TITLE: - ASSESSEMENT ON ADOPTION AND IMPLEMENTATION OF GREEN BUILDING IN ETHIOPIA, IN CASE OF ADDIS ABABA

ABDELLAH SHUKRA MOHAMMED

A Thesis Submitted to the Department of Construction Engineering and Management

School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Civil Engineering (Specialization in Construction Engineering and Management)

Office of Graduate Studies

Adama Science and Technology University

September, 2022

Adama, Ethiopia

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MESERET GETNET (PhD)

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APPROVAL PAGE OF ADVISOR

I, the advisors of the thesis entitled **"Assessment on Adoption and Implementation of Green Building in Ethiopia, In Case of Addis Ababa"** and developed by Abdellah Shukra Mohammed; hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

Meseret Getnet (PhD)	________________________	________________
Major Advisor	Signature	Date
___________________________	________________________	________________
Co-advisor	Signature	Date

APPROVAL PAGE OF BOARD OF REVIEWERS

We, the undersigned, members of the Board of Examiners of the thesis by Abdellah Shukra Mohammed, have read and evaluated the thesis entitled **"Assessment on Adoption and Implementation of Green Building in Ethiopia, In Case of Addis Ababa"** and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of Master of Science in Civil Engineering (Specialization in Construction Engineering and Management).

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Internal Examiner	Signature	Date
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DECLARATION

I hereby declare that this Master Thesis entitled **“Assessment on Adoption and Implementation of Green Building in Ethiopia, In Case of Addis Ababa”** is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation.

Abdellah Shukra Mohammed ________________________ ________________

Name of the student Signature Date

RECOMMENDATION

I, the advisor(s) of this thesis, hereby certify that I have read the revised version of the thesis entitled **“Assessment on Adoption and Implementation of Green Building in Ethiopia, In Case of Addis Ababa”** prepared under my guidance by Abdellah Shukra Mohammed submitted in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering (Specialization in Construction Engineering and Management).

Therefore, I recommend that the student has fulfilled the requirements and hence hereby he can submit the thesis to the department for further review and evaluation.

This MSc Thesis has been submitted for examination with my approval as thesis Supervisor.

Name of Advisor: Meseret Getnet (PhD)

Signature: ______________________

Date: _________________________

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TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

TABLES PAGE

LIST OF FIGURES

FIGURES PAGE

LIST OF ACRONYM

BEAM……………………………………... Building Environmental Assessment Method

BREEAM…………Building Research Establishment Environmental Assessment Method

CASBEE…....Comprehensive Assessment System for Building Environmental Efficiency

CFC…………………………….…………….…….……………chloro-fluoro carbons

CO_2 ....…..Carbon dioxide

CSH's……………………………………………….…...Code for Sustainable Homes

EPA…………………..………………………………Environmental Protection Agency

EPBD…………………………………...…Energy Performance of Building Directive

EU ………………………………………………………..………..European Union

GB…………………………………………………………………….…..Green Building

GBC …………………...……………………...……………..Green Building Councils

GHG……………………………………………………………………...Greenhouse gas

HVAC ……………………..……..…………Heating, Ventilation, and Air Conditioning

IAQ ……………...…………………………..………………………..indoor air quality

IEA……………………………………………………….…...International Energy Agency

IEA……………………………………………………...…International Energy Agency

LEED …………..…………….……….……Leadership in Energy and Environmental Design

SPSS……………………………………………..Statistical Package for the Social Science

SSA…………………………………………………………………..Sub-Saharan Africa

VOCs...…...volatile organic compounds

ABSTRACT

Green building technology is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from feasibility study to design, construction, operation, maintenance, renovation and deconstruction. Green construction and operation will promote a healthy environment for all involved, and it will not disrupt the land, water, resources and energy in and around the building. It provides some of the most effective means to achieve a range of global goals, such as addressing climate change, creating sustainable and thriving communities, and driving economic growth. Especially the developed countries accept this as a best option to the mitigation of the construction industry problems like, impacts on the environment, energy efficiency, using recycled and recyclable materials, improve building lifespan and health of occupants and have developed codes, policies and frameworks to encourage and enforce the implementation of green building concepts in their construction industries. But In a sharp contrast, the uptakes of green building in the Construction industry of developing countries of Sub-Saharan Africa (SSA) is at infant stage and characterized by the absence of green building codes and frameworks and faces challenges like unfamiliarity, misunderstanding the concept, lack of clear ways to adopt and implement green building and there are different barriers like economic issues, attitude and market, management and government, product information and sourcing, technology and training. From that fact and Ethiopia as a part of developing Sub-Saharan African country, this study was conducted in Ethiopia in case of capital city Addis Ababa to assess that the level of awareness, to identify opportunities, enablers and challenges to practice green construction. Therefore, by critical review of literatures, analysis of questionaries' and interviews by descriptive or frequency analysis by using SPSS software, the current level of awareness about green building and some of potential opportunities, challenge/barriers and enablers/promoting strategies for adoption and implementation of green building were identified and discussed. Finally concluded that green building concept is at very infant or even in null stage and its concept, adoption and implementation strategies and an increased uptake concept needs attention and tried to recommend my best at the recommendations.

Key Words: Green Building, Opportunity, Enablers, Barriers, Adoption, Implementation & Ethiopia.

CHAPTER ONE

1. INTRODUCTION TO GREEN BUILDING

1.1 Background of the Study

Today the issue of global warming, ozone depletion, resource depletion, energy scarcity, ecological toxicity, human toxicity, acid rains needs attention. These have alarmed, rather compelled the mankind to change the way they operate on the earth. Though we cannot avoid affecting the environment, the green buildings will aim and contribute towards minimizing the environmental impact. It should also be emphasized that green buildings do not only contribute towards a sustainable construction and environment but it also brings lots of benefits and advantages to the building owners and the users. It contributes towards lower development costs lower operating costs, increased comforts, healthier indoor environment quality, and enhanced durability and less maintenance costs (Godslove, 2019).

Green buildings (GBs) are increasingly being used by the industry as a means for environmental impact mitigation, resource efficiency and conservation, and corporate social responsibility while at the same time bringing constructive and healthy effects throughout the life cycle of the building. This has necessitated the interventions of Governments in many countries to enact laws, mandates, policies and other administrative instruments to boost uptake and implementation of green building concepts (GBCs) in the construction and operation of buildings. However, globally, the green building stock is still a little fraction of the totality of buildings with the developed world being several miles ahead of the developing country counterparts(Anzagira, Duah, et al., 2019).

It is compulsory that all buildings in the US meet and satisfy Leadership in Energy and Environmental Design (LEED) standards as a response to the Green building legislation that was enacted. Also, by the year 2006, the buildings in all European Union (EU) countries were directed to have energy certification and meet a minimum energy performance standard according to the Energy Performance of Building Directive (EPBD) legislation that was passed. They have also initiated a US $20 million fund to enable industry stakeholders to adopt and put to practice GB practices and technologies to ensure sustainable building design. Other government interventions such as the formulation of incentive policies like mortgage loans and discount loans have been adopted by developed countries including the US, UK, and Canada to stimulate the implementation of green practices and technologies(Godslove, 2019).

In contrast, Developing countries such as those in Sub-Saharan Africa are noted to still be grappling with the basics of GB adoption and are largely characterized by the absence of or few tried and tested rating systems of their own, the existence of few certified green buildings and the absence of mandatory GB laws, policies and incentives which is a direct contrast to the developed world counterparts(Anzagira, Badu, et al., 2019).

In Africa, the concept is now gaining popularity and efforts have been made by countries like South Africa, Kenya, Ghana, Nigeria and Egypt to green their buildings, there have been some significant increase in the number of green buildings which is quite encouraging. For instance, the first green building certification system in Ghana that is the Green Star Ghana-South Africa was issued in 2009. This green certification system was used to certify Ghana’s first green building called One Airport Square located in Accra. Subsequently, the Green Star South Africa-Ghana was used to certify Stanbic heights building in Accra (Godslove, 2019).

Despite its benefits, Different studies(Anzagira, Duah, et al., 2019),(Gibberd, 2020),(Nikyema & Blouin, 2020),(Omuh et al., 2020) indicated that sustainable or green building concept is still at its infant stage in developing countries, especially in Africa. For its extensive practice and to embrace such systems adequate further studies were needed. As per any concerning country about green and sustainable construction concept, Ethiopian construction industry needs detail and continuous studies to achieve its short and long term goals and to address its multi-disciplinary problems. In did, the aim of this study is to assess level of awareness about green building technology, to identify opportunities, Enablers/promoting strategies and challenges/barriers to adopt and implement green building technology Ethiopia, in case of capital city Addis Ababa.

1.2. Statement of the Problem

Currently in Ethiopia there is a large investment in construction industry. But still the industry faces different challenges like lack of integration between stakeholders, cost overrun, poor quality and late completion compromises, inconvenience, health & safety problems, construction material scarce and very high inflation and due to these unable to achieve affordability & cost efficient construction, energy efficiency, water efficiency , sustainability and other related problems. Due to these and others like economic, environmental, technological considerations and emerging of different environmental, sustainability and affordability concepts the area needs detail, further and continues researches. Therefore, as a part with regards to sustainability and green construction, this research was conducted to assess current status of green building awareness level, to identify opportunities, promoting factors and barriers for adoption and implementation of green building technology or sustainable construction in Ethiopia, in case of Addis Ababa.

1.3. Objective of the Study

1.3.1 General Objective

The main objectives of this study was to contribute to the enhancement of the transformation of the building practice to green building practice by assessing the extent to which green building technology concepts have been familiarized and identify opportunities, promoting strategies, barriers for adoption and implementation of green building technology concepts in Ethiopia construction industry.

1.3.2 Specific Objectives

Specifically the study has objectives, to assess current level of awareness about green building concept, to assess opportunities to adopt and implement green building technology, identify promoting strategies for adoption and implementation of green building technology and identify barriers in adoption of green building technology in Ethiopia.

1.4. Research Questions

Basically two question types/parts were prepared. Type I (Open ended questions for discussion and interview.) for focal person discussion and interviews and Part II Different questions, for questionaries' (15 questions for the first objective), 11 questions for the second objective, 14 questions for the third objective and for 15 question fourth objectives by considering different factors or parameters to achieve specified objectives. Both questionnaire and interview questions were attached at the appendix as section 1 and section 2 respectively. For both cases the following questions basically addressed.

1. What are levels of awareness about green building technology?

2. What are opportunities to adopt green building technology?

3. What are Promoting strategies to adopt green building technology?

4. What are Challenges for green building technology adoption?

The five-point Likert scales provide results that are unambiguous and hence can be interpreted without difficulty (Darko & Chan, 2018). Therefore five-point Likert scale was adopted in this study. Relative Importance Index (RII) is used to determine relative importance of quality factors involved. This allows to identifying most important criteria/factor based on participant's replies

1.5. Significance of the Study

The study would provide valuable knowledge about current awareness level of green building technology concepts, existing opportunities, promoting factors and barriers were identified and prioritized. Hope that identification and prioritization of these factors were used as a potential input element for construction modernization efforts and it helps to fill the gaps in green building body of knowledge. In addition findings obtained used as an element for policy makers, industry stakeholders, and advocates in formulating and implementing proper strategies for green/sustainable construction adoption promotion particularly for developing countries like Ethiopia.

Through its findings, it also suggested ways to increase green building technology/ sustainability construction adoption and implementation in Ethiopian building construction industry and it can be used as a useful reference for both industry practitioners and academics that are interested in green building developments. Also hope that, findings of the research used as standing point for further researches. And may the research approaches could be used as standing point to encourage further studies on sustainable building practices.

1.6. Scope of the Study

The scope of the research was to assess level of green building technology awareness and to identify existing opportunities, promoting factors and barriers to adopt green building technology concepts in Ethiopia, in case of capital city Addis Ababa. To achieve this I reviewed literatures about concepts, histories and trends in developed (e.g. like United

States, united kingdom) and developing sub Saharan African country (e.g. like Ghana, South Africa, Nigeria and Egypt). With respect to this and using GBTs tools (BREEAM, LEED and Green Star rating system) as a benchmark, especially with developing African countries, I tried to assess the existing awareness level, opportunity, enabler/stimulating factors and challenges. For the study literature review, questionnaire & interview techniques were used and seven selected/concerned Ethiopian construction ministry organizations namely Ethiopian construction authority, Addis Ababa housing development corporation, federal housing corporation, ministry of urban development and infrastructure, Addis Ababa plan and development commission, Addis Ababa construction permit and control and Ethiopian engineering and investment group were targeted.

1.7 Limitation of the study

The limitations encountered during this study were basically shortage of previously done researches and communication difficulties about Green Building technology concepts even with professionals. Since it is a new technology, different scholars define it in different ways as modern construction concepts. Example,

Due to the global appeal for the GBC, it has received a lot of attention from many researchers hence many definitions exist for green building. The term "green building" is often used interchangeably with the terms sustainable construction, and high-performance buildings, within the construction industry (Anzagira, Badu, et al., 2019). And lack of properly documented data. The same was true when we came to our country cases, some were define GB as vertical greenery others as walkways, roundabouts and garden greeneries and even others as urban agriculture. But the fact is far apart.

So to overcome the gaps the study tries to refer different national articles, policies, strategies, frame works and guide lines (Commission maps by Addis Ababa city administration (2017) , ten years construction plan, by plan and development commission (2013-2022), building spatial design(Addis Ababa city administration), National Physical Planning Standards and Guidelines, Addis Ababa city building standards). Even though their concepts were related with some green building concept, almost all of them were not concern on green building concepts and for the concept variation cases I tried to orient it.

1.8 Organization of the Study

FIGURE 1: ORGANIZATION OF THE STUDY

(Source: Computed by the researcher, August 2022

CHAPTER TWO

2. LITRETURE REVIEW

2.1 Green Construction

For the past thirty years, green building has spread around the world, beginning first in the UK, then spreading to North America, then to Western Europe, Northeast Asia, Singapore, Brazil and Colombia, China, Eastern Europe, and, in the decade of the 2010s, to the entire world. In each country, it was necessary to put an entire ecosystem” in place, consisting of rating systems, training of design and construction professionals, development of green products and systems, growth of green building consulting firms, development of a business case for commercial investors, etc. (Gou, 2020). Over the decades, significant efforts have been made to promote sustainability in property development due to the enormous amounts of natural resources being consumed daily around the world. Moreover, governments and the public worldwide are responsible for controlling this consumption and looking for innovative and efficient alternatives that potentially lead to sustainable development. The momentum of the green building movement is increasing as the environmental impact of building activities becomes more obvious and significant(Godslove, 2019).

Sustainability, the need to manage our resources so as not to exhaust them is necessary in the world today. Quite a good number of construction projects are handled from design to erection without concern for the effects of the sustainability of these projects and their effects on the environment. In the construction and building industry, there is no need to relent in the pursuit of sustainable practices because researches have shown that it has been identified as the one of the most significant destroyer of our natural habitat. The construction industry is known to consume significant quantities of resources, and release pollutants to the atmosphere. According to the International Energy Agency (IEA), construction industry is responsible for the consumption of over 40% of the total global energy and is also responsible for releasing over 40% of the total greenhouse gas (GHG) that is released to the environment(Gibberd, 2020),(Omuh et al.). An observation of the trends indicates that GHG emissions and energy demand associated with the construction industry will double by the year. When a building is developed for being resource efficient and environmentally friendly, it is referred to as a green building. A more detailed definition is given by the world council of green building defining green buildings as a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment.(Omuh et al, 2018) .

In recent years, the world has experienced environmental problems such as warming and economic crisis. Therefore, today plans of sustainable development should be considered more than previously. One of these plans is green building and architecture. Today, development of green architecture is increasingly accepted. Buildings consume relatively %40 of energy. Effectiveness of green buildings is identified worldwide in environmental, economic, and social terms(Loumer, 2015).

A major global challenge in the twenty-first century is how to tackle the challenge of climate change and the action of chloro-fluoro carbons (CFC), and reducing greenhouse gas emissions. This could be achieved by introducing or using green technology in buildings. It will be significant to primarily understand what green technology is. Green building technologies include technologies like energy efficient Heating, ventilation, and air conditioning (HVAC), solar technology, and other technologies to improve the general sustainable performance of the buildings. Green technology involves the use of knowledge for practical purposes but with preserving the environmental attributes as the main objective of the technology. Green technology has the goals of minimizing waste, reducing pollution. Green building technology is also referred to as green construction or sustainable building technology and a typical green building technology project has the objective of conserving and restoring the habitat that is vital for the sustenance of life. The protection of the environment is the primary reason green building technology should be practiced because the priority is the need for preserving the resources available thereby encouraging sustainable development practices(Omuh et al, 2018).

Today due to increase in technological advancement and economic growth, building construction has greatly increased and has accounted for almost half of the greenhouse gas emissions and energy consumed due to the energy used in the production and transportation of materials(Godslove, 2019).

The term “green building” is often used interchangeably with the terms sustainable construction, and high-performance buildings, within the construction industry.(Anzagira, Badu, et al., 2019). Climate change, environmental impact and the limited natural resources urge scientific research and novel technical solutions. The monograph series

Green Energy and Technology serves as a publishing platform for scientific and technological approaches to “green” i.e. environmentally friendly and sustainable technologies (Gou, 2020).

Green Building as “the practice of creating structures and processes that are environmentally responsible and resource-efficient throughout a buildings life-cycle from siting to design, construction, operation, maintenance, renovation, and deconstruction. Or set of environmentally related criteria including sustainable sites and transport, water efficiency, energy efficiency, indoor air quality improvement, as well as environmentally friendly materials .(Anzagira, Duah, et al., 2019).

So based on references cited earlier, green building defined as the planning, siting, design and construction of buildings by the use of resource-efficient materials and methods which will have less impact on the health of the environment, as well as the associated health and well-being of the buildings’ occupants, construction workers, the general public, and future generations throughout the life cycle of the building. Some people may think of a green or sustainable building as just a building that doesn’t really have as bad of an impact on the environment as another ‘average’ building. The construction and operation will promote a healthy environment for all involved and it will not disrupt the land, water, resources and energy in and around the building.

2.2 Green tools

According to (Anzagira, Badu, et al., 2019) Over the years, the global appeal for GB has led to the introduction of guidelines and frameworks with the aim of providing a level plat form in terms of uniformity of stands for the application of sustainable practices as well as the acceptance. Building Research Establishment Environmental Assessment Method (BREEAM) was the first GB guideline presented to the world in the U.K in 1990, following closely on its heels is the Leadership in Energy and Environmental Design (LEED), a credit based GB rating system implemented since 2000 by the U.S. Some other guidelines include the Building Environmental Assessment Method (BEAM) of Hong Kong, Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) of Japan, Green Star of Australia, Green Globes in Canada and US, Green Mark in Singapore, TERI-GRIHA in India, Green Building Index of Malaysia, and Green Star SA of South Africa amongst others.

Even though a little bite variations about climate or cultural differences within each specific system and region, these rating tools are built on mainly six (6) principles; energy efficiency, selection and development of site, resource conservation, indoor air quality, material conservation and efficiency, and water efficiency.(Anzagira, Badu, et al., 2019).

