EXAMINING THE SUSTAINABILITY OF GREEN BUILDING MATERIALS AND TECHNOLOGIES IN LUSAKA DISTRICT

BY

CHIPO MOONGA

A dissertation submitted to the University of Zambia in partial fulfillment of the requirements for the award of Masters of Education in Environmental Education.

THE UNIVERSITY OF ZAMBIA

LUSAKA

2020

DECLARATION

I, **ChipoMoonga**, do hereby declare that the dissertation submitted is my own work and it has not previously been submitted for any degree, diploma or any other qualification at the University of Zambia or any other University.

Signed: …….. Date: ……..

CERTIFICATE OF APPROVAL

This dissertation by Chipo Moonga is approved as a partial fulfillment of the requirements for the award of the Master of Education in Environmental Education by the University of Zambia.

Examiner 1	Signature	Date
……..	……	…….
Examiner 2	Signature	Date
…….	…….	…….
Examiner 3	Signature	Date
……..	…….	…….
Chairperson/ Board of examiners	Signature	Date
……..	…….	…….
Supervisor	Signature	Date
……	…….	…….

COPYRIGHT

ABSTRACT

Striving for a greener, healthier and more sustainable environment through green buildings has become a growing trend. In Africa, a number of countries have formed councils responsible for promoting green buildings. Zambia also formed the Zambia Green Building Association to look into the affairs of green construction. A green building is one which is built in a manner that least harms the environment. A building with green building materials and technologies is intended to promote resource use, water and energy efficiency as well as occupant's well-being. The National Policy on Environment places emphasis on the importance of Environmental Education in solving environmental problems. Environmental education is very vital in examining of green building as it enhances sustainability learning.

The purpose of the study was to examine the sustainability of green building materials and technologies used to construct selected buildings in Lusaka District in order to determine how friendly they could be to the environment. The objectives of this study were to examine the benefits of the green building materials and technologies in the promotion of environmental sustainability, determine prospects brought by green building and materials and technologies in promoting a green economy, investigate the perceptions of various stakeholders on green building materials and technologies and Propose a sustainability learning guide in enhancing green building materials and technologies in the emerging green economy.

The research design used was a nested case study. The study was conducted from Foxdale court, Levy Junction, Thornpark construction school, woodlands B primary school extension and Citi bank considering that they are known to be green buildings. Homogeneous purposive sampling was used as a sampling technique. The sample size was 25 which consisted of 10 occupants of green buildings and 15 stakeholders. Data collection tools used were semi structured interview guide, observation guide and semi structured interviews. The findings revealed that green building materials and technologies had great value to the environment as they enhance efficient use of water, energy and natural resources. Further, green building materials and technologies have economic benefits like massive savings from the efficient use of water, energy, natural resources as well as the use of local labor. Local people benefit in terms of jobs, for instance, growing of recycling companies. Other than that waste sold to recycling companies becomes a money generating venture. The findings also revealed that80 percent of stakeholders viewed green building materials and technologies as being beneficial to the environment while 20 percent indicated that they were not completely green as there was no proper inspection to minimize pollution during the production of these green building materials. The findings further revealed that some green building materials and technologies need to be improved in order for them to be considered more environmentally friendly. A sustainability learning programme was created from the above mentioned findings to enhance green building materials and technologies in the emerging green economy. It can be concluded that green buildings materials and technologies are vital in enhancing environmental sustainability as they have promoted water and energy efficiency, promoted wellbeing of humans and reduced resource depletion. The study recommends that there should be more sensitizations on green building materials and technologies as it was realized that very few people were aware about the concept.

Key words: *Green building materials and technologies and environmental sustainability*

DEDICATION

This research dissertation is dedicated to my husband Mr. Alfred Chitalu, my mother and father Mr. and Mrs. Moonga, my daughter Abigail Chitalu and my brothers Miracle Moonga, Luyando Moonga and Mukonka Moonga. They have been very supportive throughout my studies.

