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CHALLENGES OF APPLICATION OF GREEN BUILDING IN ADDIS ABABA: THE CASE OF NIFAS SILK LAFTO SUBCITY

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A Thesis Submitted to the School of Graduate Studies, Addis College, in Partial Fulfillment of the Requirements for The Degree of Master of Science in Construction Technology and Management.

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DECLARATION

The undersigned, declare that the study entitled “Challenges of application of green building in Addis Ababa: the case of Nifas silk lafto sub city” is the result of my own effort and study that all sources of materials used for the study have been acknowledged. I have conducted the study independently with the guidance and comments of the research advisor. This study has not been submitted for any degree in any university .it is conducted for the partial fulfillment of the MSC of degree in construction technology and management.

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ABSTRACT

The general objective of this study was to identify the challenges in the application of green buildings in Addis Ababa; –the case of Nifas silk sub city (NSLSC). In the Ethiopian building design and construction industry, there is no comprehensive regulation or standard to practice a green building approach to minimize the impact of construction specifically. As a result, professionals and stakeholders may lack a clear understanding of such a building approach, related attribute values and potential applications for a given building project. The research design used for this research was both descriptive and explanatory type. Both primary and secondary data were collected through questioner and NSLSC Construction Permit and Control office record and documentation. The collected data was analyzed by both by SPSS software and reported by narration. Moreover, the analyzed data were presented using graph, bar chart and table. The findings of the study includes the application of green building in Ethiopia relatively unfamiliarity with green building technology, lack of government enforcement and initiatives, lack of similar projects or demonstration projects, lack of research, unavailability of tested and reliable green technologies, negative attitudes from stakeholders, scarcities in green building information, higher costs for green construction, absence of provision of financial and non–financial incentive.

Keywords: Addis Ababa, challenge, Green Building

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LIST OF ABREVIATIONS AND ACRONYMS

ACM	Assessment on challenges in the application of green building
BIM	Building Information Modeling
C	Investigating the challenges in the application of green building in study area
EPA	Environmental Protection Agency
EU	European Union
GB	Green Building
GBC	Green Building Council
HVAC	Heating Ventilation and Air Conditioning
ICS	International Community School
IIDCPCA	Integrated Infrastructure Development Construction Permit and Controls Authority
ISO	International Organization for Standardization
NBE	National Bank of Ethiopia
NSLSC	Nifas silk lafto sub city
P	Identifying the green building practices in the study area
S	Developing strategic tools for the application of green building in the study area
SPSS	Statistical Package for the Social Science

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Two decades after the first significant efforts to apply the sustainability paradigm to the built environment, the resulting sustainable construction movement has gained significant strength and momentum.

In some countries, for example, the United States, there is growing evidence that this responsible and ethical approach is dominating the market for commercial and institutional buildings, including major renovations. Over 32,000 building projects have been registered with the US Green Building Council (USGBC), the major American proponent of built environment sustainability, in effect declaring the project team ‘s intention to achieve the status of an officially recognized or certified green building. The sustainable construction movement is now international in scope; with almost 73 national green building councils establishing ambitious performance goals for the built environment in their countries.

In addition to promoting green building, these councils develop and supervise building assessment systems that provide ratings for buildings based on a holistic evaluation of their performance against a wide array of environmental, economic, and social requirements. The outcome of applying sustainable construction approaches to creating a responsible built environment is most commonly referred to as high - performance green buildings, or simply, green buildings (Kibret, 2013).

All over the world, large amount of buildings is being built and their design, construction, maintenance and demolition have a tremendous impact on the environment and natural resources.

The construction industry is an immense contributor to global climate change and a number of other environmental threats, and few would argue that the sector needs to make a radical shift in its practices if it reduces the impact of these dangers (Plessis, 2007). Worldwide, the construction industry consumes 40% of total energy production, 12 - 16% of all water available, 32% of non - renewable and renewable resources, 25% of all timber, 40% of all raw materials, produces 30 - 40% of all solid wastes, and emits 35 - 40 % of carbon dioxide (Son, *et al*., 2011; Berardi, 2013) and which has grown to be one of the major issues in the building industry (Mekonen, 2019).

As stated in U.S. Green Building Council (2008), the core idea of green building is the optimization of one or more of its principles such as sitting and structure design efficiency, energy efficiency, water efficiency, materials efficiency, indoor environmental quality enhancement, operations and maintenance optimization, and waste and toxics reduction. Greening the exterior of buildings (walls and roofs) provides numerous ecological and economic benefits, including storm water management, energy conservation and mitigation of the urban heat island effects, reducing air pollutants, increased longevity of building materials, as well as providing a more aesthetically pleasing environments in which to work and live (Mohammedata, 2018)

In the developed world, there have been extensive studies on green buildings, as evidenced in the rapidly growing number of assessment tools, such as LEED United States, BREEAM UK, GBCA Australia, DGNB Germany and CASBEE Japan, to assist the green building development in the last decades.

According to the World Bank Development report of 2009, only South Africa has an established Green Building Council (GBC) but this is slowly changing with Morocco, Mauritius and Egypt being in the process of establishing their councils (Malanca, 2010). Currently, the number of GBCs in Africa has increased including countries such as Ghana, Kenya, Namibia, Rwanda, Tanzania and Zambia. Similar to the majority of developing African countries, the concept of green buildings is very new in Ethiopia.

On the other hand, Ethiopia is developing at a mind blowing pace with a booming construction industry as one of the main driving forces. Ethiopia is one of Africa ‘s fastest growing with most vibrant economies. Enjoying double digit GDP growth year-on-year for the past decade, and with a quickly growing population, the nation is ready to become a regional leader in construction. Indeed, the construction industry is a major economic growth driver for Ethiopia. Massive government investment in infrastructure and residential building projects is turning the country into one of the continent ‘s highest performing economies.

Rapid urbanization rates have created a huge need for improved infrastructure systems and a big housing backlog. Demand for quality building materials, for which Ethiopia is heavily dependent on imports, is already on the rise and is expected to skyrocket in the near future.

According to the National Bank of Ethiopia (NBE), construction accounts for half of the entire nation ‘s industry. (Bloomberg, 2016). What ‘s more, the industry is expanding

rapidly. Data from the NBE also suggests that during 2013/14 the building sector grew 37%. Industrial activity accounted for 15% of Ethiopia ‘s total output. Using these stats, it can be seen that construction accounted for 7.5% of Ethiopia ‘s total GDP during this period. According to African Economic Outlook, this equates to 9.4% of total output at current prices. This would give the construction industry a market value of around $ 6 billion. Therefore, there is a high backlog of challenges on the application of green building in Ethiopia which minimizes the unconstructive effects of conventional buildings. All this shows the importance of this study.

1.2. Problem statement

The research problem arises from Ethiopian building design and Construction industry practice trends; there are some practices and regulations within the construction and design of the building industry as fragmented based on specific firms’ outlook and initiatives, rather than the collective effort throughout the whole project. Since there is no such a green building standard and practice, professionals and stakeholders may lack a clear understanding of such a building approach, related attribute values and potential applications for a given building project. Addis Ababa city construction permits and control authority rule no.1/2011 slightly state about GB but still not sufficient and applicable.

1.3 Objective of the study

1.3.1 General Objective

The general objective of this study is to identify the challenges in the application of green buildings in Addis Ababa; -the case of Nifas Silk Lafto Subcity.

1.3.2 Specific Objectives

a. To identifying the green building practices in the study area.
b. To investigate the challenges in the application of green building practices in the study area.
c. To develop strategic tools for the application of green building practices in the study area.

1.4. Study Questions

a. How are the green building practices in the study area?

b. How are the challenges in the application of green buildings in the study area?
c. How are the strategic tools for the application of green building practices in the study area?

1.5 Significance of the study

This study provides priceless knowledge as it is one of the few studies to investigate the challenges of application of green building concepts in buildings of Addis Ababa, the case of Nifas Silk Lafto Sub City. It is significant because it contributes to a better understanding of the concept and implementation of green building principles and its role for achieving sustainability in building design and construction. Through its recommendations, it suggests ways of increasing adoption of sustainability concepts in buildings and can also be used as a useful reference for both industry practitioners and academics that are interested in green building developments. Eventually the study will persuade policy makers to focus on policies which bolster for the application of green building principles in Addis Ababa city and throughout the country.

1.6 Scope of the Study

1.6.1 Spatial Scope

This study was conducted in Nifas silk lafto subcity,Addis Ababa. The study is confined to challenges in applying green building principles in Addis Ababa city construction permit and controls authority at Nifas silk lafto sub city level.

1.6.2 Thematic Scope

This study was limited to six buildings relatively green building at NSLSC but not certified as green building.

1.7 Limitations of the study

The limitations faced during this study were: scarcity of previously done researches on Green Buildings, lack of properly documented secondary data, and baseline data especially on green building. Evidently the concept of green building is relatively new in the study area; there were complexities of communicating information about the concept. A further limitation faced is that, latest and exact number of consultants and number of employees of Addis Ababa city construction permit and controls Authority at sub city level was not known as the office responsible was not quick to respond. The other

limitation challenged the researcher is the target population is vast, homogenous, and time limitations; so the researcher has confined the study to Nifas Silk Lafto Sub City Construction Permit and Control office (NSLSCPC) office. Supplementary limitation is that, the NSLSC construction permit and control offices are closed for a long time and this made difficult to timely collect the questionnaire.

1.8 Organization of the study

The thesis is presented in five chapters: Chapter One: Introduction: It designates Background of the Study, Statement of the Problem, Objective of the study, Research Questions, Scope of the study, Limitations of the study, and Significance of the study. Chapter Two: Review of literatures: Chapter Three: Research Methodology: Explains the research design, research approach, target population, sampling, data source, collection tools and model of data analysis Chapter Four: result and discussion: In this chapter, the data collected using questionnaire is analyzed using narration and software like IBM SPSS 26 was utilized. Eventually, the data is analyzed and interpreted Chapter Five: Conclusion and Recommendation.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

In the Building, construction signifies an enormous opportunity to make use of sustainable principles for conservation of resources, to promote the use of more efficient and healthy products, and to improve the living and working environment for people (Feltes, 2007). Buildings not only use resources such as energy and raw materials but they generate waste and potentially harmful atmospheric emissions (Alnaser, et al., 2008). The approach of sustainable construction can enable construction practitioners to be more responsible for the need for environmental protection without neglecting the social and economic aspects in the quest for balanced outcomes (Rizqa, 2016). The building sector is the single largest contributor to global greenhouse gas emissions, this emission from buildings is related to the embodied energy of building materials, and the emissions from operational energy use and the role of materials are becoming increasingly important (Ruuska, et al., 2014). Most countries of the EU buildings are the largest driver for CO_2 emissions estimated to drive over 40% of its carbon dioxide emissions and emissions associated with buildings is even larger in the US, amounting to 48% of total emissions (ITU, 2012). Therefore, to address these negative effects of buildings, a recent trend called green building, which consists of the use of environmentally friendly materials, pollution prevention through recycling, and an increase in energy efficiency introduced during design, construction, operations and demolition stages of building (Bradfield, 2011).

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2.2 The concept of Green Building

The concept of green building was first introduced when people started to get aware of their role in causing global climate change. People started to realize the impact of their activities on the environment when they had to face problems like global warming, scarcity of water and shortage in energy supply (Shrestha, 2011).Green building is a whole-systems approach for designing and constructing buildings that conserve energy, water, and material resources and are more healthy, safe, and comfortable. Many think of solar panels when they think of "green" building.

The reality is that environmentally sustainable building goes far beyond energy consumption. Building materials and use of landfills during construction can have detrimental effects on volunteers, homeowners and the environment. Green building offers a response to the realization that the way we have been building everything from houses to skyscrapers is not sustainable. Many health problems today stem from, or are aggravated by poor indoor air quality and exposure to toxic substances contained in commonly used building products. Green building practices can eliminate these health-damaging conditions.

There are various aspects to consider a building as green during design, construction, and operation. Those aspects include (Gou, et al., 2016): water efficiency, energy efficiency, materials and resources, waste management and indoor environmental quality. On the other hand, according to the study by (Olaleye, et al., 2015) green building concept consists of six distinct areas, such as lighting, water, ventilation, air quality, waste generation and control, and energy. In addition, Cole (2011) puts the green building concept as an integration of the reduction of damage, energy uses, material uses, carbon emission, water use and the negative impacts on the occupants and communities.

2.3 Practices of Green Building

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland report, 1987). This definition of sustainability is wide so under this definition of sustainability subsets have been developed, such as green building and sustainable construction. These concepts offer a possibility to look at buildings and buildings life

span. Different definitions of green building according to different sources are explained below:

- Briefly, the green building concept can be seen as part of a movement that wants to put more emphasis on sustainability in the construction of buildings. (Haselbach, 2010)
- Green buildings are buildings where an attempt is made to minimize the energy consumption and to protect and conserve water resources. There is also a lot of focus on optimizing the maintenance and operational practices in the building. Along with this, is the attempt to reduce the environmental impact the materials used in a building causes from a life-cycle perspective. All of this should lead to a green building that which is environmentally sound and where the impacts on the human health are minimized. (Yudelson, 2010)
- Green building (also known as green construction or sustainable building) refers to a structure and using process that is environmentally responsible and resource-efficient throughout a building's life cycle: from siting to design, construction, operation, maintenance, renovation, and demolition. This requires close cooperation of the design team, the architects, the engineers, the suppliers, the contractors, and the client at all project stages. (Ji and Plainiotis, 2006).