World Green Building Council (WorldGBC), Founded by David Gottfried in the year 2002, the WorldGBC currently comprises over ninety-five (95) countries in three membership levels (Prospective, Emerging and Established) (WorldGBC, 2017). The WorldGBC (2017) states its mission as "to create green buildings for everyone, everywhere - enabling people to thrive both today and tomorrow". (Anzagira, Badu, et al., 2019).

According to (Nura, 2018) LEED Rating System rating tool is based on U.S standards. Any building in the world can register for LEED certification using the LEED rating tool. The LEED rating systems are developed through an open, consensus-based process led by LEED committees, various groups of volunteers representing a cross-section of the building and construction industry. LEED Credit System there is a 100-point scale with additional 10 bonus points to earn. There are four possible levels of certification that can be achieved by exceeding the following point thresholds:

• Certified 40 - 49 points

• Silver 50 - 59 points

• Gold 60 - 79 points

• Platinum 80 points and above

- Sustainable Sites (SS): 26 points; impact on the local ecosystem and the natural resources.
- Water efficiency (WE): 10 points; covers a buildings water usage.
- Energy and Atmosphere (EA): 35 points; energy and how the origin of the energy.
- Materials and Resources (MR): 14 points; sustainable materials and how to handle waste.
- Indoor Environmental Quality (IEQ): 15 points; like daylight & clean air.
- Innovation and Design (ID): 6 points; promotes the use of different innovations and designs.
- Regional Priority (RP): 4 points; addresses the geographical placement of the building.

Table 1 Green Building Guidelines, Councils, Membership and Categories

Description	BREEAM	LEED	Green Star	Green Star SA – GH
Parent Organization	Building Research Establishment Ltd.	U.S Green Building Council	Green Building Council of Australia	Ghana Green Building Council
Country	U.K.	U.S.	Australia	Ghana
Year of origin	1990	2000	2002	2011
Membership	420+	12000+	676+	-
Total no. of registered & certified projects	562300	33629+	1462	1
Type of Ratings	Pass 30–44% Good 45–54% Very Good 55–69% Excellent 70-84 %Outstanding 85+	Certified 40–49 Silver 50–59 Gold 60–75 Platinum 80+	1-3 star 10-44 4 star 45-59 5 star 60-74 6 star 75+	1-3 star 10-44 4 star 45-59 5 star 60-74 6 star 75+
Major Categories	Management Health & Well Being/indoor Env'tal Energy Water Materials Land Use, Site, & Ecology Emission & Pollution Innovation & Design (optional) Mobility & transport Waste	Sustainable Sites Water Efficiency Energy & Atmosphere Material & Resources Indoor Env'tal Quality Innovation & Design Regional priority	Management Health & Well Being/indoor Env'tal Energy Water Materials Land Use, Site, & Ecology Emission & Pollution Innovation & Design (optional) Mobility & Transport	Management Health & Well Being/indoor Env'tal Energy Water Materials Land Use, Site, & Ecology Emission & Pollution Mobility & transport

(Anzagira, Badu, et al., 2019).

2.3 Components of Green Building and Driving Forces for Adoption.

According to (Gou, 2020) green construction consists the following basic components. Components of green building;

a) Considerations of site (qualitative and quantitative features, natural and artificial consequences, neighboring, cultural norms, etc.).
b) Considerations of natural energy (maximum use of renewable energy and minimum use of fossil fuels in buildings);
c) Concentration on optimal use of electricity and water, natural and electrical ventilation, and reduction of harmful wastes.
d) Environmental quality (quality of indoor and outdoor space), and Reduction of economic costs, improvement in social quality, and maintenance of cultural identity consistent with needs of the present generation and next generations.

According to the EPA, there are seven main aspects on which green buildings are judged to measure their “greenness” aka sustainability. Being environmentally friendly with your building project can happen in many ways. Some are obvious, like saving energy, while others focus more on the human aspect, such as maintaining good indoor air quality and let’s see each one.

2.3.1 Energy Efficiency & Renewable Energy

When people think of “green” buildings, they often think of energy first. Creating an energy-efficient building begins during design and can be interpreted in many ways. Of course, once the building is completed and occupied, it can draw on sustainable energy, such as solar panels built into the building’s structure. But even the construction process can be planned to use less energy and more renewable fuels for tools such as large machinery.

Whether it’s growing a green roof, installing specialty glass for solar and heat management, or choosing a whole building system run on renewable energy, building with energy-efficiency in mind can add a host of benefits most importantly, lower utility bills.

2.3.2 Water Efficiency

In the hierarchy of green building components, water efficiency is just as important as energy efficiency. And just like energy efficiency, conserving water can happen anywhere from the construction process to the way the completed structure uses water (especially in landscaping).

Homeowners can get creative with water conservation such as using an extended piping network to add radiant heat to the house (also an energy-saving move!). Even just choosing low-flush toilets and other high-efficiency fixtures and materials can make a difference to the building's total water efficiency.

2.3.3 Environmentally Preferable Building Materials & Specifications

Of course, a green building wouldn't be anything without the green building materials used. Luckily, there are dozens of choices for sustainable materials! Building with recycled steel or even an existing item like a shipping container can reduce the need for reprocessing of the steel, saving energy and reducing emissions.

2.3.4 Waste Reduction

Reducing waste to make a building greener doesn't necessarily have to do with any "waste" produced within the building during occupancy. Rather, it has to do with the waste generated during the construction process or even future demolition. This aspect of sustainability can also include reducing waste and pollution from landscaping and even emissions from heavy machines needed for building.

2.3.5 Toxins Reduction

Reducing toxins within a structure can happen in a variety of ways. From the chemicals used to make indoor furnishings flame retardant to the glues and finishes used on building materials, many traditionally-toxic items can be replaced with greener options.

For example, buildings are made from foam pieces, rebar, and concrete, eliminating the need for chemically treated wood framing. Rammed earth or straw bale homes provide a natural source of insulation as opposed to chemical-filled commercial insulations. Reducing toxins throughout the building process can also affect other aspects of the building.

2.3.6 Indoor Air Quality

The chemicals used in older, traditional building methods can leech out of the finished structure and affect air quality. If bad enough, this can lead occupants to develop "sick

building syndrome." Sustainable materials such as bamboo are great for air quality because they absorb ⅔ more CO_2 and produce 30% more O_2 than regular wood.
But making IAQ (indoor air quality) a green aspect goes way beyond materials. A sustainable building will have designs or systems in place to circulate and filter the air in the structure. These systems will likely be energy efficient or even built directly into the design with smart elements such as the room or ceiling shape.

2.3.7 Smart Growth & Sustainable Development

It isn't enough to just be a green building. Sustainable buildings will continue to develop their sustainability and environmental impact over time. This could include dealing with storm water runoff or even occupant waste in a new, sustainable way. Green buildings will need to adapt over time to changing and ever-tightening regulations.

2.4. The Benefits of Green Buildings

The world over, evidence is growing that green buildings bring multiple benefits. They provide some of the most effective means to achieving a range of global goals, such as addressing climate change, creating sustainable and thriving communities, and driving economic growth. Highlighting these benefits, and facilitating a growing evidence base for proving them, is at the heart of what we do as an organization.

According to (Omuh et al., 2020), adoption of green construction technology has majorly a three dimensional benefit such as environmental, economic, and social.

2.4.1 Environmental

One of the most important types of benefit green buildings offer is to our climate and the natural environment. Green buildings can not only reduce or eliminate negative impacts on the environment, by using less water, energy or natural resources, but they can - in many cases - have a positive impact on the environment (at the building or city scales) by generating their own energy or increasing biodiversity.

2.4.2 Economic

Green buildings offer a number of economic or financial benefits, which are relevant to a range of different people or groups of people. These include cost savings on utility bills for tenants or households (through energy and water efficiency); lower construction costs and higher property value for building developers; increased occupancy rates or operating costs for building owners; and job creation. Since the publication of WorldGBC's groundbreaking 2013 report, The Business Case for Green Building, we have sought to strengthen the link between green buildings and the economic benefits they can offer.

2.4.3 Social

Green building benefits go beyond economics and the environment, and have been shown to bring positive social impacts too. Many of these benefits are around the health and wellbeing of people who work in green offices or live in green homes.

Our Better Places for People project focuses on creating buildings which are not only good for the environment, but also support healthier, happier and more productive lives.

WorldGBC's and the Green Building Council of South Africa established a joint project to develop a framework to enable complex socio-economic issues to be integrated into any green building rating system in the world.

With our society's increasing concern for the environment, it's no surprise that green building continues to grow in popularity. From residential structures to corporate facilities, sustainable architects are discovering new ways to preserve our ecosystem while reducing our carbon footprint. Based on literatures like(Ojo-Fafore et al., 2018) (Omuh et al., 2020) green building merits were discussed as follow:-

A. Saving Water: Reduce, Reuse, Replenish

Research shows that green architecture can not only reduce water waste through water-efficient plumbing fixtures but also reduce the strain on shared water resources. By installing specially-engineered systems to purify water, it enables water recycling and also allows for alternative sources of water (such as rainwater). These developments not only save this vital natural resource but protect clean water sources for the future.

B. Enhanced Health: Eco-Friendly for Life

Living in a sustainable building can save your life – literally. According to studies, people who reside in green structures experience a myriad of health benefits due to the eco-friendly materials utilized in construction. For example, green buildings avoid using building materials that may contain harmful volatile organic compounds (VOCs) or plastic by-products which have been known to release toxic fumes and carcinogens into the atmosphere. These dangerous materials are linked to respiratory disease, allergies, and other health disorders, and in extreme cases, an increased risk of cancer.

C. Reducing the Strain: Shared Resources, Increased Efficiency

With our planet's ever-increasing population (particularly in large cities across the globe), our local shared resources are being threatened as demands continue to grow. Based on the advancements and sustainable technologies developed by ingenious architects worldwide, vital resources such as water and energy are being protected. By increasing efficiency, green structures are capable of reducing the strain that has been placed on such resources, which can potentially be protected and preserved for future generations.

D. Reduced Operational Cost and Maintenance:

One of the greatest benefits of green buildings are their lower maintenance costs – featuring specially-engineered design elements that help reduce energy and water bills, these efficient structures can save corporate and residential owners a bundle. Although the expense required to build such structures may be initially higher than traditional non-green forms of architecture, the cost over the long term is recovered exponentially.

E. Energy-Efficient:

Developing structures that derive their energy from natural sources – such as the sun, wind, and water – is extremely beneficial to the environment, protecting the ecosystem from pollution associated with non-renewable sources (such as oil and coal). An added benefit: non-renewable energy sources are not only toxic but costly, while their energy-efficient counterparts (such as solar paneling vs. traditional electricity) can save thousands over the lifetime costs of the infrastructure.

F. Carbon Footprint Reduction:

There has been an increase in large corporations opting for green initiatives. According to the Environmental Protection Agency (EPA), buildings account for 30% of all greenhouse gas emissions in the United States. Landlords and large businesses have taken heed, as increasing sustainability is an opportunity to do something positive for both business and society as a whole.

G. Keep It Clean: Protecting Our Ecosystem

Global warming has been a growing concern for a number of years, and it’s no wonder – our planet has seen a drastic depletion of our natural resources, while pollution and the consequent climate-change is at an all-time high. Sustainable architecture is not only energy-efficient and healthier for its inhabitants, but it also benefits the planet. By reducing our reliance on non-renewable resources (such as coal and oil), green architecture can actually promote and maintain a cleaner environment.

H. Durability for the Green Homeowner:

From energy and water savings and improved air quality to overall durability, sustainable materials have been proven time and time again to last longer. Green materials (such as recycled decking and roofing) not only endure for years exposed to the elements but require much less maintenance. In addition, because many of them are free from harmful chemical treatments, they are healthier for the environment (and the inhabitants they serve).

I. Improved Indoor Environment:

When it comes to our quality of life, it’s no secret that our surroundings have a major impact on our health. Over the past several decades, designers around the globe have made massive progress, developing sustainable architecture that can dramatically affect the inhabitants of such buildings. From improved lighting sources, thermal conditions, ergonomic features and even upgraded air quality, occupants residing or working in green structures have experienced a marked improvement in their health, stress levels and overall quality of life.

J. Efficient Material: Minimal Use for Maximum Impact

Up cycling has taken the architectural world by storm – by recycling and reusing resources (and even repurposing old structures), sustainable architects, engineers, and designers are tapping into existing resources to reduce carbon footprints and save natural resources. By reducing waste, preserving natural resources (such as water and wood), protecting our air supply, and limiting energy expenditures, green building companies can create extremely efficient structures that can withstand the test of time.

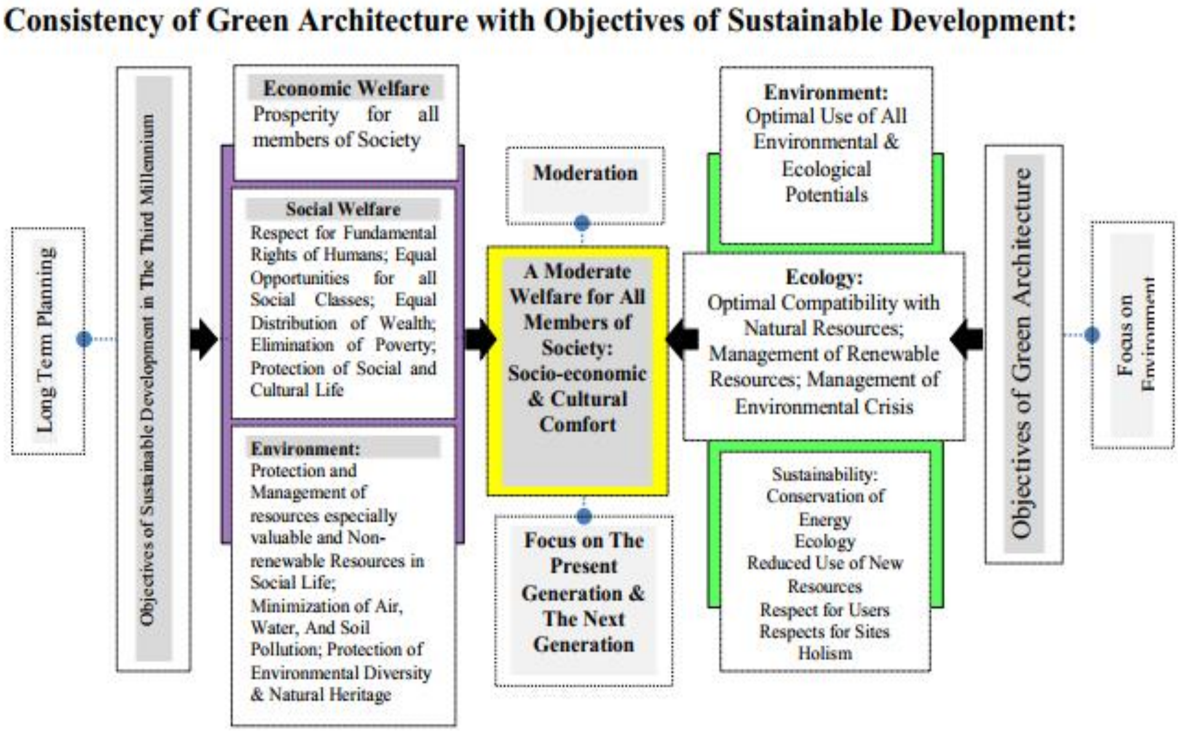

FIGURE 2: CONSISTENCY OF GREEN ARCHITECTURE & SUSTAINABLE DEVELOPMENT. Source (Loumer, 2015)

Main Structures & Components of Green Architecture

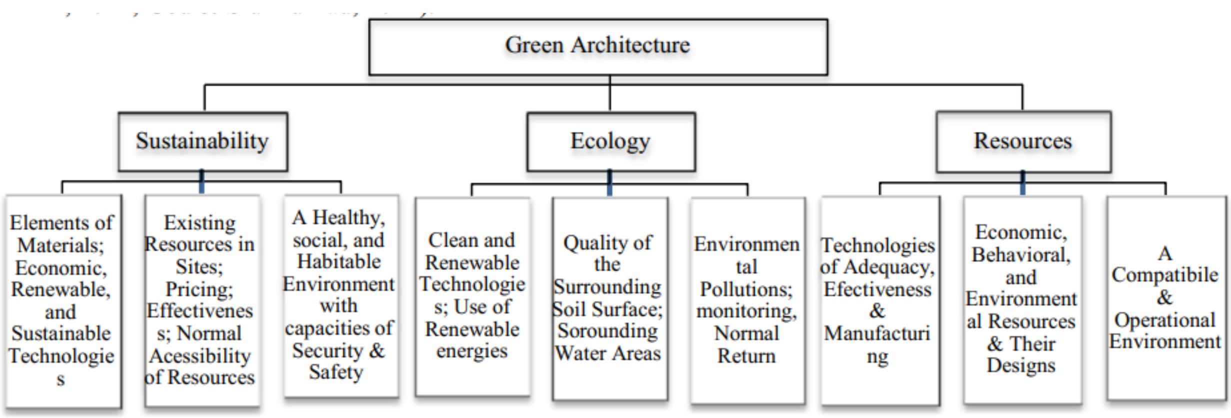

FIGURE 3: MAIN STRUCTURES & COMPONENTS OF GREEN ARCHITECTURE.

source(Loumer, 2015)

2.5 Materials for Green Building Construction

Green materials are that, that have simultaneously a purpose with the least cost, fit most harmoniously within ecosystem processes, helps to eliminate the use of inefficient materials and contributes to the attainment of a service-based economy. Green building materials are possibly composed of renewable, rather than nonrenewable resources. Green materials are environmentally responsible because impacts are considered over the life of the product(Omuh et al.). The use of green building materials and products represents one important strategy in the design of a green building. So green building materials should be; cost and energy efficient, renewable, pollution & toxic free and locally available.

2.5.1 Benefits of Green Building Materials

Green building materials offer specific benefits to the building owner and building occupants. These material benefits include.

a) Reduced maintenance/replacement costs over the life of the building.
b) Energy conservation.
c) Improved occupant health and productivity.
d) Lower costs associated with changing space configurations.
e) Greater design flexibility.
f) Pollution &toxic free
g) Locally available.

2.5.2 Green Building Material Selection Criteria

According to (Omuh et al., 2020) Green building materials are composed of renewable, rather than nonrenewable resources, environmentally responsible because impacts are considered over the life of the product are selected based on the criteria presented below.

2.5.2.1 Resource Efficiency

a) Recycled Content: Products with identifiable recycled content, including postindustrial content with a preference for post-consumer content.
b) Natural, plentiful or renewable: Materials harvested from sustainably managed sources and preferably have an independent certification (e.g., certified wood) and are certified by an independent third party.

c) Resource efficient manufacturing process: Products manufactured with resource-efficient processes including reducing energy consumption.
d) Minimizing waste (recycled, recyclable and/ or source reduced product packaging), and reducing greenhouse gases.
e) Locally available: Building materials, components, and systems found locally or regionally saving energy and resources in transportation to the project site.
f) Salvaged, refurbished, or remanufactured: Includes saving a material from disposal and renovating, repairing, restoring, or generally improving the appearance, performance, quality, functionality, or value of a product. Reusable or recyclable: Select materials that can be easily dismantled and reused or recycled at the end of their useful life. Recycled or recyclable product packaging: Products enclosed in recycled content or recyclable packaging.
g) Durable: Materials that are longer lasting or are comparable to conventional products with long life expectancies.