ACKNOWLEDGEMENTS

This study was made possible by various people from the university of Zambia, as well as respondents from the five green buildings namely Citibank, Thornpark construction school, Foxdale Court, Woodlands B primary school and Levy Junction Mail. Many thanks to my lectures who put in a lot of efforts to shape my work and these are, Dr .L. Mweemba and Mr. M. Muchanga.

My colleagues in the Environmental Education programme have equally been very helpful. These include Mr. T. C. Kabesha, Ms. S. Masendeke, Mr. S. Wambinji, Ms. M. Sankando, Mr. Mundia, Mrs. M. Kakumbi, Mr. Kafula, Mrs. M. Mpheza, Mrs. S. Mwanza, Ms. and Mr. J. Banda. Their help was invaluable.

TABLE OF CONTENTS

DECLARATION ..... **i**
CERTIFICATE OF APPROVAL ..... **ii**
COPYRIGHT ..... **iii**
ABSTRACT ..... **iv**
DEDICATION ..... **v**
ACKNOWLEDGEMENTS ..... **vi**
LIST OF FIGURES ..... **x**
LIST OF TABLES ..... **xi**
LIST OF APPENDICES ..... **xii**
ABBREVIATIONS AND ACRONYMS USED ..... **xiii**

CHAPTER ONE: INTRODUCTION **1**
1.1 Introduction 1
1.2 Problem statement 3
1.3 Purpose of Study 4
1.4 Specific Objectives 4
1.4.1. Specific Research Questions 5
1.5 Significance of the study 5
1.6 Thesis statement 6
1.7 Operational definition of concepts 6
1.8 Conceptual framework 7
1.9 Theoretical framework 8

CHAPTER TWO: LITERATURE REVIEW **10**
2.1. Introduction 10
2.2. Global perspective case studies on green building technologies 10
2.3 African context of green building and technologies 14
2.4 Zambian scenario on green building materials and technologies 19
2.5 Major Gaps Identified in Literature Review 20

CHAPTER THREE: METHODOLOGY 22
3.1 Introduction 22
3.2 Physical characteristics 22
3.2.1 Location of study area 22
3.3. Background of Targeted Entities 23
3.4 Philosophical Paradigm/Orientation 24
3.5 Research Design 24
3.6 Target Population 24
3.7 Selection criteria 25
3.8. Sample 25
3.9. Methods of data collection 26
3.9.1. Primary data collection 26
3.9.2. Secondary data 27
3.10. Ethical considerations 27
3.11. Data validation and Consistency Check 28
3.12. Data Analysis 28
3.13. Limitations 29
3.14 Conclusion 30

CHAPTER FOUR: PRESENTATION OF FINDINGS 31
4.1. Introduction 31
4.2. Examine the benefits of green building materials and technologies in the promotion of environmental sustainability 31
4.2.1. Benefits of green buildings 31
4.2.2. Green building technologies/materials that need improvements 50
4.2. Determine prospects brought by green building materials and technologies in promoting a green economy 53
4.2.1. Foxdale Court 54
4.2.2. Levy Junction 55
4.2.3. Woodlands B 56

4.2.4. ThornPark Construction School 57
4.2.5. Citi Bank 58
4.3. To investigate stakeholder's perceptions on green building materials and technologies. 58
4.4. To come up with a sustainability learning guide in enhancing green building materials and technologies in the growing green economy. 61
4.5 Conclusion 63

CHAPTER FIVE: DISCUSSION OF FINDINGS 64
5.1 Introduction 64
5.2 Discussion of findings in relation to other research findings 64
5.3. Conclusion 68

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS 69
6.1. Conclusions 69
6.2. Recommendations 70

