ***Efficient storm water design:*** The storm water design of the grand library was efficiently done due to the university campus's already well designed and functioning storm water facility which the grand library's water sewage system was also incorporated seamlessly to.
- ***Adequate reduction of pollution due to construction:*** There was no acquired data on the construction process of the grand library with regards to the reduction of pollution measures taken or not during construction.

Table 3. 4: Site sustainability features in The Grand Library.

Sustainable Feature	Presence	Description
Building responsibly	Yes	Strategic site selection, physically challenged people consideration.
Outdoor thermal comfort	No	Absence of thermal comfort features.
Urban effect management	No	Absence of thermal comfort features.
Storm water design	Yes	Efficient storm water design which is part of the campus drainage system.
Construction pollution	No data	No acquired data.



Figure 3. 12: Ramp facility within the Near East University Grand Library (Photo: L, Arafa, 2021)

3.3.2 Indoor environment quality

The indoor environment quality of the Near East Grand Library has been a priority in the design, construction and management of the library, having a proper quality of indoor quality is essential

to not only a green and sustainable building but also very critical to a library and any other building. Materials used within the interior of the building were carefully chosen to have passed quality tests in ensuring they do not alter a convenient indoor environment of the library, such as the paint finishing and the carpeting of the entire building, there is a proper airconditioned ventilation system also provided for the building. The Grand Library also has indoor plants inside the building which give a pleasant aesthetic look to the interior of the building and also functionally improve the air and environment quality of the building, an example of the indoor plants in the library can be seen in figure 3.13 above. The library also has a no smoking policy within the grand library even at the cafeteria of the library which was also an effort to improve the indoor environment quality and ensure it is not polluted with cigarette smoking within the premises of the library



Figure 3. 13: Indoor plants in the Grand Library (Photo: L, Arafa, 2021)

The near east grand library also has policies put in place with regard to cleaning and pest control agents used in the library, any chemical agents to be used in the cleaning of the premises of control of pests has to be environmentally safe, because using environmentally polluting chemical means it also pollutes the indoor environment quality which will then in turn harm the

users of the library facilities. The library also uses outdoor air ventilation to compliment the air conditioning systems installed for the ventilation and air quality of the library

3.3.3 Energy use efficiency

The Near East University Grand Library has some energy use efficiency features which have been put in place to that regard. Energy use efficiency as a factor is as paramount to the success of any green or sustainable building as the rest of the factors used in evaluating the efficiency of a building in being sustainable building.

The first notable thing in the Near East University Grand Library with regards to energy use efficiency is the fact that it lacks any form of renewable energy generation, this puts the building as solely a consumer of energy with no energy generation capabilities to complement its energy consumption. However the Grand Library has an impressive use of natural lighting and outdoor air ventilation, which goes a long way in reducing the overall energy consumption of the library building, the use of glass facades on the building ensures there is adequate sunlight penetration into the building, the use of pathways for natural lighting and outdoor air penetration into the building is done to conform with passive design principles which is a very effective way of implementing sustainability in a building design and construction. Due to the inability of the façade of the building to supply natural lighting to the central part of the building due to the vast size of the building, a central lighting “dome” was incorporated into the design of the grand library, this center dome like design is equipped with glass features which allow for natural lighting to come into the parts of the library which the exterior facade light penetration does not get to and in turn reduces the energy consumption of the building, this dome like feature can be seen in figure 3.14 below. All electric fittings in the library are also chosen carefully with respect to low energy consumption to ensure the total energy consumption of the building remains low to lower the energy demand strain of the building on the energy source of the university campus.



Figure 3. 14: Grand Library natural lighting feature (library.neu.edu.tr)

3.3.4 Water use efficiency

The Near East University Grand Library has been facilitated with some water efficiency usage features, especially in the restrooms of the library, where proximity sensors are used to ensure proper and adequate usage of the water closets in the facility, the lack of green landscaping on the exterior of the building also means the water usage of the building is low. However more can be done with respect to water use efficiency, such as the recycling of grey water and rain water harvesting which are both not done at the moment in the university library.