According to Zuo and Zhao (2014), similar with that of sustainability, green buildings have three aspects including:

- Technical and environmental Aspect: traditionally, the focus of green building is placed on environmental aspect of sustainability, which takes into account issues such as energy efficiency, water efficiency, resource efficiency and greenhouse gas emission reduction.
- Social aspects: In the construction context, social sustainability mainly covers the quality of living, occupational health and safety, and future professional development opportunities. In building context, social sustainability means providing a healthy and safe environment to all stakeholders, e.g. construction personnel, users and operators.
- Economic Aspects: there are social and economic requirements of green buildings such as access, education, inclusion, cohesion, affordability, economic value, impacts to local economy, indoor health, cultural perception and inspiration. The benefits of

energy retrofitting initiatives are reflected on not only the cost savings derived from improved energy efficiency but also the potential value added to the property. This helps to reduce the payback period of investment for energy efficiency measures. Therefore, a green building could take either a narrow definition (e.g. purely environmental sustainability) or broad definition (i.e. adopting triple bottom line approach).

2.3.1 Practices of Green building in Developed countries

2.3.1.1 USA

Over the past 15 years, we have seen a dramatic rise in sustainable building in the United States. Back in 2005, there were just 3,156 buildings registered to LEED (Leadership in Energy and Environmental Design), a standard for green construction. By 2019 there were almost 70,000. While the American Recovery Act is expected to give further impetus to the sustainable building revolution, several challenges to this kind of construction remain.

One significant issue relates to where cost savings accrue. Essentially, the savings benefits of green buildings will almost exclusively be experienced by the residents/users of a structure.

This means that construction companies may have to spend more money on green features, yet experience minimal direct benefits. That being said, the costs of green materials and construction techniques have fallen significantly in recent years. As they get closer to the cost of traditional approaches, they will become viable options for small and medium businesses(O'Malley, 2021).

Another issue is around talent and access to skilled workers. Building sustainable structures requires knowledge of new techniques, materials and technologies. This will require retraining and up skilling of the labour force, which is of course an obstacle(O'Malley, 2021).

In the United States, a study shows that from 2002 until 2005, the funding for green construction research reached $193 million a year, which represents only 0.02 % of the estimated annual funding of building construction research budget (Baum, 2007).

2.3.1.2 Germany

Berlin, Germany (9 October 2018) – The U.S. Green Building Council (USGBC) has named Hesse as the top state in Germany with the highest number of LEED (Leadership in Energy & Environmental Design) certified green buildings. Hesse is home to nearly 3 million GSM of building space comprising 95 LEED certified projects. Following very closely is Bavaria with 66 LEED certified projects comprising 1.3 million GSM of building space."Germany is a booming market for green building," said Kay Killmann, Managing Director, Green Business Certification Inc. (GBCI) Europe. "There more than 750 buildings across my home country of Germany that are using LEED. Building owners are using LEED not only to develop healthy, highly efficient and cost-saving green buildings but also to mitigate investment risks."LEED helped create the definition of a green building and is the world's most widely used building certification program across the globe, with nearly 100,000 projects certified globally(Sarah, 2018).

2.3.1.3 UK

The United Kingdom has become a leader in green building practices over the last decade. Through the introduction of legislation, such as the "Zero Carbon Homes" legislation, the UK has implemented measures to reduce the amount of carbon emissions generated by buildings. This has been done by requiring the use of energy efficiency measures and by encouraging the use of renewable energy. Furthermore, the country has set goals to reduce its energy consumption across all sectors and has implemented incentives to encourage green building practices.

This has been made possible through the supportive policies and guidelines set by the government. Additionally, there are also a number of public and private initiatives that are playing a big role in promoting green building practices in the UK(Heffernan et al., 2015).

2.3.1.4 Australia

Australia is a country that is actively working to reduce its carbon footprint. The world of green building practices is one of the many ways that the country is achieving this goal. Sustainable buildings are becoming increasingly popular, with a variety of innovative strategies being developed and implemented. These strategies focus on energy

efficiency, reduced environmental impacts and improved comfort. Green building practices have been steadily gaining traction. These sustainable building techniques reduce electricity and heating bills, while also promoting the use of renewable energy sources. Building components such as insulation and windows are designed to reduce energy costs and create a more comfortable living space. While green building materials may cost more initially, they can save money in the long run due to the reduced energy needs(Heffernan et al., 2015).

2.3.2 Practices of Green building in Developing Countries

2.3.2.1 South Africa

There are many shades of green and, in South Africa; traditional construction methods (such as mud huts with clay and dung floors) embody many of the principles which green building does today, such as the use of sustainable local materials and labor, climate appropriate design, and correct orientation. At a minimum no building should be constructed in South Africa any longer which does not take cognizance of its location (both in terms of non-high-value ecological land and also proximity to places of work or residence and local transport), orientation (to maximize morning sunlight but reduce penetration of harsh afternoon sunlight), and ability to be reused over time. Furthermore, all buildings should demonstrate sensitivity to the limits of energy and water experienced in South Africa. With this as a base, there are more elements that can be incorporated, such as natural ventilation, appropriate mechanical ventilation, energy efficient lighting and equipment, thermal mass to reduce heat loss and gain. Buildings need to be well run, with on-going waste minimization and separation at source. On-site energy generation and water collection and recycling should also be implemented wherever feasible. It is thus clear that there is not a single “green” prerogative, but a scale of greenness and a wide range of elements and practices that can be incorporated into any building at any stage of its lifecycle. The South African government and local municipalities continue to develop and improve upon policies to guide well-informed and sustainable development. This has both led to, and been enabled by, an increased voluntary buy-in to the need for sustainable building practices by private developers, and with it a rapid uptake of green building certification in the private sector. Most of the green building certifications in South Africa have been through the Green Building Council South Africa (GBCSA), which offers third-party verification of design, new buildings, operational performance

and interior fit-outs for a wide range of building types and communities. A decade ago much debate existed in South Africa and the international community as to whether there was a real advantage in formal green building certification as opposed to merely applying green principles to design and construction. It is now commonly accepted that the rigorous process of independent third party validation and accreditation holds extensive merit, and the uptake of formal certifications is increasing and no longer only associated with flagship developments(urban low emission development strategies, 2015).

2.3.2.2 China

GB started later in China and its concept was introduced in the late 1980s. In 1986, the "Civil Building Energy Efficiency Design Standards (Heating Part of Residential Buildings)" was released, and the goal was to have buildings consume 30% less energy than currently. In 1994, the standard was amended to raise the building energy saving rate target to 50%. The "Civil Building Energy Conservation Regulations" was issued in 1999 and was revised in 2005 (Wenjie, 2018).

With the deepening of building energy conservation work, the concept of GB was also introduced and applied. In 2005, the Ministry of Construction and the Ministry of Science and Technology jointly issued the "Technical Guidelines for Green Buildings" and proposed to develop GB according to local conditions. The implementation of "Green Building Evaluation Standard" started on June 1" 2006 and "100 green building demonstration projects and 100 low-energy building demonstration projects" (referred to as "double hundred project") was launched in 2007. Since then, it has also issued the "Administrative Measures for Green Building Evaluation Marking" and the "Technical Details for Green Building Evaluation", and officially launched the green building evaluation work in China (Wenjie, 2013).

In April 2012, the Ministry of Finance and the Ministry of Housing and Urban-Rural Development jointly issued the "implementation Opinions on Accelerating the Development of China's Green Buildings", clearly setting up an incentive mechanism for high-star GB financial policies, and adopting different standards for GB with two or more stars to give financial incentives to the central government. Under this guidance, local governments have also introduced incentive policies to further increase incentives.

For example, In August 2012, Shanghai issued the "Special Support Measures for Building Energy Efficiency Projects in Shanghai", which included the green building demonstration project in the scope of use of building energy conservation support funds, and clearly stated that the support standard was 60 yuan per square meter (360doc, 2018),On January 1, 2013, the No. 1 Document of the General Office of the State Council forwarded the "Green Building Action Plan" jointly formulated by the National Development and Reform Commission and the Ministry of Housing and Urban-Rural Development, highlighting the Chinese government's firm determination and support for vigorously developing GB.

The Programmed further clarified that by the end of the "Twelfth Five-Year Plan", the goal of building GB of 1 billion square meters and 20% of newly-built buildings in urban areas to meet the GB standards will require the government to invest in construction and affordable housing since 2014 (Wenjie, 2013). Large-scale public buildings shall fully implement the GB standards, and propose a series of incentive policies such as fiscal fund awards, preferential tax policies, land use preferential policies, and improving and perfecting financial services for GB. After three months, the Ministry of Housing and Urban-Rural Development also released the "12th Five-Year Plan for the Development of Green Buildings and Green Ecological Urban Areas", which combines the development of GB with the construction of green ecological urban areas and further strengthens the promotion of GB.

By the end of 2016, China had a total of 7,235 construction projects with green building evaluation marks, with a construction area of more than 800 million square meters. Among them, 3,164 construction projects with green building evaluation marks were obtained in 2016, with a construction area of more than 300 million square meters. However, the current green building operation identification project is still relatively small, accounting for only about 5% of the total construction projects (ECEP, 2016). Market demand is the most widely recognized driver of China's future green building projects.

However, in addition to the pull demand of the market itself, the owner's request is also a key driver of the Chinese market. Among them, this item accounts for 34%, and the global average of this item is as high as 40% (ECEP, 2016). Therefore, residents' cognition of green buildings is a subject worthy of study.

2.3.2.3 Kenya

Green buildings use less energy, water and natural resources compared to the convectional buildings. They also create less waste and provide healthier living environment, further they incorporate features such as efficient use of water, energy efficient and eco-friendly environment. The buildings use renewable energy and recycled materials, embrace effective use of landscape and have improved indoor quality for health and comfort(Were et al., 2015).

In Kenya and particularly Nairobi just like any other African city, intense development pressure and rapid urbanization has led to exponential growth of building operations and close monitoring is required in terms of environmental impact. In the year 2012 alone, the building and construction sector achieved improved performance with a growth of 4.8% in the review period (January December 2012), an improvement from the growth of 4.3 per cent recorded in the year 2011(January December 2011). The housing subsector, both private and public, recorded increases in the value of building plans approved and completed buildings in the review period 2012. In Nairobi alone, the number of newly completed commercial buildings in the year 2010 was estimated at 287 and this rose to 293 in the year 2011(Were et al., 2015).

According to the second East African regional workshop on Green Architecture, The quest for best practice held in August 2011 at the University of Nairobi, some Green buildings concepts have been incorporated in buildings such as the Coca Cola head offices in upper hill, Strathmore Business School and the new Standard Chartered Bank along Waiyaki Way. However, it is only the United Nations office facility at Gigiri that has put up a building that qualifies as a green building in Nairobi. The adoption of green building concept by building construction practitioners in Kenya is low.

2.3.2.4 Egypt

The Egypt Green Building Council (EGBC) has been established in 2009 and developed a national Green Building Rating System called the Green Pyramid Rating System (GPRS). Rating system to be applied in Egypt (under construction) Slow movement and rarely initiatives of green practice in Egypt State Energy Research and Development Authority awards incentives to help state agencies achieve the Executive Order objective Incentives in from of incentive grants, priority to loans and a credit against taxes allows

for individuals and corporations to claim tax credits for green buildings, green building components and high-performance buildings. Charging reduced building permit fees or provides partial rebates of building permit fees for buildings that are constructed or renovated using design principles that conform to or exceed LEED certification adopt energy-efficient building standards by giving preference when leasing facilities for state use to facilities meeting LEED® or Energy Star.

2.4 Challenges in the implementation of green buildings

2.4.1 in developed countries

2.4.1.1 USA

The most barriers in USA include higher construction cost, and unavailability of GB materials.

2.4.1.2 Germany

Challenges in the implementation of green buildings in Germen

- High Capital Costs & Green Funds

Many developers are concerned that adopting green features into their buildings will involve high upfront costs. Compared to conventional buildings, green building projects are often perceived as having higher initial design and construction costs.

- Market awareness

Another challenge for promoting the green building movement is the lack of awareness, education and information on the benefits of green building construction across all stakeholders.

2.4.1.3 UK

Scarcity of material for green building and Price escalation for green are the main challenges in implementation of green building in UK.

2.4.1.4 Australia

Higher price for green building compared to conventional building.

2.4.2 Developing countries

In most developing countries, Lack of training and education, Lack of accurate data and Lack of integrated research are common challenges in implementation of green building.

2.4.2.1 South Africa

The most important factors influencing the adoption of green building project in south Africa are the expansion of the market for green goods and materials ,the provision of economic incentive ,education and training about green building technologies' and the affordability of green building.

2.4.2.2 China

The main Challenges in Implementation of Green Construction in China are;

- Lack of support from senior management,
- Lack of knowledge and skill on green technologies and materials,
- Limited availability of green suppliers and information,
- Lack of quantitative evaluation tools for green performance and
- Additional responsibility for construction maintenance

2.4.2.3 Kenya

The following are the main challenges in Kenya for implementation of green building

- lack of enforcement on sustainable building policies
- Lack of awareness about green building
- Lack of Adequate education and training of building
- Green buildings are too expensive
- Lack of good communication
- Green building needs expensive technologies

2.4.2.4 Egypt

Challenges in the implementation of green buildings

- ✓ High Initial Cost
- ✓ Lack of Coordination in Government Policies Affecting Building
- ✓ Lack of Awareness
- ✓ Lack of Experienced Workforce
- ✓ Risk and Uncertainty

The developer may concern about the reliability of green building practices, uncertainty over the costs of developing a green building, over the economic benefits of greening existing buildings, building performance over time, and worry about the payback period.

2.5 Benefits of Green Building

A Conference held in London on Construction, Building and Real Estate identified some of the benefits of green building from different works of literature as; energy saving, enhanced occupants' health and comfort, improved overall productivity, environmental protection, improved indoor environmental quality, thermal comfort, better rental income, increased property values, preservation of natural resources, reduced use of resources, reduced carbon/greenhouse gas emissions, enhanced overall occupant satisfaction and reduced noise pollution (Darko, et al., 2018).