2.5.2.2 Indoor Air Quality (IAQ)

Low or non-toxic: Materials that emit few or no carcinogens, reproductive toxicants, or irritants as demonstrated by the manufacturer through appropriate testing.

a) Minimal chemical emissions: Products that have minimal emissions of Volatile Organic Compounds (VOCs). Products that also maximize resource and energy efficiency while reducing chemical emissions.
b) Low-VOC assembly: Materials installed with minimal VOC-producing compounds, or no-VOC mechanical attachment methods and minimal hazards.
c) Moisture resistant: Products and systems that resist moisture or inhibit the growth of biological contaminants in buildings.
d) Healthfully maintained: Materials, components, and systems that require only simple, non-toxic, or low-VOC methods of cleaning.
e) Systems or equipment: Products that promote healthy IAQ by identifying indoor air pollutants or enhancing the air quality.

2.5.2.3 Energy Efficiency

Creating an energy-efficient building begins during design and can be interpreted in many ways. Of course, once the building is completed and occupied, it can draw on sustainable energy, such as solar panels built into the building's structure. But even the construction process can be planned to use less energy and more renewable fuels for tools such as large machinery.

2.5.2.4 Water Conservation

Water efficiency is just as important as energy efficiency. Green buildings don't know the meaning of "wasted" they recycle rainwater and grey water and use them for toilet flushing, greenery and others.

2.5.2.5 Affordability

Affordability can be considered when building product life-cycle costs are comparable to conventional materials or as a whole, are within a project-defined percentage of the overall budget. So using sustainable construction materials contributes for cost efficient & affordable construction.

2.6 Barriers in Green Building

Many developing countries have understood the importance of incorporating sustainability as part of their national agenda, but it is in their ability to implement those agendas that they trail behind developed countries due to a variety of barriers. The adoption of green building practices and technologies has become standard in developed countries. However in developing countries, such as in Africa, its adoption has not yet reached that degree of success due to local and global barriers. (Nikyema & Blouin, 2020)

According to (Ahmed et al., 2021) and (Nikyema & Blouin, 2020)he worldwide sustainability movement has led to growing demands for green buildings and sustainable properties. In response, many governments took the leading role in green or sustainable building development by making public buildings greener. Voluntary initiatives have also been emerged to encourage green building development. However, the market penetration rates of green or sustainable buildings are often far below anticipation. This is due to different barriers to green development. Besides, the benefits arising from green buildings do not appeal attractive enough for or may not be realized by stakeholders. In order to acquire deeper penetrations, policies and institutional governance have to be formulated to encourage more green building developments.

As stated in (Nikyema & Blouin, 2020) potential GBTs barriers are grouped into five barrier groupings: government-related barriers, human-related barriers, knowledge and information-related barriers, market-related barriers, and cost and risk-related barriers.

The barriers can be understood as factors that slow down the process of an organization to Success. According to, sustainable development brings benefits to environment and human health, but the development is still facing the obstructions to implement green building into construction projects. The challenges of green building can be classified into two categories which are internal barrier and external barrier (Ahmed et al., 2021)

2.6.1 Internal Barriers

The internal barriers are barriers that happened within the organization and these barriers are controllable though the manipulation of upper management team. Normally, the organization will treat the financial factor as their major barrier in practicing green as earning profit in always organization main goal.

A. Economic Issues

Compare to the ordinary buildings, the cost of sustainable building will be higher due to the Green materials very expensive. The company that lack of financial resource will face the problem to implements sustainable construction. Besides, this will be a long-term profit return, so the developer or client will worry about their profitability. The client will more concern about their profitability than sustainable to environment. Builder incentive also an issue to the construction industries to practice the green construction. The construction industries will only implement the green practice in their project when they get incentive by government or private sector. However, there are few of institution and organization that provide builder incentive. This will bring the financial issue to the construction industry that concern about the profit and refuse to practice the sustainable construction.

B. Management Barrier

The top management will affect the adoption of green initiatives. If top management does not highly aware of the environmental issues and refuse to implement green initiatives, the adoption of green building technologies will be rejected. The workers will also influence by the top management and change their attitude toward the implementation of green building. Currently, there are still a lot of upper management refuse to accept the new construction method. This is because most of them are concern about the profits and they do not wish to take any risks that might be obstacle to them to earn more profits. If the upper management refuse to implement Green building development, the workers below also have no any change to make changes in the Construction method. This will lead to the obstacle in green building implementation.

C. Technology and Training

As green building concept just promoted it needs use new materials and technologies to construct. However, the materials and technologies are still rare so it is a difficulty for the developers, contractors and subcontractors to get all the materials and technologies for the construction of green building. Every new application of materials should be tested before use to determine the capabilities. The new materials and technologies should be evaluated and compared its performance with a similar product to obtain the most precise result. There are some unknown challenges towards green building concept and its materials and technologies, so these make the barriers.

Majority of green technologies are complicated and it requires professional knowledge to be success. There are also policies and standard that need to fulfill when practice the green practices in construction projects. The lack of professional or technical staff will cause the stakeholders and clients lack of confidence in green technology implementation. Some of the companies are not willing to send their workers for training to gain the new Knowledge and soft skill towards the green building. This is because they worry that the workers will turnover to another company for higher salary after training and this will cause them loss of talents and also waste their time and money. Therefore, the workers that do not attend any training will not able to control and handle the new technology that are complicated.

D. Organizational and Personal Behavioral Barriers

Some barriers may be created by an organization itself. Lack of environmental protection commitments from the administrative leaders, as well as inadequate communication between the stakeholder and administrators could create barriers to green building development. Individuals' behavioral characteristics can also be barriers to green building development. Resistance to change was a barrier to implementation of energy efficiency measures. Lack of incentives will be a barrier to investors to start investing. There are many construction firms in Asia developed countries face the problem in lacking of incentives. However, there are problem that created by the stakeholders and company which is lack of awareness towards the environmental quality and protection. Lack of awareness and communication among the stakeholders and party that involved in the project will obstruct the implementation of green initiatives. Besides, stated that individuals' behavioral play vital role in adopting green building concept.

E. Lack of Knowledge/awareness

The lack of public awareness can be a barrier to green buildings. A lack of knowledge of constructors or designers on green buildings creates additional barrier. At the same time, investors may see risk and uncertainties when making decisions on green or sustainable buildings.

Different deep interviews show that, lacking in knowledge and awareness of top management will affect the intention of the construction firm to implement green practices in the projects. The study shows the top managements are not really understand about the sustainable development although they are worry about the environmental issues. Furthermore, the construction firm will face the problem of their staffs and workers are not literate in the new technology, so the workers are not able to handle and control the green technology. This will make difficulty to the implementation of sustainable development.

Moreover, lack of communication among the parties involved also will lead to difficulty in practicing green building in construction industry. In addition, green concept is still new and complicated, so it is difficult to be practiced by the construction stakeholders if they do not have intensive experience and sufficient knowledge in related field. This will lead to the benefits of development of sustainability be ignore and construction firm resist to change.

2.6.2 External Barriers

External barriers are referring to those factors that happened outside the control of the organization such as government policy, customer satisfaction and market conditions. These factors can only be understood and mitigated through adjustment on the services and products in order to fulfill the third parties' requirements.

A. Attitude and Market

There are old generation workers that are full of experience in the construction site and they are refusing to learn the new things and technology. They believe that the traditional method is the best for the construction work. However, the traditional method is not green to the environment and will cause pollution. Besides, clients' attitude also influences to the adoption of green technology into construction projects. The client that willing to accept the trend without counting his/her profit will encourage and ensure the project team is convinced with the positive impacts of green initiatives on buildings.

When market demand is low on green building, green building will not be constructed by construction industry. Therefore, the attitude of public and clients is affecting the market to invest in green building development.

B. Government Issue

Government also should play main role in encouraging green building construction and development as government's involvement such as provision of financial and non-financial incentives, regulations and policies to building construction impact the implementation of green building. If government has low awareness about the environmental issue and importance of green practices, the construction industry will also have no concern about this issue. This is because there will not have any regulations and laws to enforce them to practice green on site.

C. Production Information and Sourcing

Green building development is having insufficient product's information. This is because the green building technologies are the new technology and lack of construction industry implements it into construction projects. The lack of information about the performance and cost needed of the technology will cause the construction industry to bear their risk of adopting the green building practices. Besides, the architects and workers will face the problem of the products do not perform well. The final products that do not perform well will influence the reputation of the company and this will reduce the profits that they can earn. Therefore, the developers and stakeholders will hesitate to start participating in green building development.

In addition, insufficient guidelines from available sources is within the consideration of developers to implement green building as there is no any precedent can refer to if there is any problem occur. Guidelines are always important to lead practitioners. Without sufficient guidelines, stakeholders and clients will worry about the potential hidden risks of this new construction method. The amount of the materials and equipment needed cannot be measured and this might lead to the increment of wastage.

D. Lack of Incentives

There can be a general lack of incentives for investors to invest in green buildings. About one-third of surveyed companies in Hong Kong stated that the lack of incentives was the main barrier of engaging in voluntary environmental initiatives(Nikyema & Blouin, 2020). Incentives are important to a firm to develop or adopt new technologies and practices. However, the incentives will not work if the construction firms are lacking of awareness and knowledge in green development. Besides, the operating and maintenance cost is too high and the incentives given are not enough to cover it. Therefore, the implementation of sustainable development will be prohibited although it is environmentally friendly and energy efficiency.

Lack of incentives will decrease the motivation of construction firm to consider sustainable development due to the construction firm do not receive any incentives and support when the construction projects are energy efficiency. For the small and medium enterprise which do not have enough capital and do not receive any incentives and funds make them not able to implement the sustainable development. Without incentives, the implementation of sustainable development will not be successful as there is no motivation force to push the realization of green building.

E. Lack of Mimetic Pressure for Green Development Policy

Lack of mimetic pressure for green development policy is obstructing green development and most of the stakeholders are yet prepared to adopt the green building policy since there are many unsolved obstructions. Majority of the construction firm choose to ignore the environment condition and benefits of green development and this led to the resistance to change of construction firm. Besides, lack of mimetic pressure for green development policy will increase the resistance to change and ignore to the benefits of new technology.

Therefore, the championing for the sustainable development will face the problem and challenge due to the resistance to change of construction firm.

2.7 Summery of Literature Review

The term “green building” is often used interchangeably with the terms sustainable construction, and high-performance buildings, within the construction industry.(Anzagira, Badu, et al., 2019). Climate change, environmental impact and the limited natural resources urge scientific research and novel technical solutions. The monograph series Green Energy and Technology serves as a publishing platform for scientific and technological approaches to “green” i.e. environmentally friendly and sustainable technologies (Gou, 2020).

Over the years, the global appeal for GB has led to the introduction of guidelines and frameworks with the aim of providing a level plat form in terms of uniformity of stands for the application of sustainable practices as well as the acceptance (Anzagira, Badu, et al., 2019).

According to (Gou, 2020) green construction consists Energy Efficiency, Water Efficiency , Environmentally Preferable Building Materials & Specifications, Waste Reduction, Waste Reduction, Indoor Air Quality and Smart Growth & Sustainable Development basic components.

Adoption of green construction technology has majorly a three dimensional benefit such as environmental, economic, and social (Omuh et al., 2020).

Green materials are that, that have simultaneously a purpose with the least cost, fit most harmoniously within ecosystem processes, helps to eliminate the use of inefficient materials and contributes to the attainment of a service-based economy. Green building materials are possibly composed of renewable, rather than nonrenewable resources (Omuh et al., 2020).

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Table 2 Drivers of Green Building uptake

Drivers of Green Building uptake	
Preservation of natural resources and nonrenewable energy sources	Increased energy efficiency of buildings
Reduced lifecycle costs of building structure	Increased water efficiency of buildings
Enhance occupants' health and comfort and satisfaction	Reduced environmental impacts of buildings
Good company image/reputation or marketing strategy	Better indoor environmental quality
Improve the performance of national economy and create jobs	Thermal comfort
Better rental income and increased rentable space	Attract premium clients and enhanced property value
Better workplace environment	Reduce construction & demolishing wastes
Set standards for future design and construction	Reduced use of construction materials
Efficiency in construction processes and management practices	Facilitate a culture of best practice sharing
Attract quality employees and reduce employee turnover	Increase overall productivity

2.8 Research Gap

Even though, green building concept and adoption has recently received increasing global attention because of its numerous sustainability benefits, it is unfamiliar in developing countries. current evidence suggests that (Darko & Chan, 2018, Godslove, 2019.; Omuh et al. 2018., L.F. Anzagira, D. Duah E. Badu, 2019), uptake of GB in the Construction industry of developing countries of Sub-Saharan Africa (SSA) is at infant stage and characterized by the absence of GB codes, strategies, frameworks and faces challenges like unfamiliarity, misunderstanding the concept, lack of clear ways to adopt and implement green building and there are different barriers like economic issues, attitude and market, management and government, product information and sourcing, technology and training. When we came to Ethiopian construction case, as one of developing countries of Sub-Saharan Africa the construction industry faces different problems like lack of integration between stakeholders, cost, quality and timely completion compromises, inconvenience, health & safety problems, construction material scarce and very high inflation and due to these, it is unable to achieve affordability & cost efficient construction. To solve these and other related problems green building concept is one of new emerging discipline. But there is no green building researches other than a few related and its concept is not clearly familiar eve for many professionals in the industry. Thus, there was limitation to access researches during reviewing and the existing level of awareness also affects the questionary process.

So to overcome the gaps the study tries to refer different national articles, policies, strategies, frame works and guide lines (Commission maps by Addis Ababa city administration (2017) , ten years construction plan, by plan and development commission (2013-2022), building spatial design(Addis Ababa city administration), National Physical Planning Standards and Guidelines, Addis Ababa city building standards). Even though their concepts were related with some green building concept, almost all of them were not concern on green building concepts and for the concept variation cases I tried to orient it.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Research Description

This study was about assessment on adoption and implementation of green construction in Ethiopia, in case of capital city Addis Ababa. The objective of the research is to assess current level of awareness about green building technology, readiness and efforts to adopt and implement green building technology, to identify existing opportunities, promoting strategies, barriers for adoption and implementation of green building technology.

Paper review, interview and questionnaire were used for data collection. Mainly structured questionnaire was used to collect data across main seven (Ethiopian construction authority, Addis Ababa housing development corporation, federal housing corporation, ministry of urban development and infrastructure, Addis Ababa plan and development commission, Addis Ababa construction permit and control and Ethiopian engineering and investment group) construction industry sectors in Addis Ababa, Ethiopia. To reach decision, collected data systematically analyzed in qualitative data and quantitative ways/techniques. Questionnaire were analyzed in quantitative ways (frequency analysis method) and SPSS soft war was used to analyze the data in a descriptive and statistical method and mean rank was used at 95% confidence level or 0.05 level of significance. Questionnaires were categorized in to four parts. Part one was about assessment about current level of awareness (15 measuring parameters), Part two was about assessment on ready nesses and efforts for adopt and implementation (11 measuring parameters), Part three was about assessment about enablers/promoting strategies (14 measuring parameters), Part four was about assessment about challenges or barriers (15 measuring parameters) to practice green building technology. For each objective each parameters analyzed and basic factors are determined in order by using the Statistical Package for the Social Science (SPSS) and results were carefully analyzed statistically using the descriptive statistics.

Note; questionnaire were attached at the appendix.

The paper reviewed and the interview transcripts were analyzed in narratives ways for qualitative data. An interview representative from each professional body was chosen because of the likelihood of getting the same responses if more than one representative was chosen from each professional body. Also in qualitative studies, the objective is to understand and give meaning to the subject matter rather than quantify and generalize to a wider population. Both categories (questioners and interview) respondents were sampled purposively from representatives of selected construction ministries and were selected based on their;

1. Experience, educational level and field of study.

2. Willingness of the participant to take apart in the research.

Finally, the research tries to cover and investigate the extent to which green building technology concepts have been familiarized, readiness and efforts for adoption and implementation of green construction practice. It also identify opportunities, challenges, determine enablers and promoting strategies for adoption and implementation of green building technology in Ethiopia, in case of capital city Addis Ababa.

3.2 Study Area

The research was conducted in Addis Ababa, capital city of Ethiopia. Addis Ababa was founded in 19th century by Ethiopian emperor Minilik II and his wife empress Taytu betul in 1886. Addis Ababa, the political capital and the most important commercial and cultural center of Ethiopia, is geographically located at the heart of the nation, 9^{o}2'N latitude and 38^{o}45'E longitude. Its average altitude is 2,400 meter above sea level, with the highest elevations at Entoto Hill to the north reaching 3,200 meters. This makes Addis Ababa one of the high-altitude capital cities of the world. (Erena D. et.al, 2017)

In the period that followed the late 1950s and early 1960s, Addis went through a massive urban makeover that was exceptionally abundant architecturally. The Emperor attracted some well-known international architects to help realize the project of making Addis Ababa a modern African city. In a very short period, Addis changed; for the better. The city became almost as beautiful as the Emperor once dreamed. Now Decades later, the Ministry of Construction indicates that the construction sector had a 9.5 percent share from Ethiopia‘s total Gross Domestic Product (GDP) in 2016.

Reports show that, construction output in 2022 will be supported by foreign investment in industrial development, coupled with the start of major industrial, transportation and energy infrastructure projects. According to the Ethiopia Investment Commission (EIC), the country received ETB119.8 billion

Construction output in 2022 will be supported by foreign investment in industrial development, coupled with the start of major industrial, transportation and energy infrastructure projects. According to the Ethiopia Investment Commission (EIC), the country received ETB119.8 billion ($2.43 billion) in Foreign Direct Investment (FDI) in the first nine months of the current Ethiopian financial year (FY) 2021/2022, which runs from July 8, 2021 to July 7, 2022.

In February 2022, the Ministry of Transportation and Logistics announced that it had identified 44 transportation projects to develop with private partnerships in the areas of air transportation, cross-country public transportation and urban mass transportation.

The industry's growth will also be supported by the government's allocation under the FY2021/22 Budget to support economic recovery. In July 2021, the Ethiopian Council of Ministers approved a FY2021/22 Budget of ETB561.7 billion ($11.3 billion), which is 18% higher than the previous budget.

The government allocated ETB183.5 billion ($4.2 billion) to capital expenditure, which marks an increase of 14.5% compared to the previous fiscal year's allocation. Although political, economic and security risks will continue to contribute to an uncertain outlook, the publisher expects the industry to regain momentum and register annual average growth of 8.1% during 2023-26, supported by investment in tourism, roads and industrial park projects. These implies the area needs attention.