- ***Rain water harvesting and usage:*** The Grand Library has a very neatly laid out rain water collection system, the rain water is collected and directly channeled to the sewage system, if the rain water was collected and stored in a reservoir it would have been very useful in other usage.
- ***Water/ gray water reuse:*** The Grand Library lacks any facility of grey water and water recycling in the building.
- ***Overall water system management:*** The Grand Library has put in some measures to ensure some efficient water management in the building, however more can be done

with regards to rain water harvesting and grey water reuse, the grand library currently uses proximity sensors in the restrooms to ensure water is dispensed efficiently and only when needed, the urinals in the restrooms are also fitted with water free urinal systems to reduce the use of water in flushing and sanitizing the urinals, with regards to water use efficiency the grand library is more on the low water consumption side of things rather than efficient water usage in the building.

Table 3. 5: Efficient water use features in The Grand Library

Efficient Water Use Features	Presence	Description
Rain water harvesting	No	The library has no rain water harvesting feature.
Water/gray water reuse	No	The library has no water reuse features.
Overall water management	Yes	Sensor equipped faucets, water pressure regulation.

3.3.5 Materials and resources

The Near East University Grand Library has some really impressive features with regards to materials and resources used in the design and construction of the library as well as the management of the library with regards to materials and resources. The materials and resources of The Grand Library make the most impact in the day-to-day management of the library, where there is use of sustainable products in the cleaning, use of IAQ compliant products such as light bulbs containing no mercury in them which is an undesirable element in the discipline of sustainability and maintenance of the building. The Grand Library is also into occupant recycling which is part of the campaign of the Near East University sustainability campaign tagged “*every waste is not a waste*”, waste recycling is made easy at The Grand Library through the use of clearly labeled waste bins for different kinds of waste such as paper waste, plastic waste and can waste, besides running the recycling activities in the building, The Grand Library also has programs which is targeted at sensitizing people towards the benefits of waste recycling (NEU, 2020).

- ***Use of non-polluting materials in the building:*** The Grand Library is actively using nonpolluting materials in maintaining the building in its day-to-day activities, such as the cleaning agents used. The grand library is also cautious in using light bulbs as it stays away from using mercury light bulbs due to their unsustainable characteristics
- ***The use of locally sourced building materials in the construction:*** there is no acquired information about significant use of locally sourced materials in the construction of The Grand Library.
- ***The use of recycled and recyclable materials in the building:*** The Grand Library is a well-known advocate of occupant recycling with its programs which are spread all around campus and even outside campus, which is targeted at sensitizing people towards the benefits of recycling.

Table 3. 6: Sustainable materials and resources in The Grand Library

Sustainable Materials and Resources	Presence	Description
Nonpolluting materials	Yes	Electric fittings, cleaning agents.
Local materials	No data	No acquired data
Recycled/recyclable materials	Yes	Active recycling program, and campaign by the library.

CHAPTER 4

FINDINGS

The analyzed case studies in this research have led to some interesting findings with regards to the performance of the libraires against the PHGBC checklist. The two libraries used for this case studies have both performed significantly in some of the sustainability features on the checklist, below are the findings of the research with respect to comparison of the AMQF library and The Grand Library.

The comparison between the two case studies reveals the similarities between the case studies, their differences, their advantages and disadvantages based on their design principles.

4.1 Similarities of Case Studies

AMQF library and The Grand library have some similarities between them based on their design principles and execution of the two libraire with regards to sustainability. Both AMQF and The Grand Library have a remarkable use of natural lighting in the interior space, both libraires have made adequate use of the sunlight available based on the similar regional climate both libraries share. AMQF library and The Grand library both used light permeable facades to allow adequate penetration of light into the building. Both libraires have also taken measures in their design to avoid excess light or allow the harshness of the sunlight into the building, the AMQF library used its aluminum façade to provide a form of shielding from the intensity of the sunlight and The Grand library used tint coating on its glass façade to reduce the intensity of the sunlight which comes into the building.