Adopting even one or two green strategies can have significant benefits for the home owner as well as for the environment:

- Energy efficiency is one of the primary advantages of green building. Energy consumption can be dramatically slashed. Below are a few of the strategies that go into making a house exceptionally energy efficient.
- Orient the house to reduce solar gain in summer and capture the sun's light and warmth in winter.
- Carefully sized overhangs or awnings will protect windows from the summer sun while admitting the sun's warming rays in winter when it is at a lower angle known

as a ground-source heat pump system, consumes no fossil fuels at all, and provides outstanding performance year-round with an extraordinarily low operating cost.

- Maximize natural light to reduce the need for electrical usage during the day.
- Compact fluorescent lights (CFL's) are big energy savers. Incandescent bulbs are highly inefficient, converting just 10% of the energy they use into light — the other 90% produces only heat. GEL's are up to six times more efficient and last up to ten times longer. Choose CFL's with warm color temperatures (around 2, 7000 to 3,000° Kelvin) which are indistinguishable from incandescent lights.
- Cut energy consumption further with clean, renewable energy from photovoltaic panels. During periods when the panels produce more power than the house is using, the electric meter will actually run backwards. In some locales, wind generated electricity is also an option.
- All newly built homes to produce more energy than they consumed by 2020. Renovate all existing buildings to save energy. Ban incandescent light bulbs by 2010. Reduce greenhouse-gas emissions by 20% by 2020.
- Increase renewable energy from 9% to 20-25% of total energy consumptions by 2020.
- Bring transport emissions back to 1990 levels. Reduce vehicle speed limits by 10 kilometers per hour. Taxes and incentives to favor clean cars. Shift half of haulage by road to rail and water within 15 years. Develop rail and public transport.
- Reduce air pollutants quantitatively.
- Create a national network of green corridors and nature reserves.
- Increase organic farming from 2% to 6% of total acreage production by 2010 and to 20% by 2020.
- Ecological groups to be stakeholders, like trade unions, in government negotiations.
- Create a body to review planting of genetically modified crops on a case- by-case basis.

2.6 Green Building Assessment Tools

A Green building assessment method is a tool for evaluating whether a building is green or not, and rank is given to the building after a detailed assessment (Ali, et al., 2009).

In the last decade, a number of assessment tools have been developed or under development across the globe (Amos, *et al*., 2016 and Gou, *et al*., 2017). Green building assessment tools have been developed for different types of buildings: residential buildings (single-family and multi-unit), schools, hospital buildings, office buildings, industrial buildings and other types of buildings (Saleh, et al., 2012).

Among the existing Green building assessment methods, the Building Research Establishment's Environmental Assessment Method (BREEAM) developed in the United Kingdom in 1990, is the first and leading GB assessment method to appear in the market in 1990 and determined the base for the following certification methods (Ruiz, 2013). Leadership in Energy and Environmental Design (LEED) developed in the United States in 1998, grew fast and is nearly the dominant building assessment system around the world. Other well-known GB assessment tools include;

- Comprehensive Assessment System for Building Environmental Efficiency(CASBEE) of Japan
- Green Star of Australia
- Building Environmental Assessment Method Plus (BEAM Plus) (formerly named as HK-BEAM) of Hong Kong
- Green Mark of Singapore
- Eco Profile of Norway
- Deutsche Gesellschaft fur NachhaltigesBauen (DGNB) of Germany,
- The Evaluation Standard for Green Building (ESGB) or Green Building Label(GBL) of China.
- The international Sustainable Building Tool (SB Tool) (formerly known as GBTool) (Li, et al., 2017).

2.7 Strategies for promoting green buildings

According to Planning and Growth Management (2012), there are three approaches to promote green buildings the prescriptive or regulatory approach, the incentive-based approach, and the promotional/educational approach.

The prescriptive or regulatory approach: involves setting rules requiring development be built to meet a specified level of environmental performance or certification under a third-party rating system. Meeting the specified standard becomes a condition of receiving a building permit, zoning amendment and/or development approval.

The incentive – based approach: involves providing bonuses, subsidies, or other incentives that make green building more attractive or feasible to a prospective developer, while stopping short of actually making it a requirement.

Educational / promotional approaches: these includes

- Web pages dedicated to promoting environmental and energy efficiency initiatives,
- Online information, guides and checklists to homebuilders and businesses to help explain the advantages of standards such as Energy Star, LEED,
- Online calendars of local sustainability events and a directory of local businesses that provide goods and services such as recycled building materials, contractors who build green, and energy auditors, among others, ¬ Research to identify obstacles to green building

The Main Actors' Prompting the Development of Green Building Principles

According to GIZ (2010), the main actors and their respective roles in the development of green buildings are discussed below:

I. Government (National and Municipal)

Governments are a dominant force in the move towards green building where their main function is to help overcome market barriers caused by the discrepancy between the private costs faced in producing green buildings and the social costs of climate change and social gains of energy efficiency. Governments not only provide the policy and regulatory framework for the construction and building materials sectors but are also a major buyer of their services. Governments play an indirect role in promoting demand and developer activity by raising awareness and demonstrating the validity of the concept. By commissioning green buildings, governments can provide the local market with tangible experience of sustainable building practices.

II. Financial institutions

Financial institutions relevant to green construction range from responsible property investors or impact investors who have strong environmental imperatives (even requirements of environmental returns on investments), to commercial actors seeking market-rate returns on individual mortgages or large loans to property developers. Engaging financial institutions requires both data and also cost incentives to invest in green construction, but investment decisions tend to be firmly rooted in short-term economic gains rather than in long-term savings in energy costs

III. Building materials and construction industry

The construction industry is vast, diverse and complex. There are no comprehensive data on the types and size of companies engaging in green building. Improved information would help to reduce transaction costs, improving efficiency and competition, which would help the industry in general and also provide the foundations for improving sustainability. Recognizing the diversity of actors within construction and materials production, and the differing incentives and needs of SMEs and of large firms, is key to promoting a commercial market for green buildings.

IV. Non – governmental organizations, membership and consumer groups

Currently, there are some 73 GBCs around the world in various stages of development. The World Green Building Council (WGBC) is the umbrella organization with regional networks for Asia–Pacific, Europe, the Americas and Africa (Malanca, 2010). One of the main activities of most GBCs is the establishment of rating tools for green buildings. The US Green Building Council has attempted to transform the market by identifying critical research needs and fostering research activity. While continual improvement of the LEED rating systems depends on pending research, the context and benefits of funding, conducting and applying such research are much broader. NGOs, civil society organizations (CSOs), consumer groups and the media can help to raise awareness of the benefits of green building. They can also monitor the performance of government and industry in creating and implementing relevant policy, private-sector adherence to regulations, and the impact on particular sectors of the population. Help can be provided through engagement with the public and private sector, facilitating leadership and bridging efforts to support public and private-sector activities

V. Research and educational institutions

Research organizations can help to address data gaps and contribute to monitoring and evaluation (M & E) work. Educational institutions can develop the skills required to build green practices into commercial activities, for example through vocational secondary and tertiary education and training for those working in the built environment.

VI. Professionals

Architects, engineers, planners and contractors have to work together with local councils to determine and identify the limitations of the environment and developing designs that incorporate environmentally friendly practices such as solar heating, recycling of local materials, and minimizing the use of materials so as to have the least possible effect on the environment.

VII. International organizations

There is a wide range of cross-country and global green building initiatives, alongside multiple programs and institutions addressing climate change and sustainable and inclusive development, all of which affect green building. The United Nations and national government partnerships have deployed regional-level approaches. UN Habitat established a five-country partnership in East Africa, sponsored by the Global Environment Facility (GEF), to focus on buildings‘ energy and resource efficiency through codes, policy, practice, housing finance, and across the building sector through reviewing the status quo (compiling data), then raising awareness and helping to leverage finance, as well as providing demonstration projects. The scheme is soon to be introduced in West Africa.

2.8 Challenges of Green Buildings

While the advantages of green buildings and sustainable development continue to show encouraging results, there are a number of challenges affecting the realization of their full environmental, economic and social potential. Some the the challenges of green building are;

Higher costs for green construction practices and materials ,technical difficulty during the construction process ,unfamiliarity with green technologies ,greater communication and interest required amongst project team members ,more time required to implement

green construction practices on site ,risk due to different contract forms of project delivery ,building codes and incentive policies and Inadequate urban planning

2.9 Green Building Technologies

The concept of green or sustainable buildings is not new, but the technologies associated with the concept have evolved and matured over time (Emmitt, et al., 2006).Most importantly, sustainable development is needed to preserve the environment by using green technology to minimize the exploitation of the natural environment (Chua, et al., 2011). The Academy of Science of South Africa defined Green technologies in the building sector as; ''*those technologies which reduce the impact of building on the environment through the development of more environmentally friendly materials and products, or through the generation and/or conservation of resources such as energy and water*'' (ASSAf, 2014).

As such, green building has been well received by many governments and promoted as a strategy for reducing the negative effects of the construction industry on the environment (Shen, et al., 2017). The popularity and acceptance gained by the green building practice have in turn caused the development of various green building technologies (GBTs) for enhancing sustainability performance during the construction process (Chan, et al., 2017).

Today nearly all structures are built combined with some sort of technological advancement of the last 100 years. Electrical and plumbing systems, appliances, wall coverings and even the skeleton of the building have all been somehow affected through technology (Bradfield, 2011). Green building technologies (GBTs) have an essential role in the development of green buildings. They are those technologies, such as passive solar technology, green roof technology, and energy-efficient HVAC systems, wall technologies and heat pump technology employed in building design and construction to improve overall sustainability performance (Ahmad, *et al*., 2016; Zhang, *et al*., 2011 and Shen, *et al*., 2011). Ultimately, green building is an integration of many environmental technologies (Brooks, *et al*., 2008).

2.10 The Green Building Councils

To have an international voice for green building initiatives UKGBC, (2007) world green building council (WGBC) was formally incorporated in 2002 with its headquarters in

Toronto, Canada. World green building council (WGBC) is an independent, non-profit organization working in the building and construction industry.

The council members of WGBC, they work to advance green building in their own countries, as well as uniting with other Green Building Councils to achieve environmental, economic and social goals on a larger, global scale. According to WGBC, (2019) currently, there are approximately 73-member Green Building Councils around the world as different regional network as:

1. Americans regional network: Americans members are Argentina, Canada, Chile, Colombia, El Salvador, Bolivia, Brazil, Costa Rica, Guatemala, Panama, Paraguay, Peru, Mexico AC, U.S, and Uruguay.

2. Europe regional network: Europe members are France, Australia, Bulgarian, Croatia, Dutch, German, Spain, Finland, Iceland, Italia, Slovenia, Hungary, Irish, Luxembourg, Montenegro, Norwegian, Polish, Serbia, Greece, Sweden, Swiss, Turkish, and United Kingdom.

3. MENA regional network: The Middle East and North Africa members are Bahrain, Egypt, Emirates, Jordan, Kuwait, Lebanon, Morocco, Palestine, and Qatar.

4. Asian pacific regional network: Asian pacific members are china, Australia, Indonesia, Sri Lanka, Hong Kong, India, Japan, Kazakhstan, Malaysia, New Zealand, Pakistan, Philippine, Singapore, Taiwan, and Vietnam.

5. Africa regional network: Africa members are Ghana, Mauritius, Namibia, Rwanda, Tanzania, South Africa, and Kenya

2.11 Empirical Study

Haileleul (2015), on Evaluation of Selected Addis Ababa Buildings with respect to the Green Building Features concluded that Indoor air quality is faced with the inevitable degradation from outdoor pollution. This in turn affects the temperature of indoor environment, formation of microbial growth and the decrease in efficiency of users.

Energy is misused due to defective building enclosures. Over using incandescent bulbs during day time and lack of knowledge on how to use renewable energy shows unhealthy consumption of energy on the assessed buildings. In the assessed buildings water

resource is over used and taken for granted. Due to this, water shortage strikes users of the buildings. This shows that the value of saving the water resource for the future which is the core notion of sustainability issue is unattained. Solid wastes are not properly sorted out, collected and damped. The buildings that have communal waste collection containers do not use their container appropriately because they don‘t like to walk to dispose their wastes especially the users of upper floors.

Another thesis work, by Mohammedata (2018), in her thesis titled Constraints and Opportunities in the Application of Green Building Principles in the Professional Building Practice in Addis Ababa concluded that a lot has to be done to bring the concept of green building in Addis Ababa. Challenges such as lack of clients ‘interest, lack of awareness and education, shortage of professionals, lack of incentives from the government, economic challenges and absence of certification system such as LEED are the main obstacles to the application of its principles. Furthermore, the study revealed raising awareness about the idea, benefits and technologies about green buildings as the most important approach.

In addition, financial incentive, research and policies were also identified as necessary strategies. However, for all to work integration of all actors including developers, designers, government, material producers, contractors and building managers from the start to finish of the project is very vital. She concluded that, out of the total 6 buildings, peace building has mixed residence and Varnero is both commercial use and residence. Nifas silk lafto buildings are used for offices, Africa CDC head quarter building for office purpose, Hope university is school and Elgel hotel is multipurpose hotel.

Solid wastes that can easily decomposable are disposed to land fill site rather than of using as a resource through compost making. From the analysis of the savings from green building found from a review of 60 LEED buildings that the buildings were, on average, 25-30% more energy efficient. However, it also attributed substantial benefits to the increased productivity from the better ventilation, temperature control, lighting control, and reduced indoor air pollution. Mekonen (2019), in a study on the potential application of green building attributes in Ethiopia has drawn the following conclusions: The building design and construction professionals ‘awareness about green building provides an important input for an understanding of status among different groups.