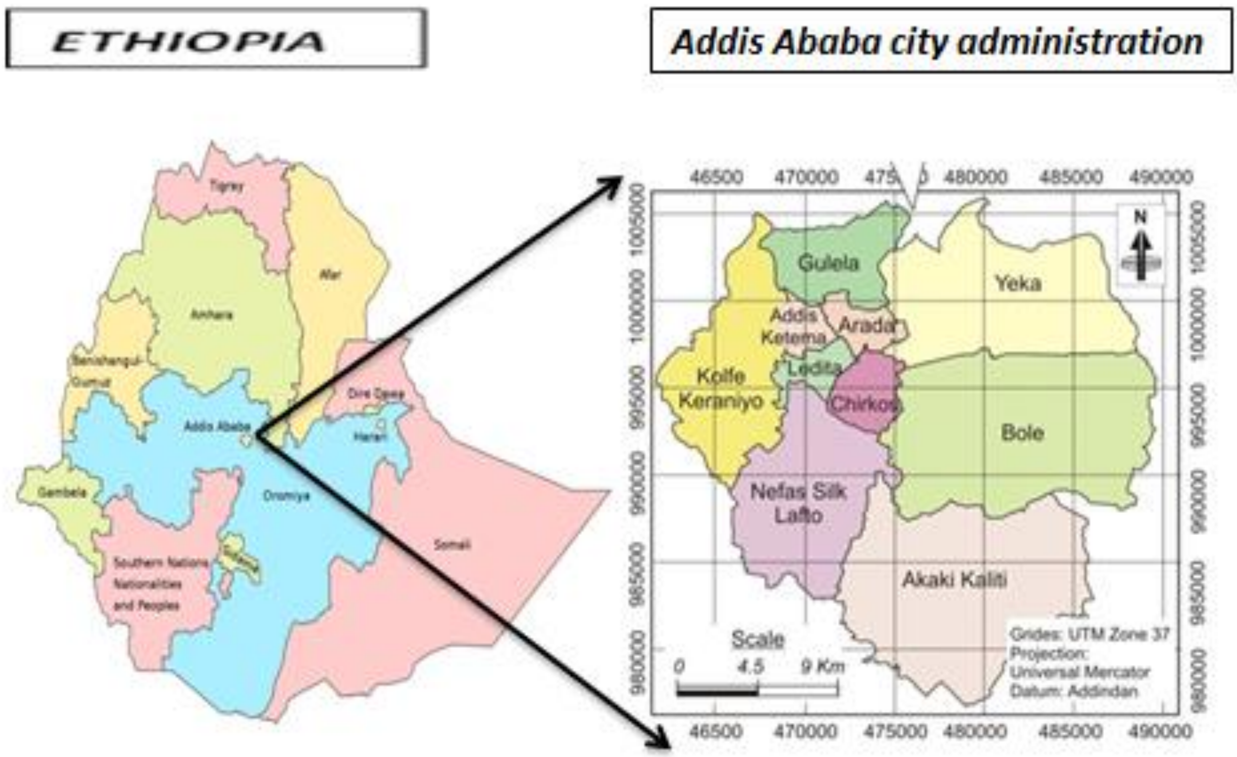


FIGURE 4: LOCATION MAP OF ADDIS ABABA.

(Source AACA, May 2022).

Note; Kura-lemi Sub City Administration is not showed In the Map

3.3 Population of the Study

The population of the research was different company of Ethiopian construction industries based on their disciplinary goals and objectives. Thus green building concerning organizations were selected as population. The selection of these organizations merely based on aims, goals and objectives to be achieved. So based on these criteria the following seven Ethiopian construction ministry organizations were selected. These were; Ethiopian construction authority, Addis Ababa housing development corporation, federal housing corporation, ministry of urban development and infrastructure, Addis Ababa plan and development commission, Addis Ababa construction permit and control and Ethiopian engineering and investment group. These organizations were work with different national articles, policies, strategies, frame works and guide lines (Commission maps by Addis Ababa city administration (2017) , ten years construction plan, by plan and development commission (2013-2022), building spatial design(Addis Ababa city administration), National Physical Planning Standards and Guidelines, Addis Ababa city building standards). Even though their concepts were related with some green building concept, almost all of them were not concern on green building concepts

3.4 Sample Size Determining

Since the green building technology concept is new concept in Ethiopia. There was no clear sampling frame for this study and sample was a nonprobability sample. Nonprobability sampling technique can be used to acquire a representative sample. It is appropriate when a random sampling method cannot be used to select respondents from the population(Darko & Chan, 2018). As a result, different green building related professionals like architects, civil engineers, construction engineers, electrical engineers, environmental engineers, urban planner, project managers, policy makers and others were sampled from targeted population or seven Ethiopian construction ministry organizations. In which appropriate sample representatives were selected based on educational background, experience, position and related skills. Totally 46 respondents; Ethiopian construction authority (12), Addis Ababa housing development corporation(5), federal housing corporation(6), ministry of urban development and infrastructure (6), Addis Ababa plan and development commission (7), Addis Ababa construction permit and controls (6) and Ethiopian engineering & investment group(4) were sampled. Thus, in this research, respondents were selected using non probabilistic or Purposive sampling method called a snowball sampling method and tried to attain a valid, effective and reasonable representative sample size.

3.5 Source of Data

The research used both primary and secondary source of data collection methods as a tool to gather all the necessary data to conduct research. The primary data collection basically focused on questionnaire and interview of the field professionals and secondary data collection focused on paper review especially green building papers conducted on developing African countries.

3.5.1 Primary Source of Data

It obtained from different construction industry ministry professionals based on their professional skills, experiences, working area, especially those who work on making, reviewing and executing different rules, regulations, directives and policies which directly related to green building technology concepts.

3.5.2 Secondary Source of Data

A comprehensive and critical review of different national and international literatures, journals articles, policies, strategies, frame works and guide lines about adoption and implementation of green building were gathered. Especially researches from developing sub-Sahara African like Ghana, Egypt, Nigeria, Kenya, Burkina Faso and South African trends were used as an input and a good parallel trend for secondary data collection.

3.6. Data Collection Techniques

All data necessary to conduct the study were gathered through interviews, questionnaire and relevant document review. During data collection, profession, experience and educational level were considered as basic criteria for questioners and interview respondents. For paper review cases in developing African countries green building technology trends considered as a model.

The method of questionnaire survey has seen wide usage in the green building research area (Darko & Chan, 2018). Questionnaire survey has been widely used in the design and construction industries as a method to collect professional opinions in green building research(Nikyema & Blouin, 2020).

Indeed, questionnaire was used as the main recognized survey research instrument that sought opinions of population or sampled groups from selected organizations. Questionnaire titled assessment on adoption and implementation of green construction in Ethiopia, in case of capital city Addis Ababa was defined based on the four clusters that constitute the objectives of the study. The five-point Likert scale was adopted in this study because of its advantage of providing results that are unambiguous and hence can be interpreted without difficulty(Darko & Chan, 2018).

3.6.1 Literature review

Critical paper review was done. Different national articles, policies, strategies, frame works and guide lines (Commission maps, ten years construction plan, building spatial design, National Physical Planning Standards and Guidelines, Addis Ababa city building standards) and different research papers especially from developing African countries like Ghana, Egypt, Nigeria and South African trend about adoption and implementation of green building were reviewed.

3.6.2 Questionaries' Survey

For formulating the questionnaire the initial strategies involved the following two steps: (1) literature review and (2) interviews with industrial professionals. In the first step, it should be noted that several developing sub Saharan African country cases on green building studies were reviewed and different case factors were identified. Factors were taken as an input for questionnaire formulation. In the second step close ended, five-point Likert scale based (rating of 1 = strongly disagree 2 = disagree 3 = neutral 4 = agree 5 = strongly agree), non-ambiguous, appropriate and valid questionnaire were designed for distribution for sampled groups. Before the questionnaire survey, interviews were performed with selected industrial professionals (based on experience & specialization) from two industry organizations (Ethiopian construction authority, ministry of urban development and infrastructures) to assess the comprehensiveness and relevance of the identified factors and they provided valuable feedbacks and approved the identified factors were also relevant in Ethiopia cases. Some of questionnaire were constructed by researcher by considering observing existing actual. The questionnaire was sectioned in to three parts, where Section 1 consist respondent profile (educational level, profession and experience), Section 2 consists description of green building technology and Section 3 consists lists of questionnaires. Further section 3 labeled in to four parts to achieve specified four specific objectives. Part A/01 consists 15 items on Level of awareness about Green Building Technology, part B/02 consists 11 items on Opportunities to adopt Green Building Technology, part C/03 consist 14 items on Enablers or strategies to adopt 'Green Building Technology and part D/04 consists 15 items on Challenges or Barriers for green building technology adoption. After questionnaire were reviewed by experts and my advisor to ensure that it was free of ambiguous expressions and used appropriate technical terms; an empirical questionnaire survey was conducted to gather the professional views on their relative importance. Thus, 50 copies were copied but 46 were distributed to sampled groups and all 46 were retrieved representing 100 percent return rate, and were used for the data analysis. Finally each factor was assigned a code to facilitate the data analyses and allow easy presentation of the results and discussion in later sections and it was attached at appendix section.

3.6.3 Interview

Interview was done for representative professionals of selected construction ministry organizations about current level of awareness about green building technology, ready ness and efforts to adopt and implement green building technology. And to identify existing or predicted opportunities, enablers/promoting strategies, challenges or barriers for adoption and implementation of green building technology.

3.7 Data Analysis Techniques

In order to achieve the research objective, the survey respondents were requested to state the importance of the factors using a five-point rating scale, as described in the preceding section. With the aid of the SPSS 20.0 statistical software, the data collected from the survey were analyzed using various statistical analysis methods, which are described as follow.

A. Data normality test

As many statistical tests require a normal distribution of the data (Kim, 2015), according to (Cramer, D.1998) the Shapiro-Wilk test, which is a widely used method for testing data normality. It was first used to test the data normality. The null hypothesis of the Shapiro-Wilk test is that 'the data were normally distributed'. The Shapiro Wilk test is test based on p-values. In SPSS analysis P- value abbreviated/labeled as "sig". P-value is used in normality test.

If p- value > 0.05 keep or retain null hypothesis and if p-value <0.05 reject or omit null. In this study, all the p-values produced by the Shapiro-Wilk test were < 0.002 (see normality Tables in chapter 4), indicating that the data collected are not normally distributed. So that non-normal distribution of the data influenced the selection of statistical tests for analyzing the data.

B. Descriptive statistics (mean/frequency analysis)

The most commonly used descriptive statistics of mean and standard deviation (SD) were used to rank the factors in order of importance, as perceived by the respondents. Following (Darko & Chan, 2018) approach, where two or more strategies had the same mean score, the strategy with the smallest SD was given the highest rank. A smaller SD suggests that the differences in responses were not statistically large and thus the average is more likely to be valid for the majority (Darko & Chan, 2018).

To obtain mean rank and the significant differences among respondents in this study, the respondents were selected from seven construction organizations based on their profession experience and position or working streams.

In line with (Darko & Chan, 2019) and related studies, mean value analysis was used to determine the need for capacity building in areas of knowledge inadequacy as indicated by the respondents. Ranking was used for variable comparison. Variable comparison is necessary to direct efforts on green technology adoption. Furthermore, test was used to compare the significant differences in the groups' responses at 0.05 level of significance.

C. Inter-group comparison

Because the respondents were from different seven companies, it was important to check whether there were any significant differences between them, through conducting an inter-group comparison (Darko & Chan, 2018)

ANOVA is a commonly applied parametric test for checking differences between mean scores from three or more groups; it has an assumption that the population from which the sample was drawn is normally distributed. But as we have seen earlier the data was not normally distributed. Therefore, owing to the non-normal distribution of the data, the Kruskal-Wallis H test was chosen over ANOVA for the inter-group comparison in this study. In addition to the inter-group comparison, the mean difference analysis was performed to determine the actual values of the differences in the mean scores from different groups.

D. Variable comparison

Further, to identify the most important factors, variable comparison was done with complement to descriptive analysis. To perform the variable comparison, two statistical techniques were taken into consideration: paired t-test and Wilcoxon's signed rank test. But paired t-test is used for normally distributed data.

Wilcoxon's signed rank test is suitable for comparing matched variables without assuming any specific nature of data distribution or requiring equal variance of data(Darko

& Chan, 2018). Thus, in this study Wilcoxon's signed rank test was used for the variable comparison.

3.8 Reliability and Validity of the Study

Before analyzing the data collected, it is necessary to check data validity. According to (Darko & Chan, 2018) Cronbach's alpha coefficient was used to evaluate the reliability of the five-point rating scale used in capturing the survey responses. Cronbach's alpha evaluates the reliability of a rating scale through examining the average correlation or internal consistency between the variables that were assessed using the scale. The value of Cronbach's alpha coefficient ranges from 0 to 1, where the higher the value, the more reliable would be the adopted rating scale. Nevertheless, the standard rule is that the scale could be said to be reliable if the Cronbach's alpha coefficient value is higher than or equal to 0.70. Therefore, in this study, the Cronbach's alpha coefficient value of 0.813 indicated that the data was valid and reliable for further analysis.

Reliability and validity are the two most important and fundamental features in the evaluation of any measurement instrument or tool for a good research (Mohajan, 2017).

Reliability is the extent to which measurements are repeatable, when different persons perform the measurements, on different occasions, under different conditions, with supposedly alternative instruments which measure the same thing. (Ellen A.)

Reliability is the faith that one can have in the data obtained from the use of an instrument, that is, the degree to which any measuring tool controls for random error and it is the stability of findings. Whereas;

Validity is concerned with the meaningfulness of research components (Ellen A.). Validity concerns what an instrument measures, and how well it does so. Or it represents the truthfulness of findings. In this study data validity analyzed in two methods namely Skewness & kurtosis test and Shapiro-Wilk test and discussed in chapter four. Thus, I tried to use both reliability and validity to evaluate my study.

Cronbach's alpha (α) or Reliability coefficients describe the consistency, or correlation, of a set of scores and poor reliability inherently weakens effect sizes. Reliability describes the consistency, or correlation, of a set of scores. A score is consistent if the measuring instrument accurately measures the intended construct. Poor reliability, or a lack of correlation between scores, is generally a result of measurement error (Katherine L, 2014).

Alpha coefficient developed by Cronbach's (1951) is generally used in acquiring reliability in terms of internal consistency regarding a single test especially in combined measurements. This coefficient which is commonly used in the studies is a test reliability index (Eğitim, 2016).

Cronbach's alpha coefficient is used to assess the reliability and validity of the data. It evaluates the reliability of a rating scale through examining the average correlation or internal consistency between the variables that were assessed using the scale.

The value of Cronbach's alpha coefficient ranges from 0 to 1, where the higher the value, the more reliable would be the adopted rating scale. Nevertheless, the standard rule is that the scale could be said to be reliable if the Cronbach's alpha coefficient value is higher than or equal to 0.70 (Darko & Chan, 2018).

Therefore, in this study, the Cronbach's alpha coefficient value 0.813 indicates that the assessment using the five-point scale and hence the data collected were reliable for further analyses. Based on this the surveyed or collected data validity and reliability checked and further analyzed.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Introduction

There were four objectives labeled in codes; code A/01 with 15 factors (to determine GBTs level of awareness), code B/02 with 11 factors (to determine GBTs opportunities), code C/03 with 14 factors (to determine GBT adoption enablers) and code D/04 with 15 factors (to determine GBT adoption barriers) and detail analysis was done for each to achieve specified objectives. Also during respondent selection basically attention was given for experience, level of education, profession or specialization, employment organization. In addition to reach the specified objectives, analysis (mean/frequency, reliability, validity, normality, variable comparison and inter comparison) was done by SPSS data analysis technique and results discussed and presented.

Respondent profiles with respect to education level, profession, experience and employments company were described below.

Table 3 Respondent education level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Degree	25	54.3	54.3	54.3
	Masters	21	45.7	45.7	100.0
	Total	46	100.0	100.0	

- For education level, from the table we can see that 25 (54.3%) of respondents had first degree and 21 (45.7%0) respondents have master's degree.

Table 4 Respondents work experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than five years	2	4.3	4.3	4.3
	five to ten years	23	50.0	50.0	54.3
	above ten years	21	45.7	45.7	100.0
	Total	46	100.0	100.0	

- For work experience, from the table we can see that, 2 (4.3%) of respondents had less than five years, 23 (50.0%) respondents had five to ten years and 21 (45.7%) of respondents have above ten years work experience and it was a good experience distribution. Thus, it implies that 95.7% of respondents had experiences more than 5 years.

Table 5 Respondents profession

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	civil or structural engineer	15	32.6	32.6	32.6
	construction technology and management	9	19.6	19.6	52.2
	architectural design	4	8.7	8.7	60.9
	urban planner	12	26.1	26.1	87.0
	sanitary engineer	1	2.2	2.2	89.1
	electrical engineer	2	4.3	4.3	93.5
	hydraulics engineer	1	2.2	2.2	95.7
	accounting or finance	1	2.2	2.2	97.8
	business management	1	2.2	2.2	100.0
	Total	46	100.0	100.0	

- With respect to respondents profession, Civil or structural engineer 15 (32.6%), construction technology and management 9(19.6 %), architectural design 4 (8.7%), urban planner 12 (26.1%), sanitary engineer 1(2.2%) electrical engineer 2(4.3%), hydraulics engineer 1(2.2%). it shows 95.7% of respondents had directly related profession with GBTs concepts.

Table 6 Respondents employment company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ethiopian construction authority	12	26.1	26.1	26.1
	Addis Ababa housing development corporation	5	10.9	10.9	37.0
	federal housing corporation	6	13.0	13.0	50.0
	ministry of urban development and infrastructure	6	13.0	13.0	63.0
	Addis Ababa plan and development commission	7	15.2	15.2	78.3
	Addis Ababa construction permit and controls	6	13.0	13.0	91.3
	Ethiopian engineering and investment group	4	8.7	8.7	100.0
	Total	46	100.0	100.0	

- With respect to respondents working company, Ethiopian construction authority 12(26.1%), Addis Ababa housing development corporation 5(10.9%), Federal housing corporation 6(13.0%), Ministry of urban development and infrastructure 6(13.0%), Addis Ababa plan and development commission 7(15.2%). Addis Ababa construction permit and controls 6(13.0%), Ethiopian engineering and investment group 4(8.7%). Thus, all professionals were from different complement companies. These companies were the main construction industry companies and they were responsible to formulate, administer and regulate different rules, regulation, policies, directives etc.
    - ❖ From the above respondent profile tables we can see that good distribution of educational level, profession, experience and employment organization and it had a good contribution for data reliability and validity.

4.2 Normality analysis

In SPSS analysis, data normality is one of basic analysis to check data validity and conduct further analysis. In this study data validity analyzed in two methods namely Skewness & kurtosis test and Shapiro-Wilk test and discussed as follow;

In many statistical analyses there are dependent and independent variables.

A. Dependent variables are depends on other factors.

B. Independent variables are variables that are not depend on other factors.

According to (Cramer, D.1998) normality can be checked:-

1. Skewness and kurtosis; in which Z- values are determined by dividing Skewness or kurtosis value for its respective standard error. Z- Values are in span of -1.96 to +1.96. The measures should be as close to zero as possible in spss analysis. Near to zero or a small departure from zero shows approximately normally distributed.

Skewness Z-value =Skewness value/its standard error

Kurtosis z- value=kurtosis value/its standard error.

For both cases the values range in [-1.96 to +1.96]

2. The Shapiro Wilk test is test based on p-values. In SPSS analysis P- value abbreviated/labeled as “sig”. P-value is used in normality test. The null hypothesis of the Shapiro-Wilk test is that ‘the data were normally distributed’. The common alpha value for testing normality (i.e., 0.05) was used in conducting the Shapiro-Wilk test.

If the *p*-value produced by the test is lower than the selected alpha value, then the null hypothesis should be rejected, and conclusion that the data are not normally distributed can be drawn. p- Value > 0.05 keep or retain null hypothesis and if p-value <0.05 reject or omit null hypothesis for 95 percent confident intervals.