The two libraries also have similar overall water management systems and storm water design, both libraires have adequate storm water design which provide proper storm water management for the buildings, and the water management of the buildings though they differ in their usage of water they both have a similarity in the use of water pressure regulation.

4.2 Advantages of Case Studies

The two libraires used as case studies in this research have their advantages and also disadvantages. the advantages of the libraries are outlined for each library as follows:

4.2.1 Advantages of AMQF library

The advantages of the AMQF library stem from the fact that the building was designed and built with the consideration of the PHGBC checklist for sustainable buildings. The fact that the entirety of the building was commissioned from inception as a sustainable library ensured the building has a lot of significant advantages which include:

- Water and gray water reuse in the building
- Electricity generation through the use of Photo Voltic panels.
- The use of vernacular Palestinian architecture design principles to aid sustainable development.
- Exceptional outdoor thermal comfort due to replanting of trees from the construction site around the building.
- Significant use of locally sourced material; limestone.
- Sustainable building tour guide.

4.2.2 Advantages of The Grand Library

The Near East University Grand Library has some considerable advantages in the context of sustainability, even though this building unlike the AMQF library was not commissioned to be designed as a sustainable library, it has managed to gain some significant sustainability features advantages which are as follows:

- Adequate use of natural lighting.
- Indoor air quality enhancement through the use of indoor plants.
- Efficient water management.

4.3 Disadvantages of Case Studies

The two case studies which were analyzed have been found to have some considerable significant advantages, however some disadvantages have also been found. The AMQF library has not recorded any design principles disadvantages from our analysis which was based on the PHGBC checklist, however The Grand Library has been found with some considerable disadvantages due to its design principles when analyzed using the PHGBC checklist, the disadvantages of The Grand Library are listed as follows:

- Poor outdoor thermal quality.
- Significant negative change on the natural environment.
- Lack of renewable energy generation and usage,
- Lack of water and gray water reuse.

CHAPTER 5

CONCLUSION

This research was aimed at shedding light on the subject of sustainable buildings and their benefits on the environment. The subject of sustainable building despite the considerable efforts been made in the architectural discipline seems to still be in its novelty stage, with the majority of the construction sector not embracing sustainable building practices.

Libraries have been identified as huge consumers of resources which conventionally place a huge burden on the environment, Sustainable libraries have been identified as a tool of sustainable building, unlike ordinary sustainable buildings, sustainable libraries are required to have all the requirements of a sustainable buildings and also have the characteristics of being a tool to sensitize the general public on the subject of sustainable buildings (Darko and Chan, 2017).

Libraries have been tools of education for humanity for a very long time. In line with the current global environmental concerns and the efforts been made by the construction industry to contribute to the efforts of environmental sustenance can be significantly complimented through the building and construction of sustainable public buildings. Libraries as public buildings tend to play a major role as seen in one of our case studies; AMQF library. The AMQF library was designed and built as a sustainable library, it conforms to the sustainable building best practices of its region and also taken up the mantle of becoming a tool of educating people with regards to the benefits of sustainable building.

Projects such as the AMQF library need to be supported and implemented in most societies because of their possible impact on sensitizing people on the subject if sustainable living, when public buildings such as libraries are designed and positioned as examples for sustainability it makes it easier for people to be exposed to sustainable living as not just a dream or an idea but a realistic way forward to sustain the planet which will inevitable convince more people to indulge in such sustainable practices of construction and general living.

The Grand Library is definitely not an all-rounded sustainable library, but it still has some really significant sustainable buildings which the library benefits from. Libraries like every other building do not need to be all rounded in sustainable standards before they can benefit from the advantages of sustainable building. Libraries can pick some sustainable features and implement them to the best of their ability, despite not having an all-rounded sustainability The Grand Library still has considerable contributions in sustaining the environment, with features such as its efficient use of natural lighting, it ensures considerable reduction in the use of electricity which means less strain on the environment for the production of electricity to that regard, also the building having indoor plants to cater to the indoor environmental quality also contribute significantly to the environment through the production of oxygen and consumption of carbon dioxide by the plants.