The assessment results showed an urgent need for green building and sustainability education to professionals to reduce the negative impact of their profession and to encourage their contribution to the sector. The rank order revealed that Energy efficiency, water efficiency, and Sustainable material and resource were the three most important in regard to the likelihood or potential green building attributes in Ethiopia based on the survey responses while Transportation, Indoor environmental quality and Sustainable site and ecology are in the bottom of the priorities. The identified and prioritize attributes can help to address the building construction's negative effects through green building and undertakes the actions needed to become sustainable using the new paradigm.

The achieved Credit percentage from the allocated, the building received 10 out of 10 points for Water and 4 out of 4 points for regional priority (equivalent to 100%) achievement in LEED from the allocated point. Similarly, the building received, attributes of Innovation achieved as 4 out of 6 points (equivalent to 66.7%), Energy & atmosphere 19 out of 35 points (equivalent to 54.3%), Sustainable sites 14 out of 26 points (equivalent to 53.8%), Material & resource 5 out of 14 points (equivalent to 35.7%), Indoor environmental quality 7 out of 23 points (equivalent to 30.4%). However, this percentage achieved points from the highest score of each criterion difficult to compare each other because each of the attributes was not based on the same point.

The Percentage of achieved Credit from total credit, Sustainable sites 14 out of 110 (equivalent to 12.7%), Water efficiency 10 out of 110 (equivalent to 9.1%), Energy & atmosphere 19 out of 110 (equivalent to 17.3%), Material & resource 5 out of 110 points (equivalent to 4.5%), Indoor 48 environmental quality 7 out of 110 points (equivalent to 6.4%), Innovation 4 out of 110 points (equivalent to 3.6%) and Regional priority 4 out of 110 points (equivalent to 3.6%). Al Sadi et al. (2019) identified that, one of the significant features of the project was the implementation of green features to the design, such as solar panels, a vegetated roof, permeable paving, highly efficient appliances etc.which transformed the conventional building design to a ―green‖ building making it LEED certified. Total cost of construction rose by 30% by adding LEED features compared to the conventional building cost. Considering the savings of $11,548 per year, it will take approximately 15 years to even out the added green feature cost. Overall, this project benefited the group engineers in learning the step by step process of designing a

steel frame house and the concept of green building and its importance. Al Sanad (2015), in the study that was carried out in Kuwait highlighted that the general awareness levels towards the concepts of green building are low. Greater effort is required to raise awareness levels in order to accelerate the growth, adoption and implementation of green building concepts in Kuwait. In addition, the implementation of green construction methods is low and that rules and regulations are required as guidelines for meeting the needs of both society and the environment. To promote the green concept, the government could revise the current standards or introduce new regulations, launching appropriate guidelines for the implementation of green practices to ensure that sustainable methods are adopted.

This will then encourage all stakeholders involved to make changes in order for them to comply with the new legislation. Cooperation between the private and governmental sectors is required to ensure that the standards and rules are set in an appropriate, achievable way to ensure that the construction industry will be able to adapt and implement the new legislation accordingly. The research revealed that ―education programs‖ (mean = 4.36) are considered the main driver in accelerating the implementation of green construction in Kuwait. The other factors identified as _set rules and legislation‘ (mean = 4.30) and was followed by _green design guidelines and construction standards‘ (mean = 4.18). Zhang et al. (2019) found out that, the concept of GB evolves as a holistic approach to deal with various problems caused by the construction industry. Green building is subject to continuous development of new technologies, integrated management of building operation, consistent standards of certification systems, and proper adjustment of policies, all of which have a significant impact on GB development.

The economy of GBs is the basic driving force and decision-making benchmark of its development. The ongoing debate over the economics of GBs seems to be where the potential financial saving can be made in the initial investment in GBs, later operation costs, or reduced resource use. Their extensive survey suggests that most GB studies focus on certification standard analysis and comparison, technologies solutions in terms of energy performance, water efficiency, and indoor environmental quality. Almost two – thirds of those surveyed predicted that GBs would save 6% on operating costs over the next year, with 80% saying the trend would continue over the next five years. With the

popularity of operating costs and health benefits, the value of GBs will continue to increase.

Tomkiewicz (2011), identified that; Information gaps stand as the largest barrier to the standardization of sustainable development practices in the residential homebuilding industry today. Although the building trade has introduced many certification programs, training and professional development seminars to educate the builder in sustainable practices, the impacts of these programs on the residential trade are negligible. C.S. Hayles and T Kooloos, (2008) carried out a study in one of the leading Green Building council member, Australia. The challenges to sustainable building approaches in Australia were found to reflect that of other developed countries, in particular higher capital costs, lack of cohesive information relating to sustainable construction and availability and affordability of appropriate materials and technology. A number of the challenges highlighted could be addressed by more appropriate approaches to green building including an integrated systems approach which would impact positively on the design and construction process as well rethinking what sustainable building practices aspire to; refocusing sustainability away from energy efficiency and highly technical solutions, to a more holistic examination of the impact of building on the environment. Cost benefits can be accrued as a result of sustainable building as integrating green principles into a building‘s planning and design process can generate 40% more savings and 40% better performance than simply adding green technologies to a traditionally planned and designed facility.

Aghimien et al. (2017) found that, the role of sustainable buildings in the delivery of quality education cannot be overemphasized. However, bold statement with regards to the poor sustainability nature of construction projects in most developing countries (Nigeria inclusive), has been made. The Nigerian Construction Industry has been characterized with poor delivery of Sustainable Construction projects, and educational buildings suffer this same fate. Based on the findings, the study concludes that the significant challenges of Sustainable Construction within the Nigerian Construction Industry are; construction related, sustainability awareness and knowledge related, finance related, and government related.

The implication of the finding is that, the method and process of operations within the Nigerian Construction Industry does not favor the realization of Sustainable

Construction. It is found that, components with given values greater than 1 that were extracted using the factor loading of 0.50 as the cut-off point. The total variance explained by each component extracted is as follows; component 1 with 38.1%, component 2 with 14.7%, component 3 with 10.4%, and component 4 with 6.6%. Thus, the final statistics of the principal component analysis (PCA) and the components extracted accounted for approximately 69.8% of the total cumulative variance. This fulfills the criterion of factors explaining at least 50% of the variation as stated by Stern (2010).

2.12 Theoretical Framework

The theoretical framework in this study was used to demonstrate various variables that affect the application of Green Building principles. Figure below portrays the theoretical framework.

Study Variable

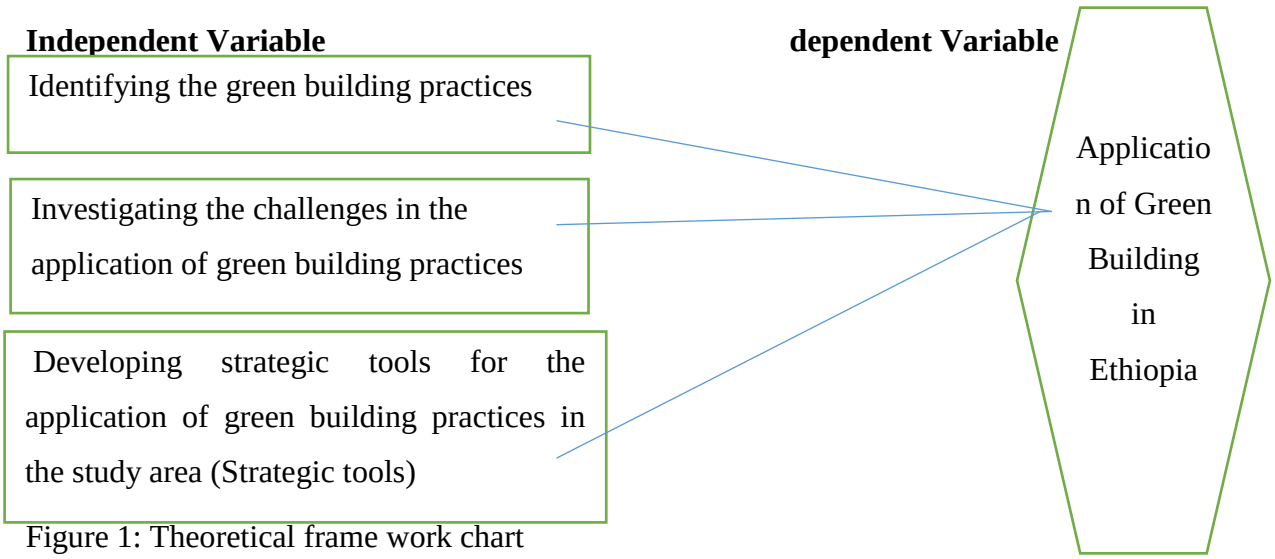

Figure 1: Theoretical frame work chart

2.13 Research Gaps

The motive behind this research is that as far as the researcher knows no one conducted research on challenges of application of green building in Addis Ababa: the case of Nifas Silk Lafto Sub City.the issues have not been addressed before. To fill this gap, the researcher will conduct the study on challenges of application of green building at the sub city level.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Study Area

Nifas Silk Lafto Sub-city is one of among the eleven sub-cities in Addis Ababa with a land area of 5876.02 hectares and this constitutes 11.31% of the total land area of the city which makes the sub-city in 5th place in area size amongst 11 sub cities. Nifas silk lafto Subcity is located in the South-West edge of Addis Ababa. The Sub-city is bounded by Kolfe Keraniyo Sub- city in the North-West, by Bole and Akaki Kality Sub-cities in the East, by Lideta and Kirkos sub-cities in the North and Oromia regional state in the South. N/S/L/Sub-city is characterized by moderately steeply type of topography with noticeable elevation difference and steeply landscape around river gorges in some areas. The sub-city is relatively flat and gently sloping. Generally speaking in the sub-city, the altitude ranged from 2074 to 2485 meters above sea level which has a range of 411 meters. The highly elevated land exists in the South West while relatively lower elevation exists in the South.

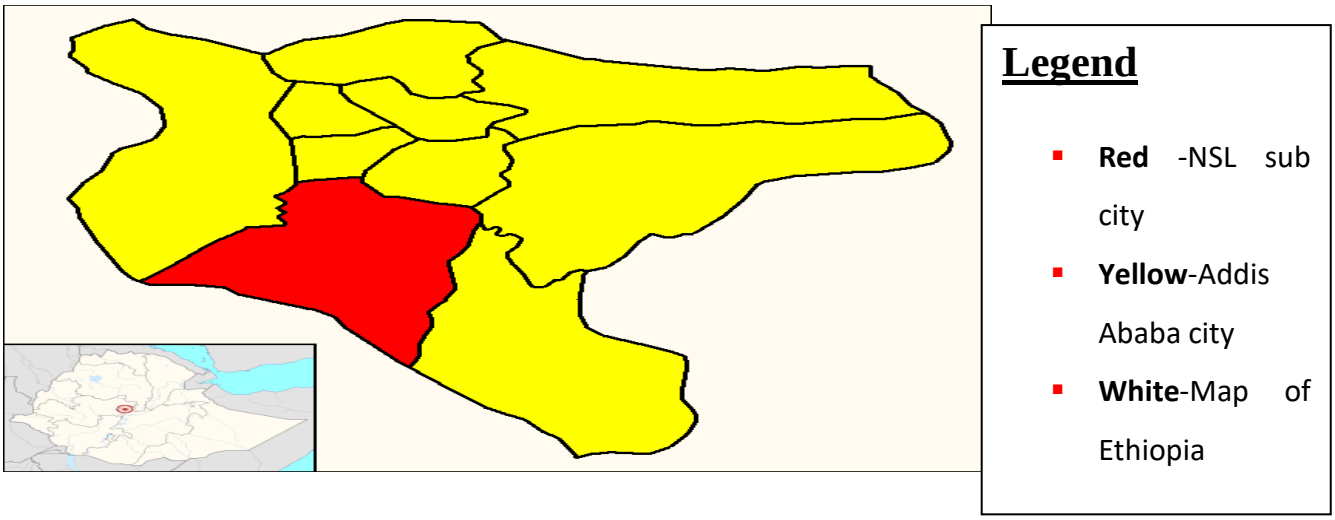

Figure 1 NSL sub city map

(Source: from Addis Ababa city plan commission, 2024)

3.2 The Research Design

The research uses both descriptive and explanatory research methods. It is designed of site survey, interview, questionnaires &document review. A mixed approach that utilizes both qualitative and quantitative data is used. The qualitative data include attitudes, opinions and experience of residents within the selected buildings concerning green building principles such as recycling, water efficiency, day lighting and energy

efficiency. For quantitative method, parameters that define green buildings, determining the degree of greenness of the sampled buildings in Nifas Silk Lafto Sub City were statistically analyzed.

3.3 Research Approach

To demonstrate the challenges in the application of green building principles in NSLSC the researcher has employed both quantitative and qualitative research methods. Data will be collected from primary and secondary sources. Quantitative approach was preferred to quantify data obtained through questionnaires.

Quantitative approaches tend to relate to positivism and seek to gather factual data, to study relationships between facts and how such facts and relationships accord with theories and the findings of any research executed previously (literature) about Green Building. Scientific techniques are used to obtain measurements and quantified data. Analyses of the data yield quantified results and conclusions derived from evaluation of the results in the light of the theory and literature.

3.4 Data type

The researcher used both Quantitative and qualitative types of data.

Qualitative data analysis (QDA) was obtained from interview of project owners, consultants, residences, engineers and contractors. Quantitative data analysis was preferred to quantify data obtained through questionnaires.