REFERENCES 72
APPENDICES 77

LIST OF FIGURES

Figure 1.1: Conceptual Framework 8

Figure 5.2: Rain Water Harvesting System 33

Figure 5.3: Glazing at Woodlands B primary allowing adequate natural light. 39

Figure 5.4: Bins placed in all rooms for Waste Separation 42

Figure 5.5: Show Compartments Holding Separated Waste 42

Figure 5.6: Food Waste Decomposition Compartments 43

Figure 5.7: Space in between the roof and ceiling which attracts Birds 50

Figure 5.8: Broken and Cracked Lime Plastering 51

Figure 5.9: Pattern of responses from stakeholders 58

Figure 5.10: Sustainability Learning guide 62

LIST OF TABLES

Table 4.1: Primary Data Collection Techniques 27

Table 5.2: Water efficiency technologies 32

Table 5.3: Energy efficiency technologies 36

Table 5.4: Waste management initiatives 41

Table 5.5: Local non-harmful building materials 44

Table 5.6: Promotion of occupant's wellbeing 47

Table 5.7: Foxdale Court 54

Table 5.8: Levy Junction 55

Table 5.9: Woodlands B Primary School 56

Table 5.10: Thornpark Construction School 57

Table 5.11: Citi Bank 57

Table 5.12: Stakeholder's perceptions on green building materials and technologies 59

LIST OF APPENDICES

Appendix 1: Consent Letter 77
Appendix 2: A semi structured interview guide 79

ABBREVIATIONS AND ACRONYMS USED

CBCSA	South African Green Building Council
CBU	Copperbelt University
COP	Conference of Parties
EIA	Environmental Impact Assessment
GHG	Green House Gases
GPS	Global Positioning System
HDI	Human Discomfort Index
HEPA	High Efficiency Particulate Air
ILO	International Labour Organisation
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
MIHD	Ministry of Infrastructure Housing and Development
MSMEs	Macro Small and Medium Enterprises
NCC	National Council for Construction
NPE	National Policy on Education
SBE	School of the Built Environment
UNEP	United Nations Environment Programme
UNZA	University of Zambia
USGBC	United States Green Building Council
WGBC	World Green Building Council

ZGBA	Zambia Green Building Association
ZGJP	Zambia Green Jobs Programme

CHAPTER ONE: INTRODUCTION

1.1 Introduction

The strife for a greener environment continues to be an alternative to mitigate many negative environmental impacts experienced today. One of the initiatives to mitigate negative environmental impacts is the promotion of green building materials and technologies. Conventional buildings are known to overlook the aspects of water and energy efficiency, good indoor air quality and resource conversation.

The Leadership in Energy and Design (2009) reveals that in the United States alone, conventional buildings account for 72% of electricity consumption and most of the electricity is generated by coal. That alone entails high levels of carbon dioxide emissions in the atmosphere. American conventional buildings also account for 39% of energy use, 38% of all carbon dioxide emissions, 40% of raw materials use, 30% of waste output which is equivalent to 136 million tons annually and 14% of portable water consumption. The United States Green Building Council (2009) however acknowledges that green buildings can reduce energy use by 24-50%, Carbon Dioxide by 33-39%, Water use by 40% and Solid Waste by 70%.

In December, 2015, world leaders gathered at 21st Conference of Parties (COP21) and adopted the Paris Agreement to limit global warming to 2 degrees Celsius. It is at this conference where, world leaders recognized that green building must and will be part of the solution to climate change. The World Green Building Council (WGBC) has networked with various green building councils from different countries in the green building movement which has been transformative. From 2015-2016, the WGBC has spearheaded the journey to Net Zero emission buildings in 10 countries and acknowledges that green buildings can improve health and wellbeing. Through the climate finance leveraged by the World GBC to Global South cities, the cities have developed green building policies (WGBC, 2015).

In Africa, a number of countries have formed councils responsible for promoting green buildings. These include Kenya, Namibia, South Africa, Tanzania and Zambia to mention a few. In South Africa, a case study was conducted by the South Africa Green Building Council (GBCSA). This was done in an area called Cator Manor in Durban, a low cost sector where the

Ethekwini Municipality built convectional buildings in 2006. Residents in the stated area experienced extreme temperatures, poor ventilation due to design of houses leading to respiratory diseases, reliance on fuels such as coal and wood for heating, reliance on municipal water and high energy consuming bulbs. The South African Government realized the importance of sustainable housing. GBCSA in collaboration with the British High Commission and WGBC retrofitted 30 houses. The Green building features which were added to these houses included solar installation, solar geysers, energy saving bulbs, rain water harvesting systems, insulation of roof (to control indoor temperatures), storm water upgrade and provision of heat retention/insulation cookers. In addition, the South African National Building Regulations now requires that environmental sustainability measures be included in all new refurbishments and designs starting with energy efficiency (GBCSA, 2012).