The Grand Library serves as an example to other buildings and also other libraries to embrace sustainable building practices even when they are not done at a 100% around the building. Sustainable buildings or libraries must not have an ideal design and implementation even though that may be the desirable scenario to ensure an adequate and efficient positive impact on the sustenance of the environment, sustainability I buildings should be practiced at every considerable level of implementation in all buildings; public buildings and private buildings.

Another benefit of sustainable buildings and sustainable libraries besides having a positive impact on the environment is the economic benefits attached to it. The economic benefits of sustainable buildings are not emphasized enough when educating people or the construction industry about the promotion of sustainable building practices, the economic benefits of sustainable buildings are significant especially when the long term perspective is considered for a building, and perhaps the economic benefits of sustainable buildings should be considered as one of the factors to emphasize on to attract architects and builders to embrace sustainable building practices. The economic benefits of sustainable building practices can be seen in both AMQF library and The Grand Library, with features such as efficient water management ensuing a considerable reduction in water usage which implies less cost of water consumed, significant use of natural lighting which also translates to less electric power consumption by

the libraries. Advantages of sustainable building transcend the primary objective of environmental sustenance, and the economic benefits of it will also pay a significant role in making people embrace the practice of sustainable building around the world.

Sustainability in libraries may be in total adherence to certification standards or partially implemented in areas the developers seem capable of doing so, either way goes a long way in ensuring sustainability of the environment as is needed in these times where the environment is faced with significant challenges of deterioration.

5.1 Recommendations

This research has comprehensively covered the topic of sustainable buildings within the context of sustainable libraries, and carried out case studies of two renowned libraries to that regard. The benefits of sustainable buildings can be practically seen when public buildings are developed using the principles of sustainable buildings development, a great example of such practicality can be seen in the AMQF library; where the library building plays its part in conserving the environment and is also a tool in the practical orientation of the society in light of sustainable building practices and their benefits. This makes sustainable libraries as very useful tools which need to be emphasized upon through design and development in most societies to forward the cause of sustainability.

Sustainable building standards as can be seen in sustainable building certification bodies such as LEED, BREEAM, and PHGBC are very essential to ensuring the best practices and principles of sustainable building are adhered to, it is also very critical for all geographic regions to tailor a checklist which will serve as a checklist specific to their own environmental characteristics as can be seen in the case of PHGBC. PHGBC made a checklist which is best suited for the Palestinian environment.

This research has highlighted the key role of technology in the implementation of sustainable buildings, where a building is directly influenced by the technology used in the design and construction of the building. Technological development for sustainable buildings should emphasize on advancing the traditional sustainable ways of building construction and usher

them into the present-day contemporary world by making them state of the art through modernization.

Further studies on this subject should be considered into the long-term effects and benefits of sustainable buildings and sustainable libraries. Such studies will expose the environmental and economic benefits attached to the construction of sustainable buildings, for instance a follow up study on the AMQF library will be a very good research to report the performance of the building on the long-term perspective, this will enable an adequate insight into advantages of sustainable buildings and sustainable libraries.

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APPENDICES

Appendix 1: Similarity Report

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<input type="checkbox"/>	Layth Arafa	THESIS	5% 	--	--		1520379707	28-Feb-2021	

Appendix 2: Ethical Approval Document



ETHICAL APPROVAL DOCUMENT

Date: 04/11/2021

To the **Graduate School of Applied Sciences**

The thesis titled “Analyzing Library Buildings According to Palestinian Higher Green Building Council as One of The Factors of Sustainability” has been evaluated. Since the researcher will not collect primary data from humans, animals, plants or earth, this project does not need to go through the ethics committee.

Name Surname: Prof. Dr. Zeynep Onur

Signature:

Role in the Thesis: Supervisor