3.5 Sources of data

The data required for this study was collected from both primary and secondary sources. Primary sources were collected through questioners and interview. Thus, the primary data of survey was collected from the employees in the Nifas Silk Lafto Sub City construction permission and control office team leaders and employees, clients, architects, contractors, consultants and residences. And the secondary data of survey was collected from Nifas SilkLafto Sub City construction permission and control record and documentation team and also from journals and articles.

3.6 Sampling Design

3.6.1 Sampling techniques

The researcher selected 6 buildings by purposive sampling technique from the whole NSLSC buildings those were Africa CDC headquarter building at Haile garment square, Elgel hotel and spa at kore, Peace building at Mekanisa,Valnero real estate at lebu, Hope University College at Buna meda and Nifas silk lafto sub city administration office building at Haile garment square. The researcher used purposive sampling because it is used to focus in depth on relatively small samples.

3.6.2 Sample population

By simple random sampling technique, a total of 40 respondents selected from NSL CPC office, consulting office, residents, building owners and managers. Among 40 respondents only 37 respondents fulfilled the questioner in well manner.

3.6.3 Sample Size determination

The researcher took 6 projects at Nifas Silk Lafto Sub City purposively and randomly selects 40 respondents from residences, clients, NSLSC CPC officers, contractors and from consultants.

3.7 Methods of data collection

The data collection technique employed in this research includes questionnaire, interview, observation and record and documentation. Pilot study was completed by distributing questionnaire to ten selected sample representatives from the research sample group. All 10 sample representatives responded to the questionnaire and improvements were made where necessary based on their feedback. This indicates that full – scale distribution of questionnaire to the selected samples or respondents was feasible. With regard to the close - ended questions, the respondents asked to indicate their level of agreement on a five point Likert scale as shown in the following ratings.

Table 1 Rating scales

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Scale	(1)	(2)	(3)	(4)	(5)

On this scale a score of 5 or 4 indicates that the item is supposed to be crucial while a score of 3 or 2 indicates that the item is supposed to be moderately important, but not crucial, while a score of 1 indicates that the item could be overlooked for being unimportant

3.8 method of data analysis

The researcher used the Statistical Package for the Social Science (IBM SPSS 26 software) to analyze quantitative data which gained from questionnaire. Qualitative data gained from interview from stakeholders, project owners, residents, contractors and consultants presented in narrative form.

3.9 Method of data presentation

The data analyzed was described and presented in the form of descriptive words, map, pictures, tables, graphs, charts and SPSS software used to check validity reliability test.

3.10 Research ethics

According to Leedy et al. (2005), there are a number of key ethical issues that relate to the rights of research participants. These are protection from harm, informed consent, the right to privacy and honesty.

The principle of informed consent requires that respondents should be given full information about the research and their consent being sought to participate in it. The participants in this study were well informed about the nature of the study in writing and orally. The questionnaire described the nature of the study, why it was carried out and notified the respondents that their participation was voluntary. The researcher also informed participants regarding their rights to confidentiality. Confidentiality implies that the dignity and privacy of a subject should be respected. Participants were informed that the information they submitted would be confidential and only be accessed by the researcher. They were also not required to provide any identifying and personal details and as such, the final study will not reflect the subject is identifying information such as their names.

CHAPTER FOUR: -RESULTS AND DISCUSSION

In this chapter the researcher briefly discussed about result and discussion in the forms of table, bar chart, histogram interns of frequency and percent.

4.1 Response Rate

A total of 40 questionnaires were distributed to selected respondents. The copies of the questionnaires were handed out personally and each respondent was briefed about the purpose of the study and how to fill out the questionnaire. Out of these 40 questionnaires, 37 were filled properly and collected and the remaining 3 questionnaires were rejected due to incomplete and invalid responses. As a result, the overall response rate was 92.5 percent which is acceptable for data analysis and discussion of the study.

Table 2 shows the breakdown of responses from sample groups.

Table 2 Response rate

Group	Distributed	Collected back	percentage
Respondents(clients, residents, consultants, NSLSC CPC office officers)	40	37	92.5

(Source: from questionnaire conducted by researcher)

The percentage of the respondents as shown in the table above which is 92.5%. This is the implication of the research is acceptable. This shows that most of the respondents were volunteer and fulfilled the questioner to researcher. The other three respondents did not full filed the question on the right way, this shows they haven't any idea about green building.

4.2 Demographic characteristics

a) Gender

Table 3 shows the gender composition of respondents as per the collected responses. Accordingly, 62.2 % respondents are male and 37.8 % are female. It means most of the respondents are male. Generally, male respondents participate more than female respondents.

Table 3 Gender information

Variable	frequency	percent
Male	23	57.5
Female	17	42.5
Total	40	100

(Source: from questionnaire conducted by researcher)

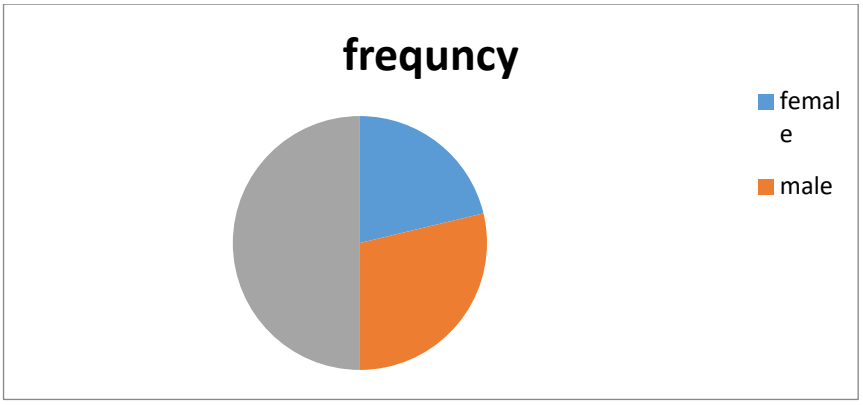

Figure 2 Gender information

(Source: from questionnaire conducted by researcher)

b) Age and Educational Background Composition

The table 4 shows respondents' age composition and the total percentage they possess. Accordingly, majorities (37.8 %) of the respondents were aged between 25 and 34 years and 32.4 % were aged between 35 and 44, 16.2 % aged between 45 and 54, 10.9 were aged between 55 and 60 and 2.7 was aged below 25.

Table 4 Respondents Age

Respondent Age	Frequency	Percent
below 25	1	2.7
25 to 34	15	37.8
35 to 44	13	32.4
45 to 54	7	16.2
55 to 60	4	10.9
Total	40	100.0

(Source: from questionnaire conducted by researcher)

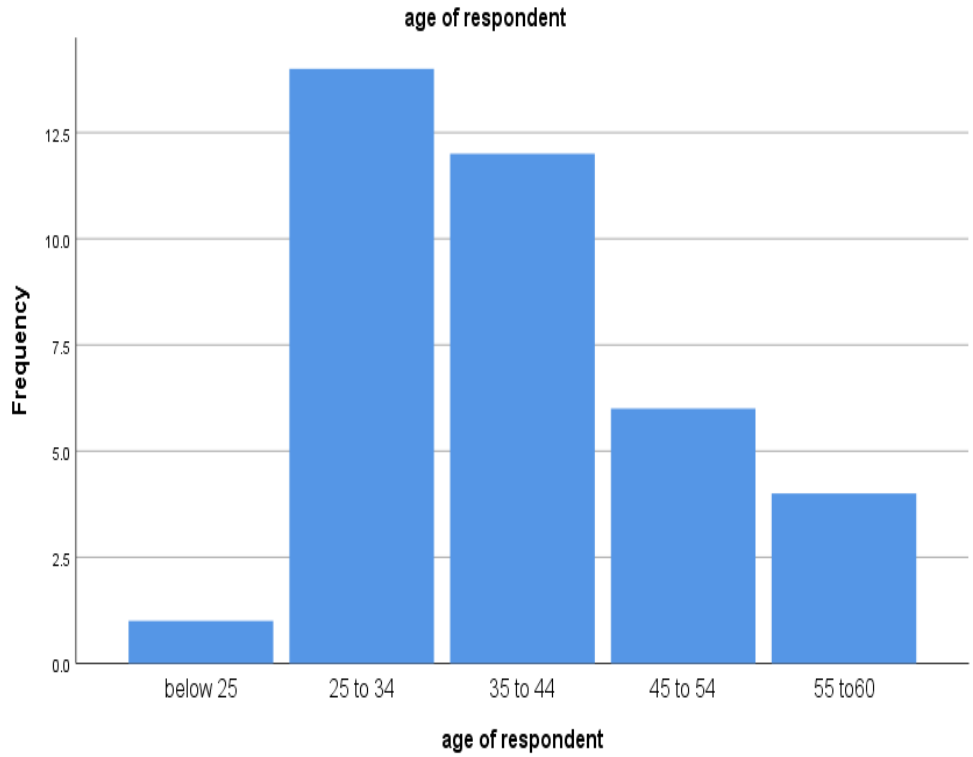

Figure 3 Respondents of Age

(Source: from questionnaire conducted by researcher)

Table 5 shows respondent's educational background and the total percentage they possess. In case of educational background / level of respondents/, majorities (78.4 %) are first degree holder, (5.4%) are diploma, (16.2 %) are Master's degree, and there is no PHD and certificate holders.

Table 5 Educational background of respondents

Educational back ground	frequency	Percent
Certificate	0	0
Diploma	3	5.4
Bachelor degree	30	78.4
Masters degree	7	16.2
PHD	0	0
Total	40	100

Figure 4 Educational back ground

(Source: from questionnaire conducted by researcher)

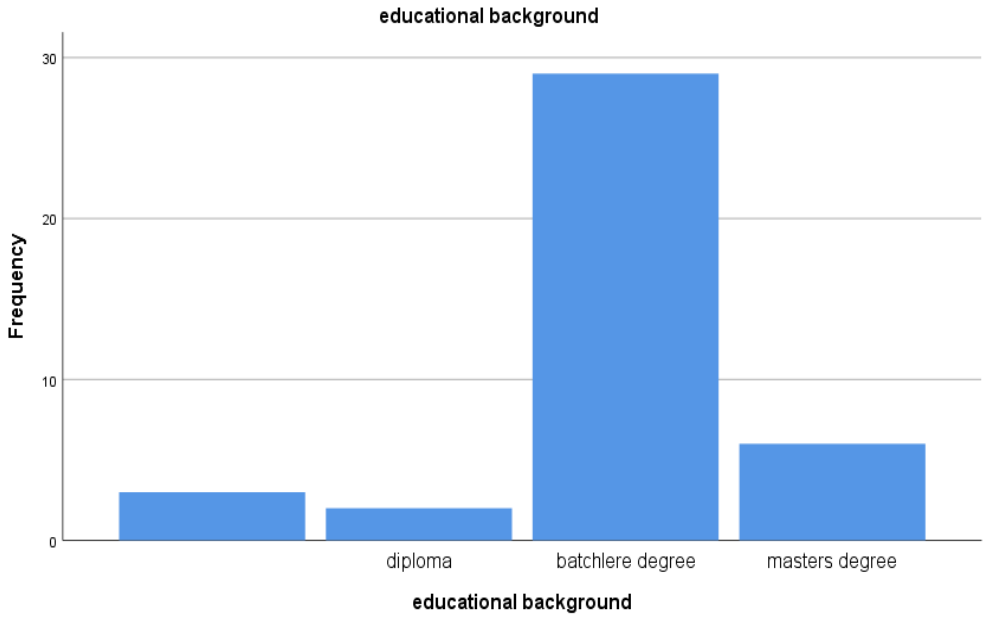

Figure 5 Educational background

(Source: from questionnaire conducted by researcher)

c) Experience of Respondents

Table 6 shows respondents total work experience, position and responsibility in their respective profession and the total percentage they possess. Accordingly, majorities (32.3%) have 11 - 15 years of experience while (13.1 %) have 3 – 5-year experience, (27.10) have above 15 and (27.1 %) have 6 - 10 years 'of total work experience on their profession.

Table 6 Total work Experience of respondents

Total work experience	Frequency	Percent
below 3	0	0
3 to 5	6	13.1
6 to 10	11	27.1
11 to 15	12	32.3
Above 15	11	27.1
Total	40	100

(Source: from questionnaire conducted by researcher)

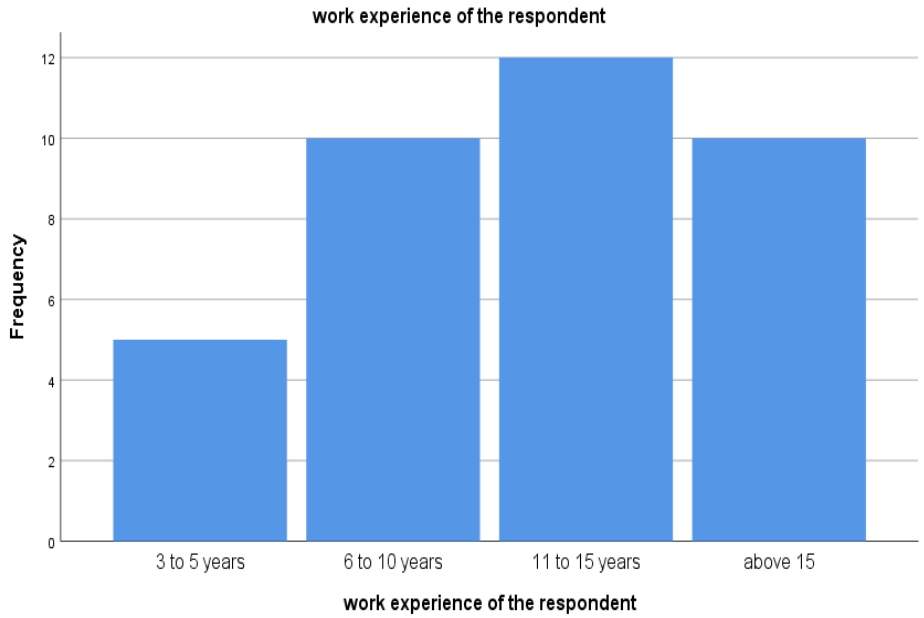

Figure 6 work experience of the respondents

(Source: from questionnaire conducted by researcher)

Figure 6: work experience of the respondent

In case of respondents 'role or responsibility the majority (27.02%) were Architects, (21.62 %) were Structural Engineers, (18.91%) were clients, , (8.11%) team leaders, and (5.42%)were contractors.