Zambia has also been victim of such environmental challenges. Most of the buildings in Zambia are conventional. As a result, many areas of the country have experienced power and water shortages, poor indoor air quality, diseases due to poor waste management to mention a few. In terms of energy, Zambia has been experiencing massive load shedding for over four years now. Hydro power is the main energy source of electricity in Zambia after wood fuel, contributing about 10% to national electricity supply. Water supply problems also continue to affect most Zambians as most buildings are conventional and do not offer alternative sources of water apart from the municipal water. In Lusaka district, areas like Misisi and John Laing and other high density areas have experienced serious water shortages and waste management remains a challenge in areas like Kalingalinga. Other than that, the designs of houses in most areas in Lusaka do not allow enough ventilation (ERB, 2016).

Sustainable Development Goal 11 aims at making cities inclusive, safe, resilient and sustainable. Green building materials and technologies in different countries have become an alternative to solve the aforementioned environmental problems. In green buildings, waste is managed by recycling, reusing, reducing and compositing. Water efficiency is maximized by using technologies like rain water harvesting systems, low flow plumbing fixtures, waster catchment systems, drip irrigation and applying sensor to control the flow of water. Green buildings have technologies that allow the use of energy efficiently like the use of energy saving bulbs, motion

sensors in the lighting systems and the use of cleaner sources of energy like solar and biogas (ZGJP, 2013).

In Lusaka district, some buildings have used green building materials and technologies. However, this study was focused on selected green buildings namely, Foxdale Court, Levy Junction, City bank, Woodlands B Primary school extension and Thornpark construction school. The study examined the sustainability of the green building materials and technologies used in these buildings.The National Policy on Environment (NPE) (2007) section 5.3 places emphasis on the importance of Environmental Education in solving environmental problems. Environmental education is very vital in examining the sustainability of green building as it enhances sustainability learning.

1.2 Problem statement

Zambia has been a signatory to many international agreements, one of them being Sustainable Development Goals (SDGs). These are meant to shape the management of the environment in the country. For instance, SDG number 9 is centered on building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation. SDG number 11 talks about making cities and human settlements inclusive, safe, resilient and sustainable. The above mentioned SDGs aim to shape the construction industry and convert it into a more environmentally sustainable one. Further, SDG number 13 puts emphasis on taking urgent action to combat climate change and its impacts. The construction industry being one of those that greatly contributes to global warming and climate change must have building technologies and materials which lessen climate change and its impact. Furthermore, SDG 7 aims at Ensuring access to affordable, reliable, sustainable and modern energy for all while SDG 6 aims at ensuring availability and sustainable management of water and sanitation for all. These SDGs should influence the use of energy and water efficiency technologies and materials in the construction industry (UN, 2019).

Despite being part of international agreements, Zambia continues to have a number of unsustainable practices in most buildings. In terms of energy, the load shedding is part of evidence that Zambia is reliant on hydroelectricity which cannot meet the demands. Water supply is another problem evident in many buildings. While some areas have abundant water

supply, others have little or no water at all. People have to cover long distances to access water. The main source of water is municipal water supply. Other than that, most buildings in Zambia have very poor waste management systems resulting in an unpleasant situation. If hydroelectricity continues being the main source of energy in Zambia, there is likely to be worse load shedding which will affect the productivity of many industries. If municipal water supply also remains the main source of water, there is likely to be worse unsanitary condition as a result of inadequate water supply. Poor waste management in buildings also has potential to cause disease outbreaks (EU, 2017).

In Lusaka district, there are a few buildings which have been built in a manner that promotes energy and water efficiency, resource use efficiency as well as good waste management systems. The essence of this study was to examine these green buildings in order to know the performance of features that were incorporated in the buildings and generally know how they benefit the environment (Global water partnership, 2014).

1.3 Purpose of Study

The purpose of the study was to examine the sustainability of green building materials and technologies used to construct selected buildings in Lusaka District and determine how friendly they may be to the environment.