Therefor in Shapiro wilk test if “sig” or p-values > 0.05 data’s are normally distributed, and if p-value < 0.05 data’s are not normally distributed.

Example if “sig”= 0.06, it is > 0.05 retain null hypothesis, or it means there is no significant difference in data distribution.

Note; null hypothesis in test of normality state or believes that, data’s are normally distributed. In this study, all the *p*-values produced by the Shapiro-Wilk test tables indicate that the data collected are not normally distributed. This is an expected result since data collected from samples that are not very large are usually not normally distributed.

Table 7 Tests of data normality/A01

A/01	Level of awareness about 'Green Building Technology' (Indicate your level of agreement for the following GBTs points.)

A/01	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
1A	.282	46	.000	.767	46	.000
2A	.303	46	.000	.620	46	.000
3A	.424	46	.000	.586	46	.000
4A	.274	46	.000	.791	46	.000
5A	.368	46	.000	.647	46	.000
6A	.393	46	.000	.615	46	.000
7A	.298	46	.000	.801	46	.000
8A	.327	46	.000	.731	46	.000
9A	.389	46	.000	.679	46	.000
10A	.392	46	.000	.673	46	.000
11A	.412	46	.000	.647	46	.000
12A	.351	46	.000	.721	46	.000
13A	.423	46	.000	.624	46	.000
14A	.334	46	.000	.753	46	.000
15A	.358	46	.000	.690	46	.000

Result

Sample characteristics

As shown in table above, Shapiro-Wilk P- values or "sig" values for all factors A/01(1A = 0.000, 2A = 0.000, 3A = 0.000, 4A = 0.000, 5A = 0.000, 6A = 0.000, 7A = 0.000, 8A = 0.000, 9A = 0.000, 10A = 0.000, 11A = 0.000, 12A = 0.000, 13A = 0.000, 14A = 0.000, 15A = 0.000) were = 0.000 & for all p-values < 0.05. Therefore, it implies that there was significant difference in data distribution. Or data was not normally distributed and all 15 factors reject the null hypothesis.

Note, AAA is mean value by analyzing factors under code A/01 or it represents factors under level of green building awareness.

Table 8 Tests of Normality/AAA

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
AAA	.171	46	.002	.864	46	.000

Result

Sample characteristics

Shapiro-Wilk test, P- value for factor AAA/01 = 0.00, and it was < 0.05. Therefor there was significant difference in data distribution. Or data was not normally distributed and it rejects the null hypothesis

Table 9 Descriptive/AAA

			Statistic	Std. Error
AAA	Mean		4.4651	.07205
	95% Confidence Interval for Mean	Lower Bound	4.3200	
		Upper Bound	4.6102	
	5% Trimmed Mean		4.5043	
	Median		4.6067	
	Variance		.239	
	Std. Deviation		.48864	
	Minimum		2.57	
	Maximum		5.00	
	Range		2.43	
	Interquartile Range		.66	
	Skewness		-1.509	.350
	Kurtosis		3.528	.688

Skewness Z-value =Skewness value/its standard error

Kurtosis z- value=kurtosis value/its standard error.

For both cases the values range in [-1.96 to +1.96]

Skewness -1.509 /.350 = -4.31

Kurtosis 3.528 /.688 = 5.12

Both -4.31 and 5.12 were out of range [-1.96 to +1.96]

Therefor there was significant difference in data distribution. Or data was not normally distributed and it rejects the null hypothesis.

- Both histogram (nonsymmetrical) and normal Q-Q pilot figures (dots were not closely and symmetrically distributed over the line) below shows non normal distribution of data's under level of awareness or AAA.

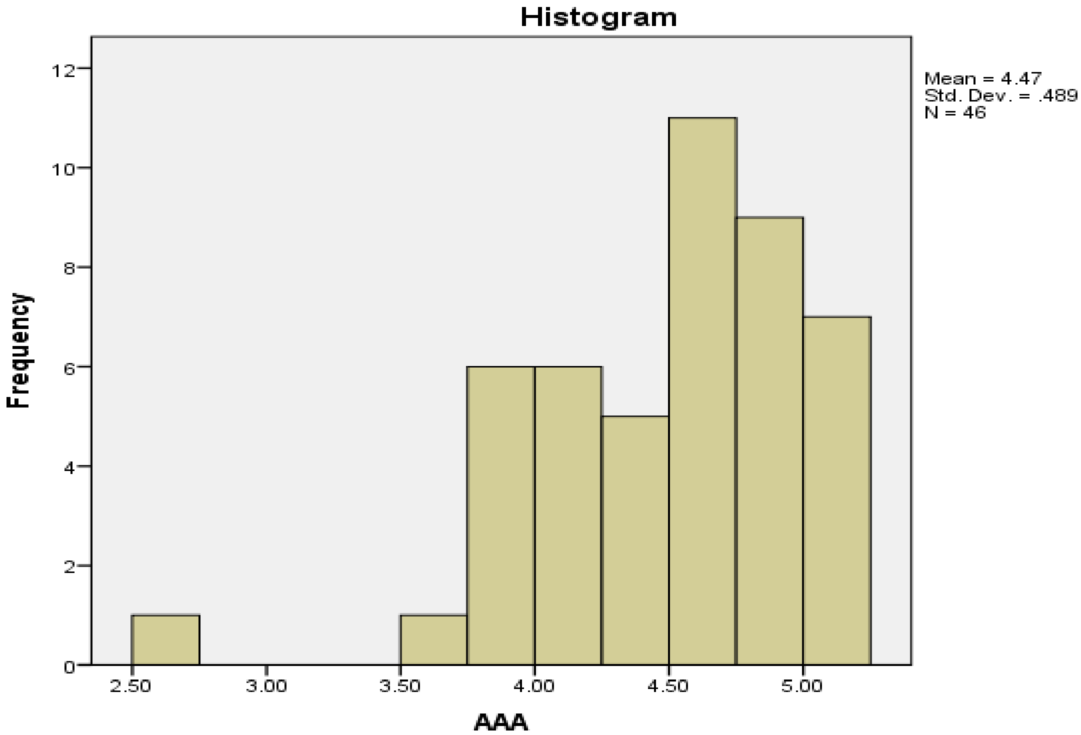


FIGURE 5: HISTOGRAM FOR AAA

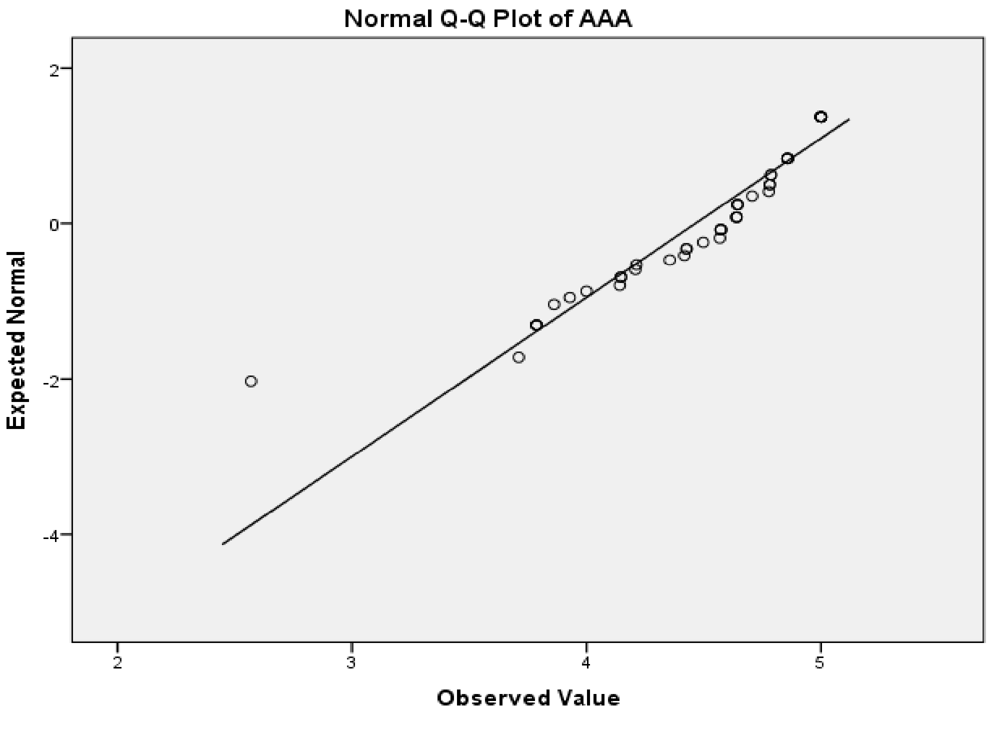


FIGURE 6: NORMAL Q-Q PLOTS AAA

Table 10 Tests of Normality/B/02

B/02	Opportunities to adopt 'Green Building Technology' (Indicate your level of agreement that the following points are being practiced or & are good opportunities for GBTs adoption.)

B/02	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
1B	.196	46	.000	.904	46	.001
2B	.202	46	.000	.903	46	.001
3B	.216	46	.000	.892	46	.000
4B	.220	46	.000	.901	46	.001
5B	.219	46	.000	.888	46	.000
6B	.276	46	.000	.844	46	.000
7B	.232	46	.000	.899	46	.001
8B	.232	46	.000	.873	46	.000
9B	.229	46	.000	.902	46	.001
10B	.206	46	.000	.895	46	.001
11B	.284	46	.000	.812	46	.000

Result

Sample characteristics

Shapiro-Wilk P- values for all factors of B/02(1B = 0.001, 2B = 0.001, 3B = 0.000, 4B = 0.001, 5B = 0.00, 6B = 0.000,7 B = 0.001, 8B = 0.00, 9B = 0.001, 10B = 0.001, 11B = 0.000)

Were ≤ 0.001 & for all p-values < 0.05. Therefor there was significant difference in data distribution. Or data was not normally distributed and it rejects the null hypothesis.

Note; BBB is mean value by analyzing factors under code B/02

Table 11 Tests of Normality/BBB

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
BBB	.083	46	.200*	.982	46	.688

Result

Sample characteristics

Shapiro-Wilk test, P- value for factor BBB/02 = 0.688, and it was > 0.05. Therefor there was no significant difference in data distribution. Or data was approximately normally distributed and it retains the null hypothesis.

Table 12 Descriptive/BBB

			Statistic	Std. Error
BBB	Mean		3.2134	.09330
	95% Confidence Interval for Mean	Lower Bound	3.0255	
		Upper Bound	3.4014	
	5% Trimmed Mean		3.2062	
	Median		3.2273	
	Variance		.400	
	Std. Deviation		.63281	
	Minimum		1.91	
	Maximum		4.64	
	Range		2.73	
	Interquartile Range		1.02	
	Skewness		.058	.350
	Kurtosis		-.259	.688

Skewness Z-value =Skewness value/its standard error

Kurtosis z- value=kurtosis value/its standard error.

For both cases the values range in [-1.96 to +1.96]

Skewness .058/.350 = 0.165

Kurtosis -.259/.688 = -0.376

Both 0.165 and -0.376 were within the range [-1.96 to +1.96]

Therefor there was no significant difference in data distribution. Or data was normally distributed and it retains the null hypothesis.

- Both histogram (symmetrical) and normal Q-Q pilot figures (dots were closely and symmetrically distributed over the line) below shows normal distribution of data's under opportunities or BBB.

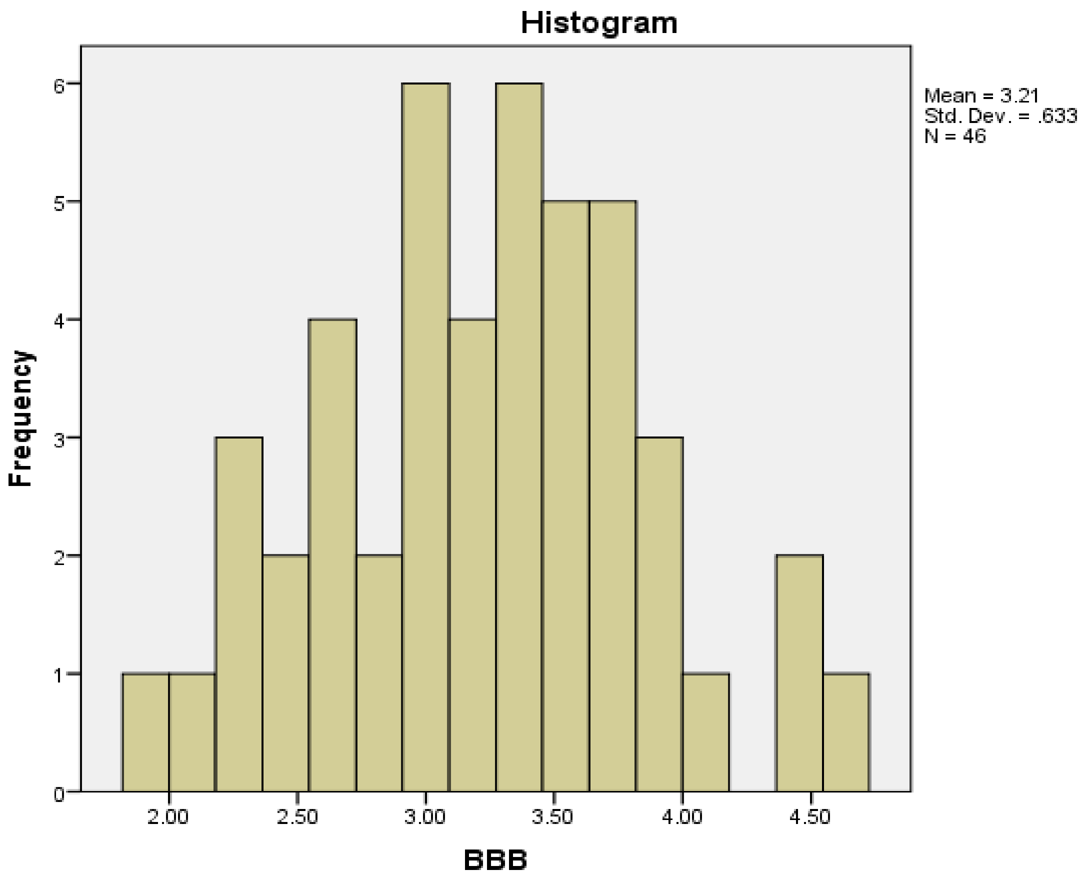


FIGURE 7 HISTOGRAM FOR AAA

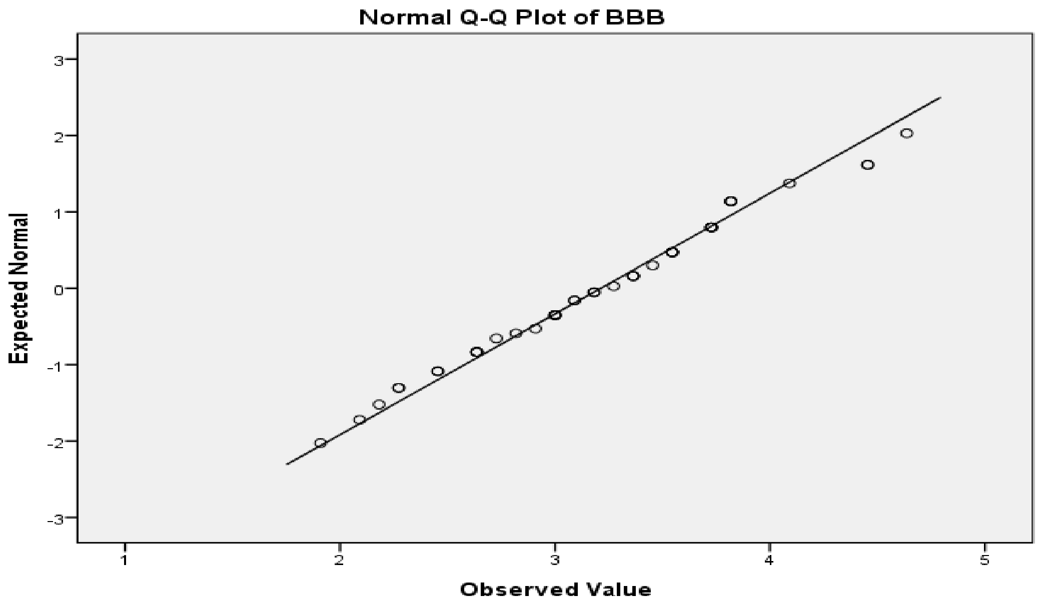


FIGURE 8 NORMAL Q-Q PLOTS BBB

Table 13 Tests of Normality/C03

C/03	Enablers/promoting/stimulating/ strategies to adopt ‘Green Building Technology’ (Indicate your level of agreement that the following points promote GBTs adoption.)

C/03	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
1C	.166	46	.003	.889	46	.000
2C	.240	46	.000	.852	46	.000
3C	.188	46	.000	.899	46	.001
4C	.240	46	.000	.886	46	.000
5C	.212	46	.000	.896	46	.001
6C	.227	46	.000	.901	46	.001
7C	.188	46	.000	.902	46	.001
8C	.218	46	.000	.895	46	.001
9C	.173	46	.001	.861	46	.000
10C	.236	46	.000	.870	46	.000
11C	.273	46	.000	.848	46	.000
12C	.304	46	.000	.814	46	.000
13C	.227	46	.000	.850	46	.000
14C	.276	46	.000	.844	46	.000

Result

Sample characteristics

Shapiro-Wilk P- values for all factors of C/03(1C = 0.000, 2C = 0.000, 3C = 0.001, 4C = 0.000, 5C = 0.001, 6C = 0.001, 7C = 0.001, 8C = 0.001, 9C = 0.000, 10C = 0.000, 11C = 0.000, 12C = 0.000, 13C = 0.000, 14C = 0.000) were ≤ 0.001 & for all p-values < 0.05. Therefor there was significant difference in data distribution. Or data was not normally distributed and it rejects the null hypothesis.

Note; CCC is mean value by analyzing factors under code C/03

Table 14 Descriptive/CCC

			Statistic	Std. Error
CCC	Mean		3.5870	.12610
	95% Confidence Interval for Mean	Lower Bound	3.3330	
		Upper Bound	3.8409	
	5% Trimmed Mean		3.6014	
	Median		3.6429	
	Variance		.731	
	Std. Deviation		.85528	
	Minimum		1.57	
	Maximum		5.00	
	Range		3.43	
	Interquartile Range		1.43	
	Skewness		-.117	.350
	Kurtosis		-.655	.688

Skewness Z-value =Skewness value/its standard error

Kurtosis z- value=kurtosis value/its standard error.

For both cases the values range in [-1.96 to +1.96]

Skewness -0.117/.350 = -0.334

Kurtosis -.655/.688 = -0.952

Both -0.334 and -0.952 are within the range [-1.96 to +1.96]

Therefor there was no significant difference in data distribution. Or data was approximately normally distributed and it retains the null hypothesis.

Table 15 Tests of Normality/CCC

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
CCC	.102	46	.200*	.973	46	.367

*. This is a lower bound of the true significance.

Result

Sample characteristics

Shapiro-Wilk test, P- value for factor CCC/01 = 0.367, and it was > 0.05. Therefor there was no significant difference in data distribution. Or data was approximately normally distributed and it retains the null hypothesis.