Table 7 Responsibility of Respondents

Role /responsibility	frequency	percent
Architect	10	27.02
Structural engineer	8	21.62
Consultants	8	18.91
Clients	7	18.91
Team leader	4	8.11
Contractors	3	5.42
Total	40	100

(Source: from questionnaire conducted by researcher)

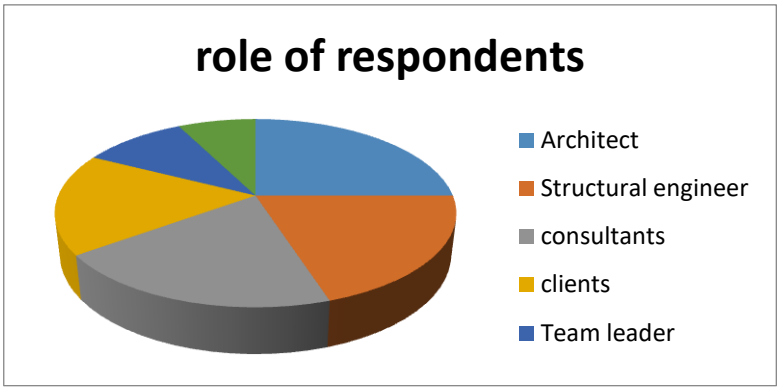

Figure 7 Role of Respondent

(Source: from questionnaire conducted by researcher)

4.3 Reliability the study

The researcher used SPSS software to conclude whether the research was reliable or not. Practice of green building, challenges GB and possible strategic tools discussed below based on its Cronbach‘s alpha value.

Identifying the green building practices (P)

Reliability statistics of in the selection of identifying the green building practices questionnaire. Cronbach‘s Alpha value for Identifying the green building practices expressed in table 8

Table 8 Cronbach's Alpha value for Identifying the green building practices

Cronbach's Alpha	Number of items(no. of questionnaire)
0.813	12

(Source: from questionnaire conducted by researcher)

Investigating the challenges in the application of green building (C)

Reliability statistics in the selection of investigating the challenges in the application of green building.

Cronbach‘s Alpha value for investigating the challenges in the application of green building practices expressed in table 9

Table 9: Cronbach‘s Alpha value for investigating the challenges in the application of green building practices

Cronbach's Alpha	Number of items(no. of questionnaire)
0.726	12

(Source: from questionnaire conducted by researcher)

Acceptable internal consistency since cronbach‘s alpha is greater than acceptable percentage 0.7 . Developing strategic tools for the application of green building practices in the study area (S) Reliability statistics of the factors in the selection of developing strategic tools for the application of green building practices in the study area questionnaire.

Table 10 Cronbach‘s Alpha value for developing strategic tools for the application of green building practices in the study area

Table 10 : Cronbach‘s Alpha value for developing strategic tools for the application of green building practices in the study area

Cronbach's Alpha	Number of items(no of questionnaire)
0.942	12

(Source: from questionnaire conducted by researcher)

Acceptable internal consistency since cronbach‘s alpha is greater than acceptable percentage 0.7.

Overall value of questions of GB

The value of cronbach‘s Alpha for reliability of all questions is shown on table 11

Table 11: Table 11: Reliability Statistics for checking Cronbach‘s Alpha of all questions

Cronbach's Alpha	Number of items(no of questionnaire)
0.858	36

(Source: from questionnaire conducted by researcher)

Acceptable internal consistency since cronbach‘s alpha is greater than acceptable percentage 0.7.

4.4 practice, challenges and strategic tools for green building at the study area

4.4.1 Hope University Library

Hope University is located in Nifas-silk Lafto Sub-city, woreda 01 around Jemo area. The university was established in 1971 on 50,000 m2 plot of land. The library is located on the left side of the main entrance. The design was done by GelukTreurniet Architecten BV of the Netherlands, in collaboration with ABBA architects from Ethiopia.

4.4.1.1 Sustainable Site

I. Site location and transportation

The building is located in Jemo area which is rapidly growing into an active neighborhood. The mixed-use neighborhood has different functions surrounding it. There is fair access to and from the compound as there is a taxi and Bajaj route along the road and a taxi stop nearby. Taxi and private car is mostly used as a means of transportation in the university. Nothing that encourages other methods of transportation such as bicycle can be seen in the campus.

II. Site design and management

a. Open space and Green areas: the campus as a whole is green with lawn surrounding most buildings. The library is no exception as a large grass lawn with scattered trees extends in front of it. Indigenous species such as Acacia abyssinica (Girar), Dracaena steudneri (Itsepatos), Cordia Africana (Wanza) and Borassus aethiopum (zembaba) are predominantly planted. Introduced species such as Grevillea robusta is also very common.

b. Pavement: tiles are mostly used around the library for circulation while on the west side of the building, there is asphalt paved parking area. The first allows infiltration to some extent while the later doesn't.

c. Storm water management: according to the librarian that was interviewed, flooding has occurred many times in the building. Before the flooding, little site work was done on the back side of the building. The storm water was channeled by a ditch to the back and during heavy rain it would overflow to the basement through its windows. The flooded water ones reached knee height and ruined many books that were stored in the

basement. Currently, concrete blocks the storm water from entering it. The entire roof is covered by vegetation so rain water from the roof is absorbed by it and what remain flows to the surrounding green.

d. Green roof: the building has an intensive vegetated green roof. The roof is sloped at some angle and is covered entirely with grass. It gives a feeling of continuity because the green roof extends to the ground level green area. According to the librarian, due to faulty waterproofing works water leakage was very common but recently intense maintenance was conducted and the problem is now fixed to some extent. Although no one was seen on the green roof during site visit, the librarian claims students can access it.

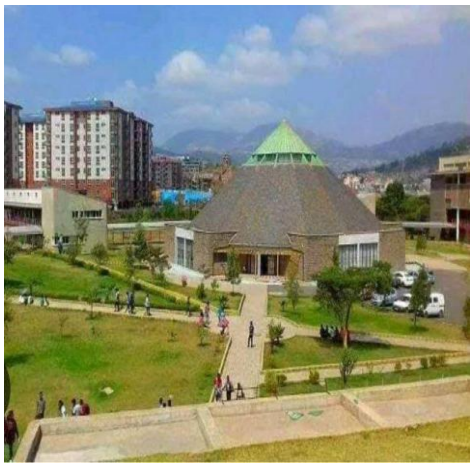

Figure 8 hope university college library and meeting hall

(Source: captured by the researcher, 2024)

4.4.1.2 Water Efficiency

Tap water is the main source of water for toilets, cleaning and other uses in the building. During dry season the green roof and the surrounding water is irrigated using hoes connected to the main line. The only water efficient fixture used is dual flushing while nothing is done to recycle wastewater. But the green roof contributes to creating a water efficient landscape. **4.4.1.3 Energy Efficiency and Atmosphere**

I. Energy Consumption The main source of energy is electricity and the items used the most include computers and light bulbs. Air conditioners and fans are not utilized at all. Natural daylight and ventilation which reduces the total energy consumption are mainly used in the building. The librarian claims, artificial light is not used during the day and none were seen during site visit.

II. Energy efficient equipment and renewable energy

Fluorescent light bulbs are entirely used in the inside while LED lights are seen on certain parts of the outside. Renewable energy is not utilized at all.

4.4.1.4 Material and Resources

I. Type of materials Roof: as mentioned before the roof is completely covered with grass. Walls: the east face exterior wall of the building is completely covered with glass while the rest is a combination of both the HCB wall and glass windows. Stones are used around the entrance and brick is used for the basement. Relatively there is little interior partition wall in the building and it is mainly HCB walls. Floor: plastic tiles are the floor finishing used in the whole building.

II. Regional materials and rapidly renewable materials

Bamboo, which is a rapidly renewable material, is used in the east face of the building as a shade. In addition, the green roof reduces the demand for virgin materials and reduces waste, in doing so, decreasing impacts associated with the extraction and processing of virgin resources.

III. Waste management Similar for both the building under review and the whole campus, waste is collected on a daily routine and burned at the back of the campus. The waste is mainly papers and no recycling or reusing scheme is used.

4.4.1.5 Indoor environmental quality

I. Lighting

The library is mostly enclosed with large window extending the length of the walls providing it with unlimited natural lighting. Bamboo sun breakers are used to protect the East face while the afternoon harsh sun is avoided with the slopping green roof. The building also has two open downs on each side with a green area at the bottom and louver windows on the side. This allows the flow of natural lighting and ventilation throughout the building. Additionally, the greenery at the bottom of the open down can be accessed by a small door but it is usually close.

The rooms with the sloppiest roof are used for computer rooms, toilets and offices. These rooms have several small opening in the roof such as skylights which is used for lighting and ventilation. Based on the questioned library users concerning lighting in the library, 18.75% replied the library is very bright while the remaining 81.25% said it is bright.

II.Ventilation

The whole building is naturally ventilated and it doesn't utilize any form of mechanical ventilation. The occupants' control of ventilation is limited in these buildings as the operable windows are small in number and size.

III.Dampness and microbial growth

As mentioned above, water leakage from the green roof was a problem in the building until maintenance work was done. Currently no dampness can be seen in the building especially inside but there is some dampness in the entrance to the building.

IV.Thermal comfort

The temperature within the building tends to have a chiller quality because North orientation is accompanied by prevailing wind and most rooms do not get to experience much warmth. In addition, the green roof also helps to regulate the indoor temperature.
VI. Efficiency and health problems

According to the librarian, no health issues have occurred due to the indoor quality of the building. Similar with the librarian's reply all users answered, they never had health problems because of the indoor environmental quality in the building.

4.4.2 Varnero Apartments

4.4.2.1 Building description

Varnero real estate compound is located in Nifas-silk Lafto Sub-city, woreda 01 around Lebu area. The compound has both villas and five story apartments and was built by Varnero construction. There are a total of eight apartments building in the compound. The building under review is chosen randomly and is located on the left side of the back entrance. It is entirely used for residence with two and three bedroom apartments. The building has a square shape facing the North direction.

4.4.2.2 Sustainable Site

I. Site location and transportation

Lebu area is a mixed use neighborhood with commercial activities along the main road leading to Jemo. The area is rapidly flourishing into a nodal area with diverse functions and services all within a walking distance from the varnero compound. Private vehicle is predominantly used as a means of transportation with large parking area for both residents and guests while bicycle parking rack is nowhere to be seen in the compound. For those using taxi, there is a taxi route along the road connecting it to city centers such as Mexico and others. A taxi stop is also located a few meters from the compound.

II. Site design and management

a. Open space and Green areas: the whole compound has large open and green areas including playgrounds and recreational green areas. Around the building being studied large green lawn areas are found in front of and adjacent to it. Indigenous species such as Acacia abyssinica (Girar), Borassus aethiopum (Zembaba), Vernonia amygdalina (Grawa) are seen to dominate while introduced species including Jacaranda mimosifolia (Yetebmenja zaf) and Spathodea campanulata (African tulip tree) can also be found.

Figure 9: Valnero Real estate green area

(Source: captured by the researcher, 2024)

b. Pavement: Asphalt is used for the main circulation and parking areas. For pedestrian circulation terrazzo tiles are mainly used, in some areas the tiles do not have cement lining in between to increase infiltration.

Figure 10: Varnero Aspalt Pavemnt

(Source: captured by the researcher, 2024)

c. Storm water management: A ditch system connected to the main drainage line diverts storm water in the compound. The rain water from the roof is released through floor drains to the adjacent green area which then passes through different layers and areas of green spaces until it reaches the drainage line.

d. Green roof

The apartment building does not have a green roof. However, the roof of the parking is covered with well-maintained and accessible grass lawn with some ornamental plants. The roof of the parking is constructed with the proper waterproofing but leakage can be seen in some areas especially around openings.

e. Green Wall:

Potted planted are seen on the balconies of most buildings but only the building that is being studied has a green wall. Climbers have grown on the wall of the building without any wires or mesh by simply clinging to it.

4.4.2.3 Water Efficiency

As an alternative water source groundwater from two boreholes is used to irrigate the green areas of the whole compound. As for drinking and other functions tap water is used. Nothing is done to reuse or recycle the wastewater. In addition, the only water efficient fixture used to reduce water consumption is dual flushing.

4.4.2.4 Energy Efficiency and Atmosphere

I. Energy Consumption

Electricity is the many source of energy. Some apartments use air conditioners and fans while the majority of the units claim they don't use artificial lighting in the daytime unless it is cloudy. The items utilized the most include kitchen equipment, laptops, television, water boilers and lighting.

II. Energy efficient equipment and renewable energy

Most apartment units claim they do not use energy efficient light bulbs while some units use both types of light bulbs. The entire compound including the building under study does not use renewable energy.

4.4.2.5 Material and Resources

I. Type of materials

Roof: stone coated steel roofing system is used for the roof.

Walls: HCB walls make up both the exterior and interior walls of the building. However, stone coated light weight steel is used for the exterior wall of the last floor.

Floor: ceramic tiles and wood parquets are the most common floor finishing in the building.