1.4 Specific Objectives

Specific objectives of the study were to:

i) examine the benefit of the green building materials and technologies in the promotion of environmental sustainability,
ii) determine prospects brought by green building materials and technologies in promoting green economy
iii) investigate the perceptions of various stakeholders on green building materials and technologies,
iv) propose a sustainability learning guide in enhancing green building materials and technologies in the emerging green economy

1.4.1. Specific Research Questions

The study was guided by the following research questions

i) What are the benefits of green building materials and technologies in enhancing environmental sustainability?

ii) What are the prospects of green building materials and technologies in enhancing a green economy?

iii) What are stakeholder's perceptions on green building materials and technologies?

iv) What learning guide should be introduced from the examination of green building materials and technologies?

1.5 Significance of the study

This study is of great relevance as it provides in-depth information on how sustainable green building materials and technologies are compared to conventional building materials and technologies. Knowing the levels of sustainability of green building materials and technologies brings out the gaps that exist and how they can be worked on. This study also brings out environmental benefits of green building materials which could help in facilitating the implementation of green building policies in Zambia.

The study can also facilitate the fulfillment of Sustainable Development Goal 11 which aims at making cities inclusive, safe, resilient and sustainable. It widens the knowledge and information on green construction materials and technologies which can be added to the Zambian literature. This study can also be a source of information to the Technical Research Centre of Finland which works with the Zambia Green jobs Programme and Copperbelt University School of the Built Environment (CBU SBE) in formulating curriculum in construction courses. Information from this study can be used to revise the curriculum and include aspects of green building in its Degree and Diploma courses in Architecture, Quantity Surveying, Land Surveying, Town and Country Planning and Advanced Technician course in construction and Architects design (ZGJP, 2015).

The knowledge from the study can also be incorporated in some courses offered by the University of Zambia (UNZA), one of the courses being Environmental Education offered by the School of Education. Environmental education encompasses the physical, political, economic

and cultural aspects. The knowledge on sustainability of green building materials and technologies would fit in the physical and economic aspect and would mainly be based on the green economy.

The other significance is that, the promotion of green building materials and technologies largely promotes the use of local materials and labour. For instance, solar panels are a clean source of energy in buildings. Solar panels produced locally would be considered to be greener than those imported. This situation automatically promotes the creation of jobs which in turn improves the economy of the country. Other than that, green building technologies automatically lead to significant savings. For instance, the use of rain water harvesting systems which reduces dependence on municipal water supply and use of solar energy which reduces dependency on municipal power supply. Both municipal power and water is paid for by users. The savings from the green technologies would be used for other purposes. The country can also benefit from knowledge through the implementation of green building policies by the Ministry of Local Government and Housing in Collaboration with Ministry of Infrastructure Development.

1.6 Thesis statement

Environmental Education is the most effective way of assessing green building materials and technologies. This is because having in-depth knowledge in environmental issues enables one to tell the pros and cons of a particular technology on the environment. This argument was sustained throughout the study. In other words, this study being environmental related could not be carried out without environmental knowledge which can be gained from environmental education (Bernstein, 2008).