- Both histogram (nonsymmetrical) and normal Q-Q pilot figures (dots were not closely and symmetrically distributed over the line) below shows non normal distribution of data's under enablers or CCC.

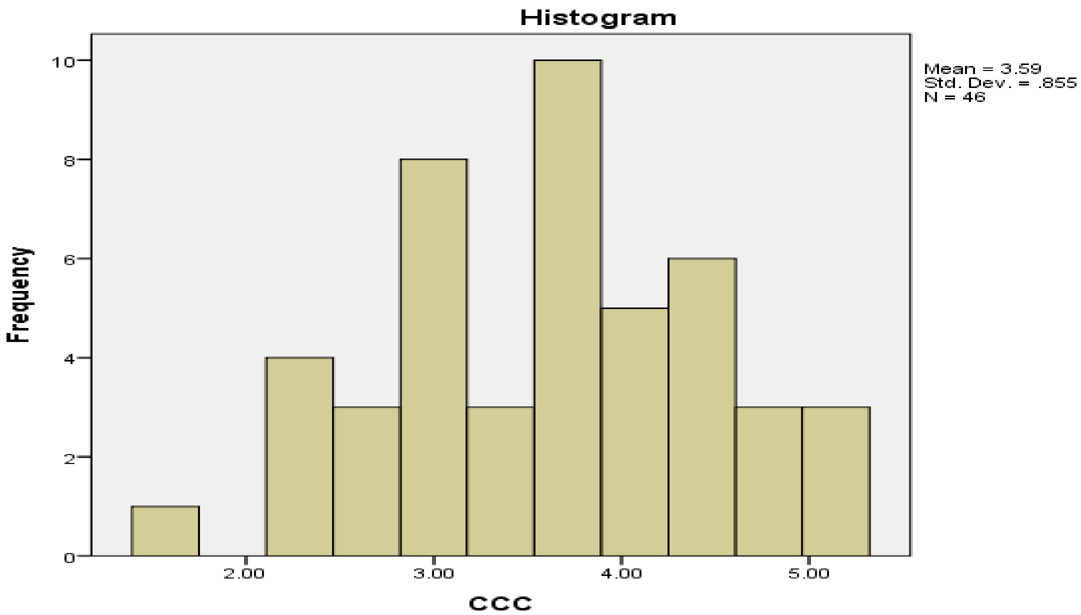


FIGURE 9 HISTOGRAM FOR CCC

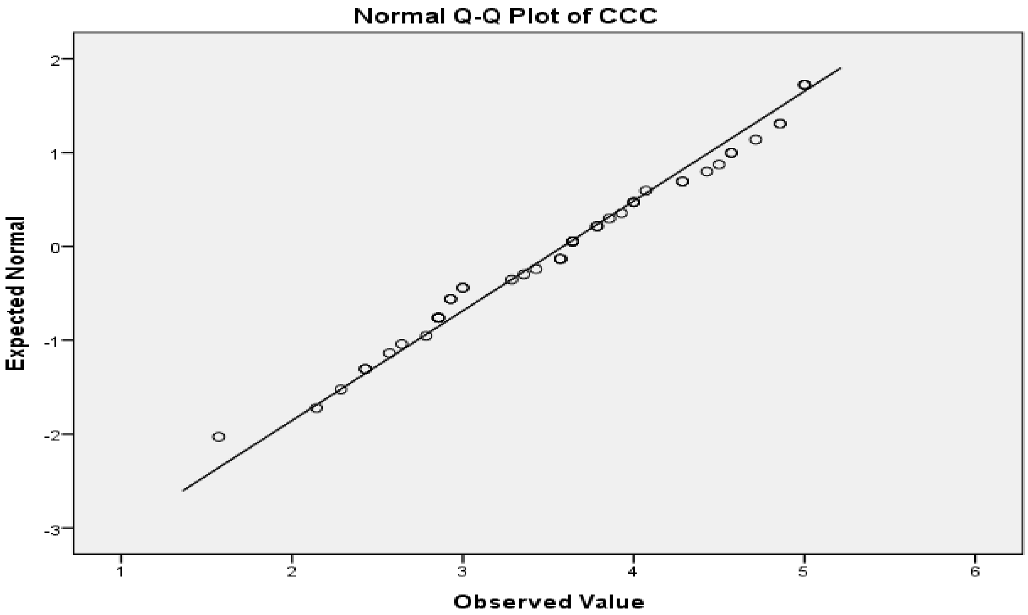


FIGURE 10 NORMAL Q-Q PLOTS BBB

Table 16 Tests of Normality/D/04

D/04	Challenges or Barriers for green building technology adoption (Indicate your level of agreement that the following points challenge GBTs adoption.)

D/04	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
1D	.235	46	.000	.829	46	.000
2D	.276	46	.000	.869	46	.000
3D	.298	46	.000	.833	46	.000
4D	.274	46	.000	.867	46	.000
5D	.248	46	.000	.875	46	.000
6D	.292	46	.000	.850	46	.000
7D	.194	46	.000	.906	46	.001
8D	.293	46	.000	.847	46	.000
9D	.247	46	.000	.862	46	.000
10D	.190	46	.000	.903	46	.001
11D	.223	46	.000	.895	46	.001
12D	.174	46	.001	.913	46	.002
13D	.212	46	.000	.901	46	.001
14D	.209	46	.000	.908	46	.001
15D	.181	46	.001	.911	46	.002

Result

Sample characteristics

Shapiro-Wilk P- values for all factors of D/04(1D = 0.000, 2D = 0.000, 3D = 0.000, 4D = 0.000, 5D = 0.000, 6D = 0.000, 7D = 0.001, 8D = 0.000, 9D = 0.000, 10D = 0.001, 11D = 0.001, 12D = 0.002, 13D = 0.001, 14D = 0.001, 15D = 0.002) were ≤ 0.002 & for all p-values < 0.05. Therefor there was significant difference in data distribution. Or data is not normally distributed and it rejects the null hypothesis.

Table 17 Descriptive/DDD

			Statistic	Std. Error
DDD	Mean		3.4145	.09992
	95% Confidence Interval for Mean	Lower Bound	3.2132	
		Upper Bound	3.6157	
	5% Trimmed Mean		3.4230	
	Median		3.4000	
	Variance		.459	
	Std. Deviation		.67767	
	Minimum		1.73	
	Maximum		4.93	
	Range		3.20	
	Interquartile Range		.68	
	Skewness		-.129	.350
	Kurtosis		.439	.688

Skewness Z-value =Skewness value/its standard error

Kurtosis z- value=kurtosis value/its standard error.

For both cases the values range in [-1.96 to +1.96]

Skewness -0.129/0.350 = -0.368

Kurtosis 0.439/.688 = 0.638

Both -0.368 and 0.638 are within the range [-1.96 to +1.96]

Therefor there is no significant difference in data distribution. Or data is normally distributed and it retain the null hypothesis.

Table 18 Tests of Normality/DDD

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
DDD	.115	46	.158	.976	46	.460

Result

Sample characteristics

Shapiro-Wilk test, P- value for factor DDD/01 = 0.46, and it is > 0.05.

•Both histogram (symmetrical) and normal Q-Q pilot figures (dots were closely and symmetrically distributed over the line) Therefor there is no significant difference in data distribution. Or data is approximately normally distributed and it retains the null hypothesis.

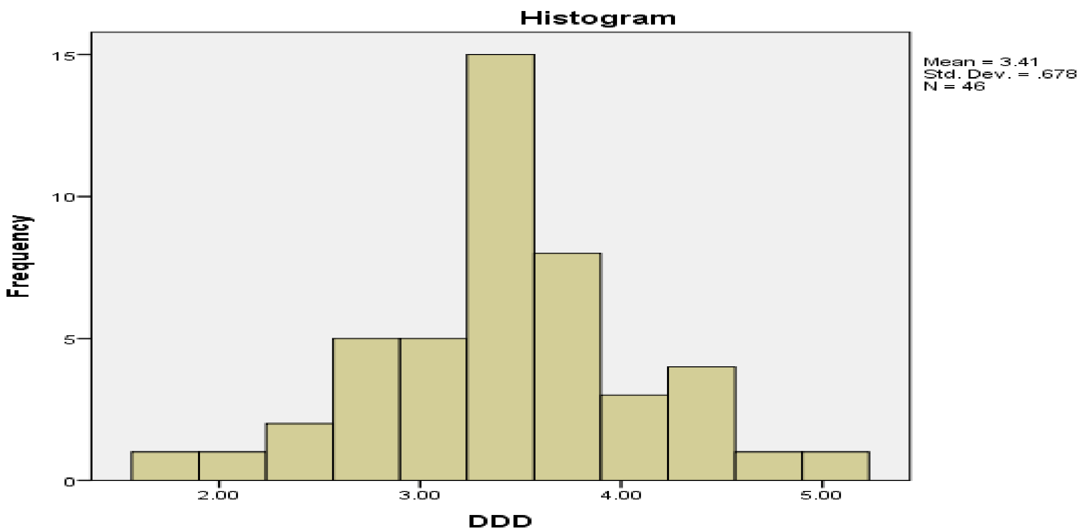


Figure 11, Histogram for DDD

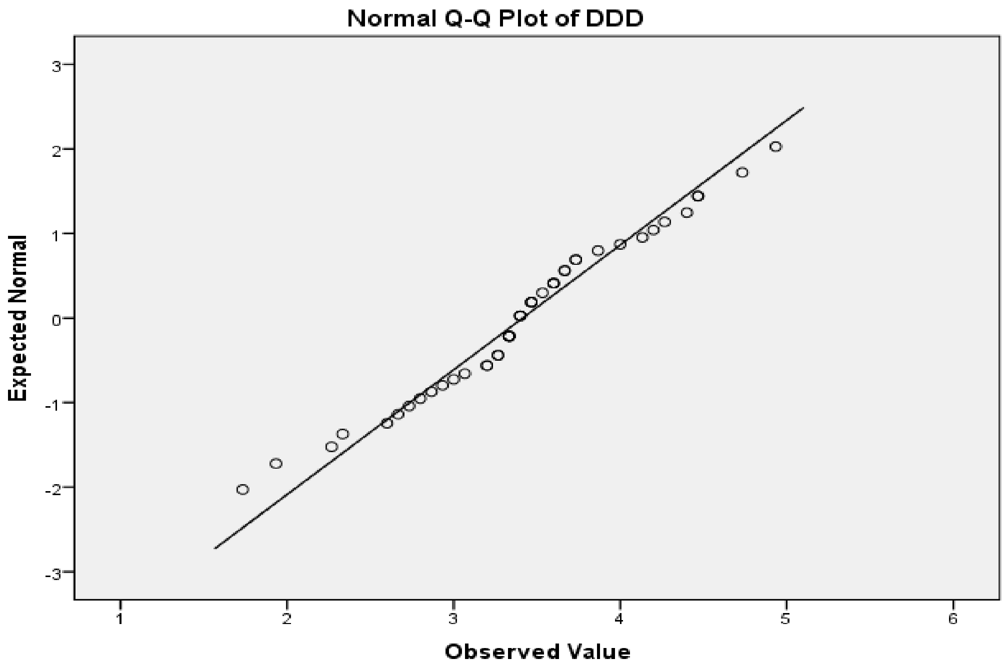


FIGURE 12: NORMAL Q-Q PLOTS DDD

Table 19 Descriptive Statistics for four means

	N	Mean		Std. Dev.	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
AAA	46	4.4651	.07205	.48864	-1.509	.350	3.528	.688
BBB	46	3.2134	.09330	.63281	.058	.350	-.259	.688
CCC	46	3.5870	.12610	.85528	-.117	.350	-.655	.688
DDD	46	3.4145	.09992	.67767	-.129	.350	.439	.688
Valid N (list wise)	46							

Skewness Z-value =Skewness value/its standard error

Kurtosis z- value=kurtosis value/its standard error.

AAA; Skewness Z-value= -1.509/0.350= -4.3

Kurtosis z- value= 3.528/0.688=5.127

For case AAA both Skewness & kurtosis values were out of the range [-1.96 to +1.96]. Therefor there was significant difference in data distribution. Or data was not normally distributed and it rejects the null hypothesis.

BBB; Skewness Z-value = 0.058/0.350 = 0.165

Kurtosis z- value = -0.259/0.688 = -0.376

CCC; Skewness Z-value = -0.117/0.350 = -0.334

Kurtosis z- value = -0.655/0.688 = -0.952

DDD; Skewness Z-value = -0.129/.350 = -0.368

Kurtosis z- value = 0.439/0.688 = 0.638

For all three cases (BBB, CCC &DDD), both kurtosis & Skewness values range within [-1.96 to +1.96].

Therefor there was no significant difference in data distribution. Or data was normally distributed and it retains the null hypothesis.

4.3 Reliability analysis

Reliability analysis was another complement analysis element in SPSS data analysis technique. Reliability analysis refers to consistency test or degree to which error free test is made and how a method measures something. Reliability test classified as;

A. Test retests reliability -over time test

B. Across item test – internal reliability test

C. Interpreter test – across researcher test

Internal reliability test is measured In Cronbach's alpha coefficient and it measures how well items are positively correlated to one another.

As stated (Darko & Chan, 2018) Cronbach's alpha is a statistic commonly quoted by authors to demonstrate that tests and scales that have been constructed or adopted for research projects are fit for purpose. Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability.

For internal reliability analysis we use Cronbach's alpha correlation coefficients which range from zero to +1 and interpreted as follow.

Table 20 Cronbach's Alpha coefficients

No	Coefficient of Cronbach's Alpha	Reliability Level
1	More Than .90	Excellent
2	0.80-0.89	Good
3	0.70-0.79	Acceptable
4	0.60-0.69	Questionable
5	0.50-0.59	Poor
6	Less Than 0.59	Unacceptable

Table 21 Reliability Statistics/A/01

A/01	Level of awareness about 'Green Building Technology' (Indicate your level of agreement for the following GBTs points.)
Cronbach's Alpha/AAA	N of Items
.882	15

Result

Sample characteristics

Cronbach's Alpha value for A/01 factor = 0.88. Therefor the factor was reliable in good range.

Table 22 Item-Total Statistics/A01

A/01	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1A	62.52	46.833	.550	.874
2A	62.43	46.296	.494	.878
3A	62.17	46.947	.713	.869
4A	62.85	46.399	.337	.893
5A	62.30	46.794	.607	.872
6A	62.26	45.619	.734	.866
7A	62.39	44.510	.681	.868
8A	62.39	46.599	.661	.870
9A	62.26	48.953	.493	.877
10A	62.24	48.186	.632	.873
11A	62.22	49.018	.491	.877
12A	62.35	48.143	.552	.875
13A	62.26	48.242	.486	.877
14A	62.54	46.520	.522	.876
15A	62.37	47.394	.500	.876

Result

Sample characteristics

Cronbach's Alpha value for all A/01(1A = 0.874, 2A = 0.878, 3A = 0.869, 4A = 0.893, 5A = 0.872, 6A = 0.866, 7A = 0.868, 8A = 0.870, 9A = 0.877, 10A = 0.873, 11A = 0.877, 12A = 0.875, 13A = 0.875, 14A = 0.876, 15A = 0.876) ranges between [0.80 to 0.89]. Therefor the factors were reliable in good range.

Table 23 Reliability Statistics/B/02

B/02	Opportunities to adopt ‘Green Building Technology’ (Indicate your level of agreement that the following points are being practiced or & are good opportunities for GBTs adoption.)

Cronbach's Alpha/BBB	N of Items
.839	11

Result

Sample characteristics

Cronbach's Alpha value for B/02 factor = 0.839. Therefor the factor was reliable in good range.

Table 24 Item-Total Statistics/B/02

B/02	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1B	32.39	39.132	.579	.820
2B	32.15	39.821	.639	.816
3B	32.28	39.318	.559	.822
4B	32.28	40.429	.441	.834
5B	32.15	40.087	.634	.817
6B	31.57	42.073	.520	.826
7B	31.89	40.943	.521	.825
8B	32.39	39.577	.520	.826
9B	32.26	39.619	.570	.821
10B	32.33	40.980	.478	.829
11B	31.78	45.596	.227	.845

Result

Sample characteristics

Cronbach's Alpha value for all B/02(1B = 0.820, 2B = 0.816, 3B = 0.822, 4B = 0.834, 5B = 0.817, 6B = 0.826, 7B = 0.825, 8B = 0.826, 9B = 0.824, 10B = 0.829, 11B = 0.845) ranges between [0.80 to 0.89]. Therefor the factors were reliable in good range.

Table 25 Reliability Statistics/C/03

C/03	Enablers/promoting/stimulating/ strategies to adopt 'Green Building Technology' (Indicate your level of agreement that the following points promote GBTs adoption.)

Cronbach's Alpha	N of Items
.944	14

Result

Sample characteristics

Cronbach's Alpha value for C/03 factor = 0.944. Therefore the factor was reliable in excellent range.

Table 26 Item-Total Statistics/C/03

C/03	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1C	46.85	119.332	.795	.938
2C	46.33	125.425	.782	.938
3C	47.04	119.065	.771	.938
4C	46.98	120.377	.734	.940
5C	46.85	122.665	.678	.941
6C	46.74	122.686	.807	.937
7C	46.78	124.574	.775	.938
8C	46.83	120.725	.818	.937
9C	46.70	119.816	.738	.939
10C	46.48	129.233	.594	.943
11C	46.35	126.987	.737	.940
14C	46.46	123.365	.712	.940

Result

Sample characteristics

Cronbach's Alpha value for all C/03(1C = .0938, 2C =0.938, 3C = 0.938, 4C = 0.940, 5C = 0.941, 6C = 0.937, 7C = 0.938, 8C = 0.937, 9C = 0.939, 10C = 0.943, 11C = 0.940, 14C = 0.940) > 0.90. Therefor all factors were reliable in excellent range.

Table 27 Reliability Statistics/D/04

D/04	Challenges or Barriers for green building technology adoption (Indicate your level of agreement that the following points challenge GBTs adoption.)

Cronbach's Alpha	N of Items
.883	15

Result

Sample characteristics

Cronbach's Alpha value for D/04 factor = 0.883. Therefore the factor was reliable in good range

Table 28 Item-Total Statistics/D/04

D/04	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1D	48.93	93.440	.311	.888
2D	47.57	92.162	.472	.878
3D	47.30	92.128	.573	.874
4D	47.72	88.296	.622	.871
5D	47.57	85.673	.760	.865
6D	47.39	90.243	.695	.870
7D	47.76	93.119	.440	.879
8D	47.50	89.544	.574	.874
9D	47.39	92.599	.538	.876
10D	47.72	92.385	.514	.876
11D	47.65	94.099	.391	.882
12D	48.24	93.430	.437	.880
13D	48.22	86.574	.691	.868
14D	47.96	87.643	.634	.871
15D	48.13	90.160	.553	.875

Result

Sample characteristics

Cronbach's Alpha value for all D/04(1D = 0.888, 2D = 0.878, 3D = 0.874, 4D = 0.871, 5D = 0.865, 6D = 0.870, 7D = 0.879, 8D = 0.0.874, 9D = 0.876, 10D = 0.876, 11D = 0.882, 12D = 0.880, 13D = 0.868, 14D = 0.871, 15D = 0.875) ranges between [0.80 to 0.89]. Therefor all factors were reliable in good range.