Figure 11 varnero real estate types of materials

(Source: captured by the researcher, 2024)

II. Waste management

Residents dump their waste at the disposal site found in the compound without sorting it or any plans to reuse or recycle the waste

4.4.2.6Indoor environmental quality

I. Lighting

Every room expects certain toilets have windows and access to natural lighting. Balconies are provided for the living and dining rooms of each apartment unit.

II. Ventilation

All the rooms in each apartment unit are naturally ventilated except for certain toilets. But in addition to the natural ventilation, air conditioner and fans are used in some apartment units. There is no restriction or designated area for smoking and most

apartments allow it in their balconies. Residents have full control over ventilation as all the windows in the building are operable.

III. Dampness and microbial growth

All the questioned residents claim there is no microbial growth in the entire building. Water leakage is observed in the parking garage with the green roof.

IV. Thermal comfort

The apartments at the rear side experience higher temperature than those on the front. The bedrooms face the east and west sides while the living room and kitchens face the north and south face.

V. Acoustic and views

The building under study is located at the back side so noise disruption from the street is not an issue. As for interior noise pollution, the walls have noise reduction materials embedded in between the HCB blocks to prevent noise transfer through the walls.

VI. Health problems

All of the questioned residents of the building answered that they have not had any health issues because of the indoor quality of the building.

4.4.3 Africa CDC head quarter building

4.4.3.1Building description

Africa CDC head quarter building (Africa center for diseases control and preventation) is located in Nifas-silk Lafto Sub-city, woreda 01 at Haile garment square constructed by the Chinese construction giant -- China Civil Engineering Construction Corporation (CCECC).

4.4.3.2Sustainable Site

I. Site location and transportation

Africa CDC head quarter building located in front of Nifas silk lafto sub city administration office and and it is near to Haile garment square .it is also a road to

Mexico,Jem,Megenagna and Tuludimitu which has good access for bus and taxi transpiration.

4.4.3.3 Africa CDC head quarter building design

Parking and access of the compound is asphalt paved and pedestrian is constructed with terrazzo. The rest part of the compound is planted with Indigenous species such as Acacia abyssinica (Girar), Borassus aethiopum (Zembaba), Tid and grass.

As the researcher observed almost all wall constructed from aluminum which has light material but no green roof and green wall at all.

Figure 12: Africa CDC head quarter building

(Source: captured by the researcher, 2024)

4.4.4 Nifas Silk Lafto Subcity administration office building

4.4.4.1. Building description

The building is located in Nifas silk lafto Sub-city, Woreda 15 around Haile garment. This building is one of the 10 typical buildings built for each of the 10 sub-cities. Designed by MGM consult and constructed by Etete construction, it was completed in

2014.It is a B+ G+12 stories building housing all the sub-city's offices. The building is mostly used for offices but it also has a conference hall, restaurants and a Decker at the ground floor. The building gives its longest side to the North south direction.

4.4.4.2 Sustainable Site

I. Site location and transportation

The building is located around Haile garment. In regards to transportation, mexico taxi,tuludimitu taxi,jemo taxi, Megenagna taxi and bus station is located very close by. There is a vehicle parking in the left and back side of the building, but no bicycle racks or any other devices that encourage alternative transportation. The employees use the public service buses provided by the government.

II. Site design and management

a. Open space and Green areas: the building has small green lawn in the front entrance, at the back and around the outside boundary of the compound. The green areas are mostly covered with grass and ornamental plants. Introduced species such as Cypress, Araucaria and Grevillea robusta are predominantly planted.

b. Pavement: Asphalt is the main paving material used in the compound followed by concrete which is used mostly around the building.

Figure 13 : Nifas Silk Lafto Subcity administration office building parking area

(Source: captured by the researcher, 2024)

c. Storm water management: according to the building administrator interviewed, flooding has occurred a few times in the building overflowing in to the basement floor.

The main method used to manage storm water is a ditch system around the building. In addition, water pumps are installed on opposite sides of the building to divert storm water away from the building. Rain water is released to the ditch through the downpipes from the roof.

D.Green Roof and wall: there are no green roofs and walls in the building.

(Source: captured by the researcher, 2024)

Figure 14: NBL administration office building

(Source: captured by the researcher, 2024)

4.4.4.3 Water Efficiency

Municipal tap water is the main source of water used for toliets, cleaning, irrigation and other uses. No action is taken to reuse and recycle wastewater or rainwater. Dual flushing is the only water efficient fixture used in the building.

4.4.4.4 Energy Efficiency and Atmosphere

I. Energy Consumption

The main source of energy for the building is electricity and the items used the most include computers, lighting, elevators and others. Natural daylight and ventilation is mainly used in the building. According to the building administrator, the building doesn't utilize air conditioners. Electric breakers are found on the corridor outside each office to turn off lights left lit after working hours; this is checked by security every night when they do their rounds.

II. Energy efficient equipment and renewable energy

The building is uses LED lights in the circulation areas while fluorescent light bulbs are used for the offices. Both consume less energy than regular light bulbs. No renewable energy is used in this building.

4.4.4.5 Material and Resources

I. Type of materials Roof: corrugated iron sheet and marble with the aluminum framed skylight in the middle make up the roof of the building.

Walls: the interior wall partitions are mostly aluminum. The exterior wall materials range from black and white marble gladded walls to grey and white clinker wall finishing.

Floor: Marble floor finishing is used for the circulation around the elevators while porcelain tiles are used for the offices. Carpet and parquet is used for the conference hall and gymnasium respectively.

II. Waste management: The office is cleaned twice a day and waste is collected and disposed in the dumping site found at the back of the building. There are no actions taken to recycle and reuse wastes within the building. In addition, no trash cans can be seen inside the building.

4.4.4.6. Indoor environmental quality

I. Lighting

The building is supplied with sufficient lighting through the windows which cover most of the walls in all sides of the building. Additionally, an open down with a skylight in the middle of building showers the interior with ample day light. The main circulation and staircases also have windows illuminating it. To some extent the deep volume of the balconies protects the rooms from direct sunlight but there are no sun breakers or shades protecting the building from the harsh sun so most offices are seen using newspaper to cover their windows. According to the surveyed building occupants concerning lighting, 45.8% answered it is normal, 41.7% said the building has bright lighting while the remaining 12.5% replied it is very bright.

II. Ventilation

Natural ventilation is mainly used in the building. According to the building administrator, opening windows is the only method used to cool themselves and most windows are operable. Smoking area with a balcony is provided adjacent to the toilet but it is usually closed and not functional. In regards to the air quality, the minority of 8.3% said it is variable in a bad way, the majority of 41.7% answered it is normal, 33.4% replied it varies in a good way while the remaining 16.6% said the indoor air is clean and fresh.

III. Dampness and microbial growth

The building administrator interviewed claims there are no microbial growth in the entire building. But water leakage resulting in dampness can be seen in the building and damp conditions inside a building might cause microbial growth if not taken care of early.

IV. Thermal comfort

The building administrator claims, the temperature in the building is moderate and that it doesn't get hot. He also added being located near the mountainous area of Megenagna, adds to the chiller air quality of the building. In order to study the indoor temperature building occupants were asked about the temperature during hot and cold weathers, their reply is as follows.

During hot weather, 25% said it is cold, 37.5% answered it is normal while the remaining 37.5% said the indoor temperature is hot. During cold weather, 12.5% said it is very cold, 25% said it is cold and the majority of 54.2% answered it is normal whereas the remaining 8.3% replied the indoor temperature is hot.

V. Acoustic and views

In the interview the building manger stated that, the only noise disturbance is from the busy street outside and that the interior acoustic isn't a problem. The building offers a view to all four sides without restrictions.

Concerning acoustics, 4.17% said it is very noisy, 20.8% answered noisy, 33.3% replied the building has normal noise level while 25% and 16.6% answered quiet and very quiet respectively.

VI. Efficiency and health problems

There are no recorded health issues arising from the indoor air quality of the building. Concerning their productivity and efficiency, 62.5% of the building occupants responded that it remains the same while 37.5% answered it decreases throughout the day.

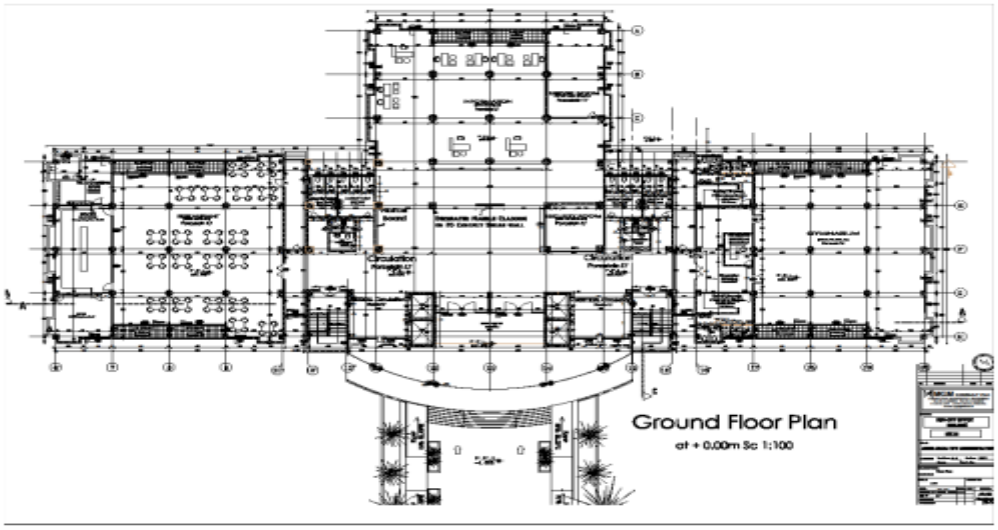

Figure 15 NSL administration office building floor plan

(Source: from NSL sub city administration, 2024)

4.4.5 Elgel Hotel

4.4.5.1 Building description

Elgel hotel is located at Mechanisa Kore near forest hill residence, the road to Bisrate Gebriel which is -2b+G+ 6+ T four star hotels. The hotel include swimming pool with skylight roof, gymnasium, bar, meeting hall at terrace floor and Elgel garden at the back of the hotel. Even if the hotel is four star no sufficient and standard parking area.

Figure 16: Elgel hotel garden area

(Source: captured by the researcher, 2024)

4.4.5.2 Sustainable Site

I. Site location and transportation

The building is located in Nifas Silk Lafto, Mekanisa Kore the road to Sarbet. No taxi and bus station near the building since the building on the structural road.

II. Site design and management

a.Open space and Green areas: there are open and green spaces at the back of the building.

b.Pavement: pavements seen are the cobble stoned pedestrian walkways and ceramic walk way inside the Elgel garden.

c. Storm water management: rainwater from the roof passes through the downpipes to the main drainage line without being harvested or reused.

d. Green roof: the building doesn't have a green roof and the roof is also not suitable to accommodate one.

e. Green wall; there are potted plants in all the balconies and the back of the Hotel.

4.4.6 Peace building

4.4.6.1 Building description

Peace building is located in Nifas silk lafto Sub-city, Woreda 02 around Mekanisa near to sido building. The building stands on 650 m2 plot and has six stories with a mezzanine at the top and one basement. The entire building is used for offices of different companies including Central bank of Ethiopia; Mekanisa.The building has a slightly slanted North South orientation.

4.4.6.2 Sustainable Site

I. Site location and transportation

The building is located in nifas silk lafto, mekanisa the road to Mexico. There are taxi routes passing through the road adjacent to the building, taxi stations are available within a walking distance.

Taxis and private cars are mostly used as a means of transportation by employees of the building. Nothing that encourages other methods of transportation such as bicycle can be seen.

II. Site design and management

a. Open space and Green areas: there are no open and green spaces surrounding the building. b. Pavement: as mentioned above the buildings footprint lies on the whole plot so the only pavements seen are the cobble stoned pedestrian walkways.

c. Storm water management: rainwater from the roof passes through the downpipes to the main drainage line without being harvested or reused.

d. Green roof: the building doesn't have a green roof and the roof is also not suitable to accommodate one. There are potted plants in all the balconies and around the entrance.

e.Green wall; Potted planted are seen on the balconies of peace buildings but only the building that is being studied has a green wall.

4.4.6.3 Water Efficiency

Tap water is the main source of water for toilets, cleaning and other uses in the building. No water efficient fixtures are used and nothing is done to recycle or reuse rainwater and waste water.

4.4.6.4. Energy Efficiency and Atmosphere

I. Energy Consumption

The main source of energy is electricity and the items used the most include computers and light bulbs. Air conditioners and fans are utilized at all. Artificial lighting is used in almost every room of the building during the day. While some rooms require artificial lighting other rooms with sufficient daylight also use light bulbs perhaps due to negligence.

II. Energy efficient equipment and renewable energy

Fluorescent and LED lights make up the majority of the light bulbs used in the building. Renewable energy is not utilized at all.

4.4.6.5. Material and Resources

I. Type of materials Roof: corrugated iron sheet is the main material used for the roof. Walls: the interior partition walls differ from office to office; it includes aluminum, wood and glass. The exterior walls are made of HCB walls with stone finishing.

Copper is used for the door and windows. Floor: for the circulation granite is used while for the offices different materials such as ceramic and plastic tiles are the most common.

II. Waste management

Waste is collected from each office on a daily basis and dumped at the back of the building. Recycling and reusing waste is a new notion in the building and nothing is done to apply this concept.

4.4.6.6 Indoor environmental quality

I. Lighting

As one enter, it is hard not to notice large windows that extend the length of two floors.

These windows would have let in ample daylight but because of the afternoon sun, most of the occupants use curtains which are closed all day long somewhat restricting natural

lighting. In addition, the partitions are done is away that reduces access to natural lighting. Glass block windows are used for the staircases and a dormer window is used on the pitched roof of the building to allow natural lighting.