1.7 Operational definition of concepts

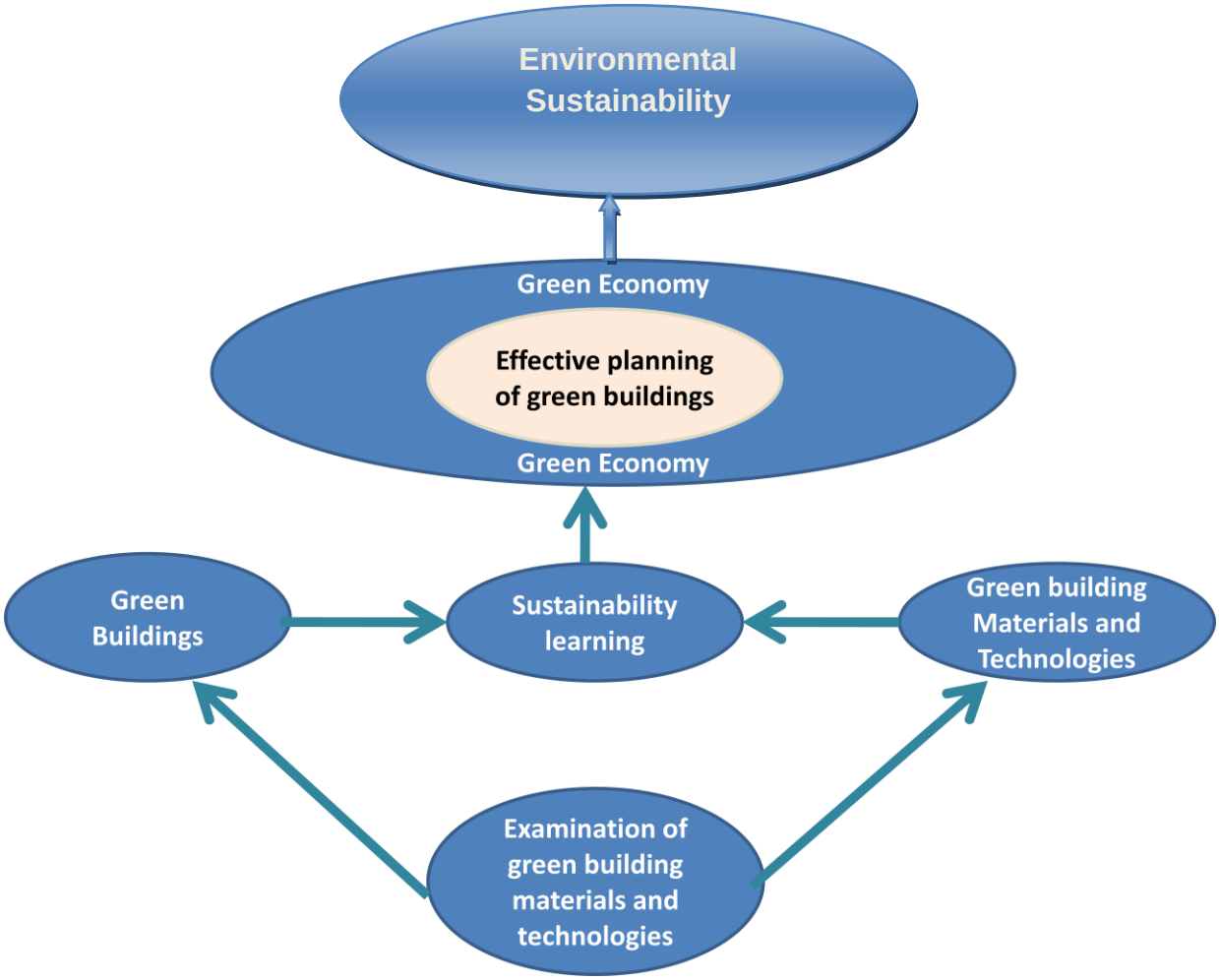
Environmental Sustainability: In this study environmental sustainability refers to the aspect of green building materials and technologies that enhance eco friendliness.

Green Building materials: These are items (Products) used in construction projects to enhance environmentally friendliness in a building. For instance, timber (renewable), rain water

	tanks (used for rain water harvesting), Low VOC paints e.t.c.
Green Building Technologies:	Building technologies that are environmentally friendly, used in such a way that least disturbs the environment.
Green Building:	A building which consists of green building materials and technologies, built in a manner that provides comfort and good health to the occupants and also lessens the harm to the environment.
Green:	The aspect of being eco-friendly (environmentally friendly).

1.8 Conceptual framework

Figure 1.1 shows the conceptual framework of this study. Generally, it shows how examination of green buildings can lead to environmental sustainability. The interpretation of the figure starting from the bottom is as follows. Examination mainly targets green building materials and technologies and this eventually leads to sustainability learning in that the outcomes of the study reveals levels of sustainability in green building materials and technologies used in Lusaka, which in turn helps to make recommendations on how best the materials and technologies can be improved. Sustainable learning from the study eventually leads to effective planning of green building materials and technologies which results in a green economy (Best, 1970).