4.4 Mean-Frequency analysis

The most commonly used descriptive statistics of mean and standard deviations (SD) were used to rank the factors in descending order of importance, as perceived by the respondents. When two or more factors had the same mean score, the factor with the smallest SD was given the highest rank. A smaller SD suggests that the differences in responses were not statistically large and thus the average is more likely to be valid for the majority(Darko & Chan, 2018). Mean or frequency analysis was done for all four factor points (A/01, B/02, C/03 and D/04) and ranked based on their mean values.

Table 29 Descriptive Statistics/A01

A/01	Level of awareness about 'Green Building Technology'

	N	Mean		Std. Dev.	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Err	Statistic	Std. Err
3A	46	4.65	.094	.640	-2.200	.350	5.777	.688
11A	46	4.61	.091	.614	-1.340	.350	.807	.688
10A	46	4.59	.086	.580	-1.068	.350	.218	.688
9A	46	4.57	.091	.620	-1.135	.350	.305	.688
13A	46	4.57	.106	.720	-1.360	.350	.384	.688
6A	46	4.57	.111	.750	-2.050	.350	4.413	.688
5A	46	4.52	.111	.752	-1.877	.350	3.823	.688
12A	46	4.48	.097	.658	-.896	.350	-.247	.688
15A	46	4.46	.119	.808	-1.568	.350	2.099	.688
8A	46	4.43	.106	.720	-1.258	.350	1.619	.688
7A	46	4.43	.134	.910	-.629	.350	1.725	.688
2A	46	4.39	.141	.954	-2.323	.350	6.023	.688
1A	46	4.30	.120	.813	-1.144	.350	1.050	.688
14A	46	4.28	.131	.886	-.801	.350	-.702	.688
4A	46	3.98	.183	1.238	-1.059	.350	.175	.688
Valid N	46							

Result

Sample characteristics

The mean scores of the importance of the factors range from 3.65 to 4.65. It was noteworthy that the mean scores of all the factors were much higher than 3.00, which is the middle value of the rating scale, implying that all the factors had significant importance. Although all the factors were important, ranking them would enable the industry professionals and acadamitians to understand which factors are worth focusing and needs more attention. Thus prioritizing these factors would be helpful for GBTs adoption promotion activities. From the mean analysis results, the top five factors (mean $\geq$ 4.57 & SD $\leq$.72) were 3A, 11A, 10A, 9A and 13A.

Based on mean calculation, top five opportunities to adopt green building technology were determined. Thus, Proper designs & orientations for window and door openings increase natural air ventilation & day light access (M=4.65 & SD=0.640) ranked first, Proper building designs & orientations for window and door openings increase natural air circulation and it is good for occupant health (M=4.61 & SD=0.614) ranked second, Managing Indoor air quality of buildings is necessary for occupant health. (M=4.59 & SD=0.580) ranked third, Proper waste treatment and recycling process is needed in construction industry (M=4.57 & SD=.620) ranked fourth and Water Conservation, recycling used water and rainwater harvesting contribute to address water scarce problem (M=4.57 & SD=0.720) was ranked fifth. Thus, hope that the determination & prioritization of these factors would be used as an input for the industry and academic professional for GB adoption.

Table 30 Descriptive Statistics/B/02

B/02	Opportunities to adopt 'Green Building Technology' (Indicate your level of agreement that the following points are being practiced or & are good opportunities for GBTs adoption.)

	N	Mean		Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
6B	46	3.78	.124	.841	-.733	.350	1.488	.688
11B	46	3.57	.111	.750	-.728	.350	1.983	.688
7B	46	3.46	.145	.982	-.315	.350	-.369	.688
2B	46	3.20	.141	.957	-.253	.350	-.159	.688
5B	46	3.20	.138	.934	-.410	.350	-.166	.688
9B	46	3.09	.158	1.071	-.066	.350	-.149	.688
4B	46	3.07	.174	1.181	-.216	.350	-.950	.688
3B	46	3.07	.166	1.124	-.428	.350	-.496	.688
10B	46	3.02	.154	1.043	.078	.350	-.884	.688
1B	46	2.96	.164	1.115	-.012	.350	-.921	.688
8B	46	2.96	.170	1.154	-.456	.350	-.717	.688
Valid N (list wise)	46							

Result

Sample characteristics

The mean scores of the importance of the factors range from 2.96 to 3.78. It is noteworthy that the mean scores of all the factors except 1B (M=2.96) and 8B (M=2.96) were higher than 3.00, which is the middle value of the rating scale, implying that all the factors had significant importance. Although all the factors were important, ranking them would enable the industry professionals and academicians to understand which factors are worth focusing and needs more attention. Thus prioritizing these factors would be helpful for GBTs adoption promotion activities. From the mean analysis results, the top five factors (mean $\geq$ 3.20 & SD $\leq$0.934) were 6B, 11B, 7B, 2B and 5B.

Based on mean calculation, top five opportunities to adopt green building technology were determined. Thus, Ethiopia signed different continental & international sustainability, environmental protection, poverty reduction agreements & it contributes for GBTs adoption (M=3.78 & SD=0.841) ranked first, The established ten years prosperity Road map and framework, newly revised building policies may contribute for GBTs adoption. (M=3.57 & SD=0.750) ranked second, The established ten years prosperity Road map and framework, newly revised building policies may contribute for GBTs adoption. (M=3.46 & SD=0.982) ranked third, Existing building codes and standards encourage GBTs principles. (M=3.20 & SD=.957) ranked fourth and The Ethiopia construction industry has flexible and easy policy approach to adopt new innovations like GBTs adoption. (M=3.20 & SD=0.934) was ranked fifth. Thus, hope that the determination & prioritization of these factors would be used as an input for the industry and academic professional for GB adoption.

Table 31 Descriptive Statistics/C03

C/03	Enablers/promoting/stimulating/ strategies to adopt 'Green Building Technology' (Indicate your level of agreement that the following points promote GBTs adoption.)

	N	Mean		Std. Dev.	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
12C	46	4.00	.103	.699	-.408	.350	.401	.688
13C	46	3.98	.134	.906	-.517	.350	-.524	.688
2C	46	3.89	.143	.971	-.535	.350	-.620	.688
11C	46	3.87	.138	.934	-.587	.350	-.360	.688
14C	46	3.76	.174	1.177	-.792	.350	-.326	.688
10C	46	3.74	.144	.976	-.341	.350	-.803	.688
9C	46	3.52	.198	1.346	1.353	.350	4.762	.688
6C	46	3.48	.161	1.090	-.426	.350	-.448	.688
7C	46	3.43	.151	1.025	-.334	.350	-.094	.688
8C	46	3.39	.174	1.183	-.234	.350	-1.016	.688
1C	46	3.37	.190	1.289	-.154	.350	-1.186	.688
5C	46	3.37	.187	1.271	-.339	.350	-.966	.688
4C	46	3.24	.195	1.320	-.342	.350	-1.081	.688
3C	46	3.17	.197	1.338	-.158	.350	-1.164	.688
Valid N (list wise)	46							

Result

Sample characteristics

The mean scores of the importance of the factors range from 3.17 to 4.00. It is noteworthy that the mean scores of all the factors were much higher than 3.00, which is the middle value of the rating scale, implying that all the factors had significant importance. Although all the factors were important, ranking them would enable the industry professionals and academicians to understand which factors are worth focusing and needs more attention. Thus prioritizing these factors would be helpful for GBTs adoption promotion activities.

From the mean analysis results, the top five factors (mean ≥ 3.76 & SD ≤1.177) were 12C, 13C, 2C, 11C and14C.

Based on mean calculation, top five enablers to adopt green building technology were determined. Thus, Less environmental impact (M=4.00 & SD=0.699) ranked first, Better indoor air quality (M=3.98 & SD=0.906) ranked second, Enhance of occupant's health & comfort (M=3.89 & SD=0.9971) ranked third, Greater water efficiency principle of GBTs (M=3.87 & SD=.934) ranked fourth and Cooperative works of construction industry with other ministries (M=3.76 & SD=1.177) was ranked fifth. Thus, hope that the determination & prioritization of these factors would be used as an input for the industry and academic professional for GB adoption.

Table 32 Descriptive Statistics/D/04

D/04	Challenges or Barriers for green building technology adoption (Indicate your level of agreement that the following points challenge GBTs adoption.)

	N	Mean		Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
3D	46	3.91	.138	.939	-1.001	.350	1.165	.688
9D	46	3.83	.140	.950	-.449	.350	-.621	.688
6D	46	3.83	.137	.926	-.866	.350	.941	.688
8D	46	3.72	.169	1.148	-.793	.350	-.232	.688
5D	46	3.65	.171	1.159	-.612	.350	-.502	.688
2D	46	3.65	.162	1.100	-.721	.350	-.115	.688
11D	46	3.57	.157	1.068	-.521	.350	-.150	.688
10D	46	3.50	.148	1.006	-.206	.350	-.432	.688
4D	46	3.50	.172	1.169	-.742	.350	-.167	.688
7D	46	3.46	.158	1.069	-.338	.350	-.347	.688
14D	46	3.26	.177	1.201	-.290	.350	-.818	.688
15D	46	3.09	.167	1.132	.015	.350	-.874	.688
13D	46	3.00	.176	1.193	.082	.350	-1.052	.688
12D	46	2.98	.154	1.043	.045	.350	-.616	.688
1D	46	2.28	.198	1.344	.832	.350	-.448	.688
Valid N (list wise)	46							

Result

Sample characteristics

The mean scores of the importance of the factors range from 2.28 to 3.91. It is noteworthy that the mean scores of all the factors except 12D (M=2.98) and 1D (M=2.28) were higher than 3.00, which is the middle value of the rating scale, implying that all the factors had significant importance. Although all the factors were important, ranking them would enable the industry professionals and academicians to understand which factors are worth focusing and needs more attention. Thus prioritizing these factors would be helpful for GBTs adoption promotion activities. From the mean analysis results, the top five factors (mean $\geq$ 3.65 & SD $\leq$1.15) were 3D, 9D, 6D, 8D and 5D.

Based on mean calculation, top five challenges/barriers to adopt green building technology were determined. Thus, Lack of awareness and training (M=3.91 & SD=0.939) ranked first, Lack of local database and information relating to green and sustainable products (M=3.83 & SD=0.950) ranked second, Unfamiliarity with the new green products or technologies (M=3.83 & SD=0.926) ranked third, Lack of initiative and promotions by the government/ private bodies (M=3.72 & SD=1.148) ranked fourth and No culture and experience for green construction between construction stakeholders (M=3.65 & SD=1.159) was ranked fifth. Thus, hope that the determination & prioritization of these factors would be used as an input for the industry and academic professional for GB adoption.

4.5 Variable comparison

Wilcoxon's signed rank test is suitable for comparing matched variables without assuming any specific nature of data distribution or requiring equal variance of data(Darko & Chan, 2018). Thus, in this study Wilcoxon's signed rank test was used for the variable comparison.

Note; Wilcoxon's signed rank test result is significant at the significance level of 0.05 (*p*-value < 0.05), suggesting that the two compared variables are statistically different and which reject the null hypothesis.

Wilcoxon Signed Ranks Test
Ranks

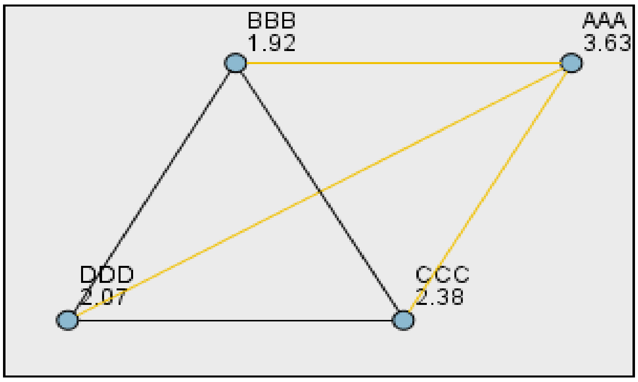
Table 33 Wilcoxon Signed Ranks Test

		N	Mean Rank	Sum of Ranks
BBB – AAA	Negative Ranks	43[a]	24.53	1055.00
	Positive Ranks	3[b]	8.67	26.00
	Ties	0[c]		
	Total	46		
CCC – AAA	Negative Ranks	35[d]	26.03	911.00
	Positive Ranks	9[e]	8.78	79.00
	Ties	2[f]		
	Total	46		
DDD – AAA	Negative Ranks	42[g]	25.05	1052.00
	Positive Ranks	4[h]	7.25	29.00
	Ties	0[i]		
	Total	46		
CCC – BBB	Negative Ranks	19[j]	17.45	331.50
	Positive Ranks	26[k]	27.06	703.50
	Ties	1[l]		
	Total	46		
DDD – BBB	Negative Ranks	20[m]	20.85	417.00
	Positive Ranks	26[n]	25.54	664.00
	Ties	0[o]		
	Total	46		
DDD – CCC	Negative Ranks	27[p]	24.19	653.00
	Positive Ranks	19[q]	22.53	428.00
	Ties	0[r]		
	Total	46		

a. BBB < AAA	j. CCC < BBB
b. BBB > AAA	k. CCC > BBB
c. BBB = AAA	l. CCC = BBB
d. CCC < AAA	m. DDD < BBB
e. CCC > AAA	n. DDD > BBB
f. CCC = AAA	o. DDD = BBB
g. DDD < AAA	p. DDD < CCC
h. DDD > AAA	q. DDD > CCC
i. DDD = AAA	r. DDD = CCC

Table 34 Wilcoxon Signed pairwise comparision

Pairwise Comparisons



Each node shows the sample average rank.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
BBB-DDD	-.141	.269	-.525	.600	1.000
BBB-CCC	-.457	.269	-1.696	.090	.539
BBB-AAA	1.707	.269	6.339	.000	.000
DDD-CCC	.315	.269	1.171	.242	1.000
DDD-AAA	1.565	.269	5.815	.000	.000
CCC-AAA	1.250	.269	4.644	.000	.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Table 35 Wilcoxon Signed Ranks hypothesis summary AAA-BBB

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between BBB and AAA equals 0.	Related-Samples Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Wilcoxon's signed rank test result is significant at the significance level of 0.05 (*p*-value < 0.05), suggesting that the two compared variables are statistically different and which reject the null hypothesis. Thus, BBB - AAA, had *p*-value = 0.00, *p*-value < 0.05, it suggest that the paired factors were statistically different or there was significant difference and which reject the null hypothesis.

Table 36 Wilcoxon Signed Ranks hypothesis summary BBB-CCC

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between BBB and CCC equals 0.	Related-Samples Wilcoxon Signed Rank Test	.036	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Wilcoxon's signed rank test result is significant at the significance level of 0.05 (*p*-value < 0.05), suggesting that the two compared variables are statistically different and which reject the null hypothesis. Thus, BBB - CCC, had *p*-value = 0.036, *p*-value < 0.05, it suggest that the paired factors were statistically different or there was significant difference and which reject the null hypothesis

Table 37 Wilcoxon Signed Ranks hypothesis summary BBB-DDD

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between BBB and DDD equals 0.	Related-Samples Wilcoxon Signed Rank Test	.177	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Wilcoxon's signed rank test result is significant at the significance level of 0.05 (*p*-value < 0.05), suggesting that the two compared variables are statistically different and which reject the null hypothesis. Thus, BBB - DDD, had *p*-value = 0.177, *p*-value > 0.05, it suggest that the paired factors were not statistically different or there was no significant difference and which retain the null hypothesis.

Table 38 Wilcoxon Signed Ranks hypothesis summary CCC-DDD

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between DDD and CCC equals 0.	Related-Samples Wilcoxon Signed Rank Test	.219	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Wilcoxon's signed rank test result is significant at the significance level of 0.05 (p-value < 0.05), suggesting that the two compared variables are statistically different and which reject the null hypothesis. Thus, CCC-DDD, had p-value = 0.219, p-value > 0.05, it suggest that the paired factors were not statistically different or there was no significant difference and which retain the null hypothesis.

Table 39 Wilcoxon Signed Ranks hypothesis summary AAA-DDD

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between DDD and AAA equals 0.	Related-Samples Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Wilcoxon's signed rank test result is significant at the significance level of 0.05 (p-value < 0.05), suggesting that the two compared variables are statistically different and which reject the null hypothesis. Thus, AAA- DDD, had p-value = 0.000, p-value < 0.05, it suggest that the paired factors were statistically different or there was significant difference and which reject the null hypothesis.

Table 40 Wilcoxon Signed Ranks hypothesis summary AAA-CCC

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between AAA and CCC equals 0.	Related-Samples Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Wilcoxon's signed rank test result is significant at the significance level of 0.05 (*p*-value < 0.05), suggesting that the two compared variables are statistically different and which reject the null hypothesis. Thus, AAA- CCC, had *p*-value = 0.000, *p*-value < 0.05, it suggest that the paired factors were statistically different or there was significant difference and which reject the null hypothesis

Table 41 Wilcoxon Signed Ranks hypothesis summary entire comparison

Test Statistics[a]

	BBB – AAA	CCC – AAA	DDD - AAA	CCC - BBB	DDD – BBB	DDD - CCC
Z	-5.621[b]	-4.855[b]	-5.588[b]	-2.100[c]	-1.349[c]	-1.229[b]
Asymp. Sig. (2-tailed)	.000	.000	.000	.036	.177	.219

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.
c. Based on negative ranks.

Wilcoxon's signed rank test result is significant at the significance level of 0.05 (*p*-value < 0.05), suggesting that the two compared variables are statistically different.

Thus, all BBB - AAA , CCC – AAA, DDD – AAA, CCC – BBB had *p*-value < 0.05 the compared paired factors were statistically different. But the two paired factors DDD – BBB and DDD – CCC had p-value > 0.05, it suggest that paired factors were not statically different or there was no significant difference and which retain the null hypothesis.

4.6. Inter-group comparison

It was important to check whether there were any significant differences between them, through conducting an inter-group comparison (Darko & Chan, 2018). Since the respondents were from different companies, experience, educational level and profession I was checked that whether there is any significant differences or not across the groups.

ANOVA is a commonly applied parametric test for checking differences between mean scores from three or more groups; it has an assumption that the population from which the sample was drawn is normally distributed. But as we have seen earlier the data was not normally distributed. Therefore, owing to the non-normal distribution of the data, the Kruskal-Wallis H test was chosen over ANOVA for the inter-group comparison in this study. In addition to the inter-group comparison, the mean difference analysis was performed to determine the actual values of the differences in the mean scores from different groups.

Kruskal-Wallis Test

Table 42 Kruskal-Wallis Test/experience ranks

	Respondent work experience	N	Mean Rank
AAA	less than five years	2	27.25
	five to ten years	23	23.00
	above ten years	21	23.69
	Total	46	

Table 43 Kruskal-Wallis Test/experience Test Statistics[a,b]

	AAA
Chi-Square	.193
Df	2
Asymp. Sig.	.908

a. Kruskal Wallis Test
b. Grouping Variable: Respondent work experience

Table 44 Kruskal-Wallis Test hypothesis summary for AAA across experience.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of AAA is the same across categories of Respondant work experiance.	Independent-Samples Kruskal-Wallis Test	.908	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Note: a Kruskal-Wallis test result is significant at the significance level of 0.05 (p-value < 0.05), suggesting that the tested variables are statistically different across the given categories.