The surveyed occupants in regards to lighting answered as follows, 28% said their room is dark while 44% answered it is normal and the remaining 28% replied it is bright.

II. Ventilation

The building doesn't use any air conditioners or fans and is naturally ventilated. The only method used by the occupants to cool themselves is opening windows. There is very high movement in the first and second floors. On the subject of air quality, 20% said it is fresh and clean, 32% replied the air quality is normal while the remaining 48% of the occupants were split three ways equally answering the air quality is stuffy, variable in a good way and variable in a bad way.

III. Dampness and microbial growth

The interviewed building manager and all occupants claim there is no dampness and microbial growth and none were seen during site visit as well.

IV. Thermal comfort

The combination of directly entering harsh sun, high movement of people, turned on light bulbs and closed window creates a warmer temperature in the first and second floors.

On the topic of temperature during hot weather, 16% replied it is very cold, 32% said it gets cold while another 32% answered it is normal and the remaining 20% said it is hot. When asked during cold weather 28% said it is very cold, 32% responded it is cold while the remaining 40% were split equally saying it is normal and hot.

V. Acoustic and views

According to the building manager, noise is not a problem especially in the upper floors however in the first and second floor where there is high activity, noise pollution exists.

The building offers view to the outside surrounding through its large window without restriction.

VI. Efficiency and health problems

All of the questioned occupants replied that they have never encountered health problems due to the indoor quality. As regards to productivity and efficiency, 34% said their productivity decreases due to the indoor quality while the majority of 64% responded it remains the same.

4.5 Green building practices in the study area.

According to the data collected from the respondents in the study area the practice of green building is summarized in table 12.

Table 12: Green building practices in the study area .

No.	Practice of GB	Strongly agree	agree	neutral	Disagree	Strongly disagree
1	Green roofing	64%	30%	2%	3%	1%
2	Green wall	64%	26%	4%	4%	2%
3	sustainable materials,	40%	54%	4%	1%	1%
4	efficient energy system	32%	60%	2%	5%	1%

(Source: from questionnaire conducted by researcher)

As shown in table 12 above the majority of the respondents(64%) agreed as green roofing practice has greater contribution to the study area, in particular and to the city Addis Ababa in general. However, it is only 1% of the respondents replied as green roofing has no contribution to the study. The responses of the respondents implied that if the practices of green roofing is practiced at the study area the local community will be willing to practice it accordingly. Similarly, the respondents towards green walling have good opinions towards the use of green walling as the majority of the respondents (64%) had positive opinion to use green walling implying that if the concerned bodies works towards enhancing the concept of green walling their applications will bring positive results to the study area and Addis Ababa as a whole.

As depicted in Table 12, the opinions of the respondents about the contribution of green building and walling practices towards the sustainable use of materials and efficient use of energy showed positive agreement. This implies that the respondents have good knowledge towards the contribution of green walling and roofing.

From the respondents opinions (responses) it can be understood that they have good knowledge about green roofing and practices together their contribution. This shows that if the responsible government body or office wants to promote green roofing and walling there will be good acceptance from the local community as the respondents had strong awareness to green roofing and walling. This could also help to establish policies to implement green roofing and walling through building permit practices.

4.6 Challenges in the application of green building in the study area

The opinions of the respondents towards the challenges of the application of green buildings in the study area are summarized in Table 13.

Table 13: Challenges in the application of building in the study area.

No.	Challenges of GB	Strongly agree	Agree	Neutral	disagree	Strongly disagree
1	inadequate Urban planning	59%	35%	2%	3%	1%
2	Higher costs for green construction practices and materials	58%	32%	4%	4%	2%
3	Technical difficulty during the construction process	50%	44%	4%	1%	1%
4	Unfamiliarity with green technologies	72%	20%	2%	5%	1%
5	Building codes and incentive policies	53%	40%	4.5%	1.5%	1%

(Source: from questionnaire conducted by researcher)

As the data collected from the respondents showed (Table 13) unfamiliarity with green technologies, inadequate Urban planning and Higher costs for green construction practices and materials are the major challenges in implementing green building practices. About 72%,59% and 58% of the respondents strongly agree as unfamiliarity with green technologies, inadequate Urban planning and Higher costs for green

construction practices and materials respectively are the major challenges in implementing the practices of green building.

This implies that due attentions should be given from the concerned sub-city offices which works about greening and related issues. From this Table (Table 13) the majority of the respondents (ranging from 53% to 72%) identified the pre-identified and presented challenges by the researcher and to them.

This shows that the respondents have good knowledge about green building; the problem is the inadequate promotion from the responsible body/office side. Therefore, if the responsible body gives due attention to the above five challenges the local community will implement the green building accordingly.

Moreover, the responsible government office need to promote green building practices through compensations, for example presenting plants for free or with minimal cost and providing relevant trainings and technical supports.

This will help to reverse the high cost of greening, and absence of educational training for clients, consultants and contractors and lack of well urban planning on the study area.

4.7 Strategic tools for the application of green building in the study area

The practices of green building and challenges to the application of green buildings are well identified from the respondents under sub-sections 4.5 and 4.6. In accordance with these, the following strategies as suggested by the respondents and comprehended by the researcher are presented in Table 14.

Table 14: Strategic tools for the application of building in the study area

No.	Strategic tools	Strongly agree	agree	neutral	disagree	Strongly disagree
1	Investment in Green Building related research including cost-benefit	58%	34%	2%	5%	1%
2	Financial incentives	56%	32%	4%	5%	3%
3	Education and training focusing on green buildings	60%	33%	4%	1%	2%
4	Improved involvement by local governments	42%	38%	12%	5%	3%
5	Public Awareness campaign	52%	30%	4%	10%	4%

(Source: from questionnaire conducted by researcher)

As shown in table 14, the strategies assumed to be implementable at the study area and city level includes education and training focusing on green buildings, Investment in Green Building related research including cost-benefit, Financial incentives, Public Awareness campaign and Improved involvement by local governments.

This implies that appropriate trainings about green building and related issues specific to the study area should be given. It will be good if the training is tailored based on building types and with building permits as this will enhance the concept of green building.

Furthermore, the government shall also provide some incentives like lifting some taxes or other rewards to promote green building practices. This shows that if the responsible body or government dedicated to apply the aforementioned strategies positive results will be achieved.

FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on the finding of the study, the conclusion is drawn as follows.

The opinions of the respondents towards the practices of green building in the study area were found good. Because the majority of the respondents agreed as the practices together their benefits have positive contributions towards green building practices.

Thus, if the responsible body works strongly to raise the awareness of the local community implementing green building will achieve high performance.

Some of the challenges which got very strong and strong response towards the application of green building includes unfamiliarity with green building technologies, inadequate Urban planning, Higher costs for green construction practices and materials and difficulty during the construction process.

This shows that if the responsible body works strongly against them implementing green building will get higher acceptance by the local community.

Based on the identified practices of green building and challenges in application of green building in the study area, strategies are developed which could help promote green building practices including appropriate training focusing on green buildings, Investment in Green Building related research including cost-benefit, Financial incentives, Public Awareness campaign and Improved involvement by local governments.

In the end, this study concluded that it is essential to change the construction from conventional to green building technologies by availing reliable green market suppliers, availing similar projects or demonstration projects of green buildings to make the technology familiar with consultants, contractors and clients has a paramount importance and also Formulating strategies, building codes and incentive policies is the turning point for introduction and development of the technology.

5.2 Recommendations

Based on the findings of the study, the following recommendations are forwarded:

It is found necessary for the government to review all technology and construction related Universities and institutes curriculum in order to produce technical experts on green building, government's framing a bold strategy to erase negative attitudes from stakeholders and familiarizing with green building technologies by providing abundant green building information is essential, in Ethiopian building design and construction industry, accommodating various uncertainties is vital in the future so that it will not be out - of - date. This includes buildings should incorporate the features of green building principles and the government is also expected to adopt other county's best practices, standards, formulate Green Building codes and regulations and evaluation standards, new policies on green construction practices emphasis must be employed, revised and enforced on the construction industry. In addition, there must be a dialogue between the Government and all stakeholders in the construction sector in order to adhere and collect the professionals 'feedback on the laws and legislations.

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Annexes

Addis College

Department of Construction Technology and Management

Dear sir/Madam

My name is Ezekiel Mihiret Haile; I am Master's Degree student at Addis College, under the department of Construction technology and Management. The purpose of this questionnaire is to gather information on the practice of green building concept, as part of my master's degree research entitled "The Challenges of Application of Green Building in Ethiopia, the Case of Nifas silk lafto sub-city".

This questionnaire has two parts: the first part contains demographic related questions of the respondent; the second part contains close-ended questions related to the above mentioned research topic. The information you will provide is crucial to this research. Thus, I would kindly request you to fill the questioner honestly and carefully. The information which will be collected from you will be applied only for academic purpose. It will be kept confidential and will not be passed to any third part. Thus, no names are required to be appeared and anonymity is guaranteed. Your clear and accurate information helps me to achieve the objectives of the study.

Thank you very much for your time and patience to fill this questionnaire!

For further information, you can contact me through my address:

Ezekiel Mihiret Haile

Email: ezekielmihiret19@gmail.com

Mobile Number: +251911969761

Part one: Background or Personal Information

Direction: please indicate your answer by ticking in the box that corresponds to your answer or write the correct answer on the given blank spaces.

1. Please indicate your gender.
   □ Male□ Female
2. Please indicate your age:
   □Below 25 25 to 34 □35 to 44 □45 to 54 □55 to 60 □Above 60

3. Please indicate your educational background.
   □ High school □ Certificate □ Diploma Bachelor degree □ Master's degree □ PhD
4. Please indicate your total work experience, in years.
   □Below 3 □3 to 5 6 to 10 □11 to 15 □Above 15

5. Please indicate your experience (in years) as consulting office Manager or Building Permit Team Leader or Building Supervision Team leader
   □Below 3□ 3 to 5 □ 6 to 10 □ 11 to 15 □ above 15

6. Kindly indicate the responsibility that describes your role in the above Position.
   □ Clients (Owner of the buildings) □Contractor □Consultant □Sub-city building permission and control office staff

Part two: Close Ended Questioners

Rate the given issues (practices, awareness, challenges and strategies) on green building, by ticking in the space provided under the rating scales, which are (1) Strongly disagree, (2) Disagree, (3) Neutral, (4) Agree and (5) Strongly agree.

1. Building construction practices and awareness about application of green building (GB) principles

No	Description	1	2	3	4	5
1	Do you expect awareness is created about green building application in your profession					
2	Do you agree green building is better than conventional building?					
3	Do you practice the green building principles in your day-to-day activities?					
4	Do you think stakeholders are knowledgeable and feel they have adequate and right information, to adopt GB practices and technologies?					
5	Are there short-term trainings about green building practices in your institution?					
6	Do you include the green building principles in your architectural, structural, electrical and sanitary designs?					
7	During design comments, are the green building principles included as the main criteria to give a comment in your office?					
8	Do architects advise you to use green materials in building or constructing houses?					
9	Have you ever been trained about green building materials in your field of work?					
10	Are there scarcities in Green Building information and issues such as research and education, awareness, familiarity, knowledge, and technical expertise?					
11	There are demonstration projects of Green Building technologies.					
12	Knowledge and awareness is created about Green Building technologies and their benefits.					

Write additional information related to the above issues, if any----------

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2. From the table below please Rank in a scale of 1 – 5 the factors you feel largely challenge the application of Green Building Concepts in Addis Ababa specially Nifas silk lafto sub city.

No	Description	1	2	3	4	5
1	Do you think economic factor hinder the application of green building?					
2	Clients resist the application of green building principles due to cost of construction.					
3	Consultants focus only on the conventional building designs because of ease of designing.					
4	Contractors want to construct the usual or conventional compared to green building.					
5	Government did not give due focus on the application of green building principles.					
6	The high cost premium of green building materials compared to conventional made them non preferable.					
7	Stakeholders' (clients/owners and customers/ tenants) attitude, lifestyle, behavior, and culture influence the application of Green Building.					
8	There is unwillingness of clients to change from the use of traditional ways of construction in the Green Building market.					
9	There is familiarity of green Building Technologies in Ethiopia.					
10	Implementation of Green Building technologies is time consuming and causes a project delay.					
11	There are financing schemes (micro financing institutions and bank loans) for Green building technology.					
12	There is lack of interest and market demand.					

Write additional information related to the above issues, if any----------

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3. What are the suitable strategies for application and implementation of green building practice?

No	Description	1	2	3	4	5
1	Do you think Ethiopian government has given due focused on planning a strategy for green building practice?					
2	Ethiopia has green building strategy for implementation.					
3	The Ethiopian building code consist the green building principles.					
4	When reviewing architectural and structural designs, did the building code require reviewing in accordance with the green building principles?					
5	The government encourages green building aspects with various incentive mechanisms that may include tax break for green building materials.					
6	The Ethiopian government formulated green building codes and regulations/legislations, and evaluation standards.					
7	Ethiopian government provides financial and non-financial incentives to encourage the green Building aspects.					
8	The government acts as an advocator or promoter of the sector or paved the way for the promotion of the Green building Technologies.					
9	There is adapted global best practice, and singled out green growth philosophy which contributed for considerable sustainable benefits.					
10	The government provided systematic Planning, analysis, implementation and monitoring and comprehensive assistance for the industry's major stakeholders.					
11	There are experts or skilled labors on Green Building technologies in Ethiopia to draft a bold strategy for the technology.					
12	Sufficient green building rating system and labeling programs are available in Ethiopia.					

Write additional information related to the above issues, if any----------
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"Thanks for your time!"