(Best, 1970)

Figure 1.1: Conceptual Framework

1.9 Theoretical framework

The study was guided by the Ecocentrism theory. According to Kotze (2008: 23), "This theory states that ecosystems matter in their own rights and individuals have value by virtue of their contribution to the ecosystems." In connection to this study, green building materials and technologies should by all means be a way of preserving the environment so as to enable ecosystems function effectively. Considering that ecosystems matter in their own right as the theory says, green building materials and technologies should aim at preserving the environment or promoting environmental sustainability (Roux, 2009).

1.10 Conclusion

The transformation taking place in the construction industry across the world shows the realization of many to create a more sustainable environment for the present and future generation. Today, Green building materials and technologies have been embraced by many countries including Zambia. Poor waste management systems, excessive load shedding and inadequate water supply in some areas to mention a few, are part of the evidence that there is more to be done in terms of greening the construction industry in Lusaka district. Since green buildings were introduced to address these challenges, it was important to conduct this study in order to know their performance. The information in this study can be essential in formulating future green building policies as it contains both pros and cons of the materials and technologies.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

Following the many negative environmental impacts faced by the world today, many studies have been carried out so as to raise awareness on how the environment can be conserved. The building construction industry has become the source of attraction in the last decades especially where environment sustainability is concerned. The main concern has been how the building construction industry can be made sustainable. A number of publications have been made to enlighten people on how the construction industry can be made green. These publications have covered global, regional and local environmental issues. This review of literature was done using the spatial design. This implies that literature was reviewed from the global context narrowed to the Africa context and finally to the local (Zambian) context. Throughout the review of literature, comments were provided to either critique or appreciate other studies done. The final stage indicates the gaps which this study identified.

2.2. Global perspective case studies on green building technologies

A study was carried out by Smart Market to find out world green building trends in 2016. It focused on global green building growth. During the research, 1,026 survey participants from 69 countries were engaged. The *World Green Building Trends 2016 Smart Market Report*, presented by Dodge Data & Analytics and United Technologies Corporation, provides new world green building trends data to support green building development. This study demonstrated that green buildings continue to influence construction in both developed and developing economies. The findings of the study revealed that green materials and technologies were sustainable in that they offer significant operational cost savings compared to traditional buildings (Smart market, 2016).

Based on the response from respondents, the findings reviewed that, new green buildings would have 14% savings in operational costs over five year and 13% savings in operational costs over five years for green retrofit and renovation projects. Building owners also report that green building whether new or renovated command a 7% increase in asset value over traditional

buildings. Overall, the survey data indicated that global commitment to green buildings is transforming the built environment in a positive way (Ibid, 2016).

This survey was well executed. However, it would have been strengthened by physical inspections by researchers rather than relying entirely on information from the people in different countries who may give responses based on their opinions and not facts.

In a case study done by Harvard University (2017), a building was refurbished to include green features that enhance environmental sustainability. The 40 Concord Avenue Renovation project consisted of the full-gut renovation of 40 Concord Avenue, a small office building located in the Radcliffe Institute for Advanced Study's Bunting Quadrangle in Cambridge, Massachusetts. Some green building features added included energy efficiency and good indoor air quality. To promote energy efficiency, the following technologies were employed. Reduced lighting power density by 45% below the America Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) 90.1 baseline standard, high performance LEDs installed throughout the project space, installation of occupancy sensors in the lighting system and lighting controls with multiple lighting levels to provide adequate illumination for a higher indoor environment. To enhance good indoor environmental quality, an indoor Air Quality Management Plan was enacted to ensure the protection of building systems, building occupants, construction related occupants and interior building materials from air pollutants, excessive moisture exposure, and moisture damage during construction. The selection of low VOC materials was upheld. It was reported that from the above mentioned interventions, the building become very highly energy efficient and has been well known for its good indoor air quality (Harvard University, 2017).