AAA had p-value = 0.908, P-value > 0.05, thus it suggests that the distribution of GB awareness level had no significant difference across the categories of respondents work experience and it retain the null hypothesis.

Kruskal-Wallis Test

Table 45 Kruskal-Wallis Test/education level

Ranks

	Respondent education level	N	Mean Rank
BBB	Degree	25	24.06
	Masters	21	22.83
	Total	46	

Table 46 Kruskal-Wallis Test/education level

Test Statistics[a,b]

	BBB
Chi-Square	.096
Df	1
Asymp. Sig.	.757

a. Kruskal Wallis Test

b. Grouping Variable: Respondent education level

Table opportunity hypothesis test summary

Table 47 Kruskal-Wallis Test hypothesis summary for BBB across education level.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of BBB is the same across categories of Respondant education level.	Independent-Samples Mann-Whitney U Test	.757	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Kruskal-Wallis test result is significant at the significance level of 0.05 (p-value < 0.05), suggesting that the tested variables are statistically different across the given categories. BBB had p-value = 0.757, P-value > 0.05, thus it suggests that the distribution of GB opportunities had no significant difference across the categories of respondents education level and it retain the null hypothesis.

Kruskal-Wallis Test

Table 48 Kruskal-Wallis Test/profession

Ranks

	Respondent profession	N	Mean Rank
CCC	civil or structural engineer	15	25.67
	construction technology and management	9	26.28
	architectural design	4	19.50
	urban planner	12	19.21
	sanitary engineer	1	24.50
	electrical engineer	2	41.00
	hydraulics engineer	1	35.50
	accounting or finance	1	1.00
	business management	1	8.00
	Total	46	

Table 49 Kruskal-Wallis Test/profession

Test Statistics[a,b]

	CCC
Chi-Square	10.732
Df	8
Asymp. Sig.	.217

a. Kruskal Wallis Test
b. Grouping Variable: Respondent profession

Table enabler hypothesis test summary

Table 50. Kruskal-Wallis Test hypothesis summary for CCC across profession.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of CCC is the same across categories of Respondant profession.	Independent-Samples Kruskal-Wallis Test	.217	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Kruskal-Wallis test result is significant at the significance level of 0.05 (p-value < 0.05), suggesting that the tested variables are statistically different across the given categories.

BBB had p-value = 0.217, P-value > 0.05, thus it suggests that the distribution of GB enablers had no significant difference across the categories of respondents profession and it retain the null hypothesis.

Kruskal-Wallis Test

Table 51 Kruskal-Wallis Test/employment Company

Ranks

	Respondent employment company	N	Mean Rank
DDD	Ethiopian construction authority	12	16.67
	Addis Ababa housing development corporation	5	27.10
	Federal housing corporation	6	33.83
	Ministry of urban development and infrastructure	6	19.50
	Addis Ababa plan and development commission	7	33.64
	Addis Ababa construction permit and control	6	14.00
	Ethiopian engineering and investment group	4	26.50
	Total	46	

Table 52 Kruskal-Wallis Test/employment Company.

Test Statistics[a,b]

	DDD
Chi-Square	14.809
Df	6
Asymp. Sig.	.022

a. Kruskal Wallis Test

b. Grouping Variable: respondent employment company

Table barrier hypothesis test summary

Table 53 Kruskal-Wallis Test hypothesis summary for DDD across Employment Company.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of DDD is the same across categories of Respondant employement company.	Independent-Samples Kruskal-Wallis Test	.022	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Kruskal-Wallis test result is significant at the significance level of 0.05 (*p*-value < 0.05), suggesting that the tested variables are statistically different across the given categories.

BBB had *p*-value = 0.022, P-value < 0.05, thus it suggests that the distribution of GB barriers had significant difference across the categories of respondents employment company and it reject the null hypothesis.

4.7 Result and discussion for interview & paper reviews

Different national articles, policies, strategies, frame works and guide lines (Commission maps by Addis Ababa city administration (2017) , ten years construction plan, by plan and development commission (2013-2022), building spatial design(Addis Ababa city administration), National Physical Planning Standards and Guidelines, Addis Ababa city building standards). Even though their concepts were related with some green building concept, almost all of them were not concern on green building concepts. Example;

- ten years construction plan, by plan and development commission (2013-2022) mainly concern on;

Accident reduction, corruption reduction, create job opportunities, shared experience with foreign contractors, improve contract administrations and construction management, replace 80% of main construction import materials by local materials etc.

- Addis Ababa city building standards & ministry of urban development mainly concern on;

-Building height standards, roundabouts, parking areas, City Parks, urban agriculture, river buffer and others.

-Building spatial design code standards partially discuss about ventilation, lighting, water supply and sanitation.

As we have seen above data replacing 80% of main construction import materials by local materials, City Parks, urban agriculture, river buffer, and ventilation and lighting systems are a part of green building concepts.

Currently the concept of sustainability and green construction is emerging in Ethiopian construction industries. For this purpose government schedules different international sustainability exhibitions, seminars, project visits, conference participations and others for shared experience.

During focal person discussion and interview, the factors described in questionnaire out puts were also discussed. Proper designs & orientations for window and door openings increase natural air ventilation & day light access, Proper building designs & orientations for window and door openings increase natural air circulation and it is good for occupant health, Managing Indoor air quality of buildings is necessary for occupant health, Proper waste treatment and recycling process is needed in construction industry Water Conservation and recycling used water and rainwater harvesting contribute to address water scarce problem are also a good concept which support the concept of green construction.

Others like, the sign of different continental & international sustainability, environmental protection, poverty reduction agreements, the established ten years prosperity Road map and framework, newly revised building policies, team works and collaboration trends between construction stakeholders, existing building codes and standards and construction industry policy approaches to adopt new innovations are also described as best opportunities to adopt green building. Strategies to adopt GB include education and training, financial incentives, public awareness campaign investment in green building related research, promoting green procurement and establishing a green building rating system.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Green Building Technology (GBTs) is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle; from feasibility study to design construction, operation, maintenance, renovation and deconstruction/demolish. Green construction and operation will promote a healthy environment for all involved, and it will not disrupt the land, water, resources and energy in and around the building. It provide some of the most effective means to achieving a range of global goals, such as addressing climate change, creating sustainable and thriving communities, and driving economic growth.

Green building implementation provide most effective means to achieving a range of global goals, such as addressing climate change, creating sustainable and thriving communities, and driving economic growth. Especially The developed countries accept this as a best option to the mitigation of the impacts on the environment and have developed codes, policies and frameworks to encourage and enforce the implementation of green building concepts in their construction industries. But In a sharp contrast, current evidence suggests that, uptake of GB in the Construction industry of developing countries of Sub-Saharan Africa (SSA) including Ethiopia is at infant stage and characterized by the absence of GB codes and frameworks and faces challenges like unfamiliarity, misunderstanding the concept, lack of clear ways to adopt and implement green building and there are different barriers like economic issues; attitude and market; management and government; product information and sourcing; technology and training. Therefore, by critical review of literatures, questioners' and interview, awareness level, opportunities, challenges and barriers were identified and, Also I tried to identify ways and possible strategies for GB implementation in Ethiopia in case of capital city Addis Ababa.

Based on SPSS mean analysis, respondents define green building as; Proper designs & orientations for window and door openings increase natural air ventilation & day light access, Proper building designs & orientations for window and door openings increase natural air circulation and it is good for occupant health, Managing Indoor air quality of buildings is necessary for occupant health, Proper waste treatment and recycling process is needed in construction industry Water Conservation and recycling used water and rainwater harvesting contribute to address water scarce problem.

The Ethiopia's sign of different continental & international sustainability, environmental protection, poverty reduction agreements, the established ten years prosperity Road map and framework, newly revised building policies, team works and collaboration trends between construction stakeholders, existing building codes and standards and construction industry policy approaches to adopt new innovations are described as best opportunities to adopt green building.

Less environmental impact, better indoor air quality, enhance of occupant's health & comfort, greater water efficiency principle and Cooperative works principles of GB stated as top five promoting factors to adopt green building technology

Finally; Lack of awareness and training, lack of local database and information relating to green and sustainable products, unfamiliarity with the new green products or technologies and lack of initiative and promotions by the government/ private bodies to implement green building were identifies as basic challenges.

In conclusion, GBT is at null stage in Ethiopia and government has to take the lead to initiate green building technology and to become a model for private developers. Again the drivers for uptakes of GBT in construction industry are to be reviewed to enable stakeholders identify and place emphasis on the key ones. Another emphasis is, there have to be propose ways and means by which stakeholders can promote the fast, successful and widespread uptake of the green building concepts and technologies in the Ethiopian construction industry. Implementing green building concepts and technologies would enable the achieve goals of the SDGs in developing countries especially in Ethiopia. It also needs to improve the understanding of key stakeholders and guide them in the design and implementation of applicable measures for GBT adoption promotion as well as design and support further researches to focus on empirical assessments on GBT.

5.2 RECOMMENDATION

Findings suggest that the government still has a significant role to play in guiding toward sustainable buildings and remove barriers. The study results show that one of the most significant barriers to approaching or switching to green building is a lack of experience and awareness among construction employees. There are also other barriers like knowledge and education gaps between stakeholders, lack of compatible regulations and standards, lack of demand from the local market, lack of skilled workers or experts to work in green, Absence of government incentives.

Implications to uptake Green Building technology in Ethiopia cases, like efforts to meet the Sustainable developments goals, ten years development roadmap, green legacy and others like the new Addis Ababa building special design promote green construction practices.

On the other hand there are also green building demands especially in Addis Ababa, like unstable power supply, highest energy demand, which can be achieved by using energy saving technologies, natural daylight and ventilation, renewable energy technologies, highest water demand and existing water supply shortage and scarce.

According to findings of the study, the following recommendations were made by the researcher, to facilitate the adoption of GB constructions in Ethiopia's construction industry:

To start, there is the need to create awareness among stakeholders of the numerous benefits that drive the adoption of green building. A national education, awareness and Publicity through the electronic media of the internet and television, imposition of mandatory government policies and regulations on GB development on stakeholders in the built environment, incentives to stakeholders to incorporate GB technologies in their projects. Such policies as modifying the procurement and bidding process to require green features, including green practices in lease contracts, giving green projects priority permits etc. are proposed, in sure all government projects are built to green standards while existing ones are retrofitted to green standards, training and educating stakeholders, incentives for highly water and energy efficient buildings with less adverse effects on the environment. Trainings should be conducted for workers on new technologies and products. There is need to improve poor documentation system of construction industry. There is also a need to invest on friendly local construction materials like bamboo, using alternative construction materials like earth block, partial replacement studies.

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APPENDIX

Section 1

Research Questions/ Type I

(Open ended questions for discussion and interview.)

Respondent profile:-

Name____________________ Educational level_________________

Profession______________ Name of employer company__________________

Area of work________________ Position_______________________________

Experience__________________ Address (mobile)_______________________

Research Questions for questioners and interviews:-

1. On behalf of your organization:

a) Are you familiar with term Green building technology and its concepts? If yes what it mean?

b) Is there any practice from feasibility study to construction and maintenance in which the company practice green construction? If yes what are practices?

c) Do you belief green construction is better than conventional construction? If yes what are its merits?

d) Is there any demerit or dis advantage for green construction? If yes what are its demerits?

e) As per existing or current situation what opportunities and challenges are there to adopt green construction?

f) Are stakeholders cooperating for green construction adoption and its practice? If yes in what extent? And how?

2. Is there any trend about recycling water, storm water management, vertical greenery using solar energy, HVAC (heat, ventilation and air conditioner) system, indoor air ventilation system in Addis Ababa housing development project?

a) If yes, which one and in what extent?

b) If no, why?

c) Is there any incentive for residential or commercial market to push them to adopt green construction?

3. Is there any policy, rule and regulation which enforce in law to promote green construction practice?

a) If yes, ways of practice and how much you fund? Or you funded?

4. It is obvious that there is scarce in electricity, clean water, and proper waste disposal problem in Addis Ababa. To address these problems:

a) What measurements take place before?

b) Is there any Future plan? If yes what are these plans?

5. Is there any international or national organization who support and fund green building implementation?

6. Do you think it is feasible and compatible to adopt and practice green building in Ethiopia, as well in your organization?

a) If yes, how?

b) If no, why?

7. Is there any barrier to adopt green building in your organization and in Ethiopia? If there what are barriers?

a) Is there any proposed solution to overcome such barriers?

b) What area of green building needs more research?

8. Is there any green rating or certificate practice in Ethiopia? If there who or which company?

9. Is there any green stare building or construction in Ethiopia?

If there, list them.

Section 2

Research Questions/ Type II

(Questions for Questionnaires.)

1. Name: - …………………………………………………………………….………………

2. Educational level:-

Diploma ☐ Degree ☐ Masters ☐ PhD & Above ☐

3. Profession:-……………………………………………………………….………………

4. Name of employer company:-……………………………………………………..…

5. Area of work:-……………………………………………………………….………

6. Position:-……………………………………………………….…………………

7. Experience:-…………………………………………………………………………

Less than five years ☐ five to ten years ☐ above ten years ☐

8. Address (mobile):-…………………………………………………...…………………

Section 2, Description

Green Building Technology (GBTs) is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle; from feasibility study to design construction, operation, maintenance, renovation and deconstruction/demolish. Green construction and operation will promote a healthy environment for all involved, and it will not disrupt the land, water, resources and energy in and around the building. It provide some of the most effective means to achieving a range of global goals, such as addressing climate change, creating sustainable and thriving communities, and driving economic growth.

This research is for partial fulfillment of the requirements for the degree of Master's in construction engineering and management, the Graduate program of the department of Construction Engineering & Management and has been carried out by Abdellah Shukra Mohammed, at Adama science and technology university.(Academic research.)

Researcher Address; 0923333409 (Abdellah) (for any suggestion, question & difficulties)

Section 3, questionnaire

The following questions are about the assessment on adoption and implementation of green building technology in Ethiopia, in case of capital city Addis Ababa.

Dear respondents, please indicate your level of agreement with the following statements by using the following scale. (With great thanks for your time, loyal & truth!)

Five-point Likert Agreement scale/level 1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree

No/codes	Questions	Level of agreement				
		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
		1	2	3	4	5
A/01	Level of awareness about 'Green Building Technology' (Indicate your level of agreement for the following GBTs points.)					
1A	Using energy efficient building appliances and fixtures save energy.					
2A	Using alternative energy source like solar energy saves conventional electric energy.					

3A	Proper designs & orientations for window and door openings increase natural air ventilation & day light access.					
4A	Proper building designs & orientations for window and door openings decrease needs for HVAC (heat, ventilation and air conditioner) system and it also decrease using artificial lights or bulbs for daylight case.					
5A	It is necessary to minimize construction pollution (noise, dust etc.) and carbon dioxide emissions in construction process.					
6A	It is advisable to use local, cost efficient and toxic free construction materials for construction.					
7A	It is necessary to Conserve natural resources, avoid or minimize using hazardous chemicals & construction materials during construction.					
8A	Construction site/topography management is advisable to minimizing soil erosion and degradation.					
9A	Proper waste treatment and recycling process is needed in construction industry.					
10A	Managing Indoor air quality of buildings is necessary for occupant health.					
11A	Proper building designs & orientations for window and door openings increase natural air circulation and it is good for occupant health.					
12A	Avoid using hazardous chemicals or materials for construction contribute to increase occupant health.					
13A	Water Conservation, recycling used water and rainwater harvesting contribute to address water scarce problem.					
14A	Reducing construction, operation and maintenance costs enable to achieve cost efficient & affordable construction.					
15A	Using energy efficient home appliances & fixtures, alternative energy source like solar, and re using used water for toilet or greenery minimizes cost of utility bills					

	for energy & water consumption.					
B/02	Opportunities to adopt 'Green Building Technology' (Indicate your level of agreement that the following points are being practiced or & are good opportunities for GBTs adoption.)					
1B	Existing conventional construction practice promotes GBTs.					
2B	Existing building codes and standards encourage GBTs principles.					
3B	There is continuous improvement & training of construction professional's skill about sustainable construction & it encourage GBTs.					
4B	The construction industry professionals participate in different continental & international GBTs related conferences & visit GBTs models for shared experience & it may promotes GBTs.					
5B	The Ethiopia construction industry has flexible and easy policy approach to adopt new innovations like GBTs adoption.					
6B	Ethiopia signed different continental & international sustainability, environmental protection, poverty reduction agreements & it contributes for GBTs adoption.					
7B	The existence of team works and collaboration trends between construction stakeholders and which may facilitate GBTs adoption.					
8B	Government Provide incentives like low cost loans; tax free or tax reduction system to promote sustainable construction & it may encourages green building adoption.					
9B	Ethiopian construction industry has rules, regulations and policies which force and push to practice GBTs principles.					
10B	Ethiopian construction industry has easy access to renewable and local construction materials & it may encourage green building adoption.					

11B	The established ten years prosperity Road map and framework, newly revised building policies may contribute for GBTs adoption.					
C/03	Enablers/promoting/stimulating/ strategies to adopt 'Green Building Technology' (Indicate your level of agreement that the following points promote GBTs adoption.)					
1C	Availability of better information on GBTs principles					
2C	Enhance of occupant's health & comfort.					
3C	Availability of different public awareness creation medias (print media, television radio etc…), workshops, seminars, and conference.					
4C	Low-cost loans system from government and financial institutions and tax free material supply.					
5C	Mandatory green building policies and regulations.					
6C	Greater energy efficiency principle of GBTs					
7C	Green rating and labeling programs for GBTs					
8C	Acknowledging and rewarding GBTs adopters publicly.					
9C	Availability of institutional framework for effective GBTs implementation.					
10C	Availability of local green building construction materials.					
11C	Greater water efficiency principle of GBTs					
12C	Less environmental impact					
13C	Better indoor air quality					
14C	Cooperative works of construction industry with other ministries. E.g. ministry of environmental protection.					
D/04	Challenges or Barriers for green building technology adoption (Indicate your level of agreement that the following points challenge GBTs adoption.)					
1D	Believe that green construction is not important.					

2D	Resistance to change in current practice and fears of new changes.					
3D	Lack of awareness and training.					
4D	Difficulty for finding experienced or expertise workers to green projects.					
5D	No culture and experience for green construction between construction stakeholders.					
6D	Unfamiliarity with the new green products or technologies.					
7D	Lack of national codes, standards and regulations which push or enforce to practice green certification system.					
8D	Lack of initiative and promotions by the government/ private bodies.					
9D	Lack of local database and information relating to green and sustainable products.					
10D	Concerns of the high cost of investing in green construction and Believe that cost of green construction will be more.					
11D	Lack of experience of designers and limited creativity in green projects.					
12D	Needs extra design approval time and process.					
13D	Lack of local production and unavailability of green products.					
14D	Lack of demand for green construction products.					
15D	Probability of Poor quality of local green materials/products or supply deficiency.					

Section 4, Factor means.

Code	Description
AAA	Mean value for factors under level of awareness or A/01
BBB	Mean value for factors under opportunities or B/02
CCC	Mean value for factors under enablers or C/03
DDD	Mean value for factors under barriers or D/04

Section 5, Ethical Consideration

All participants had the right to privacy and anonymity.

Research participation was voluntary based.

Consent obtained from all participants before starting the research.

Confidentiality of data provided by individuals maintained.