In a study conducted by UNEP in 2012, there was a clear distinction of sustainability using comparisons between conventional buildings and green buildings. UNEP indicated that buildings account for 40% of global energy use,38% of global Green House Gas (GHG) emissions,12% of global potable water use and 40% of solid waste streams in developed countries but can achieve30-50% reduction in energy use,35% reduction in GHG emissions,40% reduction in water use and70% reduction in waste outputs through the use of green building materials and technologies (UNEP, 2012).

From the above book, it is observed that through the use of green building materials and technologies, there is a reduction in energy use, GHG emissions, potable water use and waste output. However, a gap is realized as there is no basis provided on how the percentages were arrived at.

Further, the WGBC (2017), revealed a case study done at the University of Nottingham in the UK where a wooden laboratory (Green building) was built to demonstrate some of the benefits of green building materials and technologies. It is known to be the first carbon lifecycle neutral laboratory in the UK. Materials employed in its construction were selected to have the least possible negative impact on the environment, using natural materials wherever possible and products with a large recycled content or sustainably produced to limit the initial 'carbon cost.

The WGBC (2017:2) indicates that the lab was highly environmentally sustainable because of the following features. Firstly, it is a wooden building. Three quotas of the building had timber which is a renewable resource. It also had a roof covered three quotas with solar panels and the openings were large enough to utilise natural lighting. This cuts off unsustainable use of energy. It also had a Green roof which was essential for capturing carbon from the atmosphere. And lastly, was built on a brown field. According to the Environmental Protection Agency (2002:35), "A Brownfield is defined as "A real property, the expansion, redevelopment, or reuse or which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant." In simpler terms, a Brownfield is simply land (previously developed for commercial or industrial purposes) that has possibly been compromised by something harmful. It is sustainable to construct a building on a brown field unlike using a green field which requires the destruction of a new field.

The study above is satisfactory as it demonstrates the sustainability of the green building through clean source of energy and a green roof which captures carbon (One of the most persistent greenhouse gases). It is also built on a brown field unlike a green field which requires the destruction of a natural sight.

United States Department of Energyequally conducted a case study to demonstrate how green buildings are essential in conserving the environment. This was done through the construction of the first net-zero energy affordable housing community in Hawaii, Kaupuni village which sought

to create a sustainable community. Created in close collaboration with various stakeholders, the building was said to optimize passive design and reduce energy demand by 40 per cent, with remaining energy supplied by on-site solar panels. Additionally, the development was said to promote healthy and sustainable lifestyles.

The main essence of the case study was to reach net-zero energy usage. It is revealed from this study that energy efficiency was achieved in the following ways. Each home was designed to have at least 40% lower energy consumption than the baseline, which is minimally 2006 International Energy Conservation Code (IECC) compliant. According to Jim (2013:34), "Energy efficiency is one of the most important aspects of a green building". Under this case study, houses were design in a manner that optimises natural light in interior spaces, shaded high performance glazing which reduces heat gain through windows, well insulated exterior walls and roof which reduces heat gain through exterior wall and minimizes cooling costs, high energy efficiency appliances, low volatile organic compounds finishes which provides a healthier indoor environment, aquaponics which enables homeowners to raise fish and grow vegetables for food, renewable electricity produced by sunlight hitting the roof, hot water solar panels to enhance water heating which minimizes electric bills, light colored roof which minimizes heat gain through the roof, high solar reflect index roofing which reflects and minimizes heat absorption through the roof, clothesline which reduces need to use electric clothes dryer and insulated roof which minimizes heat gain and cooling cost. Recycled building materials were also used (U.S. Department of Energy: 2012).

Another case which demonstrated the sustainability of green buildings is that which took place in January 2011 at Harvard University Campus. The university embarked on services and began the process of attaining a green building certification called Leadership in Energy and Environmental Design (LEED). The facility achieved Platinum certification, the highest rating possible within the LEED system. This was followed by major renovations in 2006. Green building features added were mainly energy efficiency technologies as well as waste reduction. Energy efficiency was improved through, Replacement of 32W T8 lamps with 25W, replacement of 24W stair sconces with 18W bulbs, replacement of 32W CFL bulbs in pendant lighting with 26W, installation of occupancy sensors in basement open office area to control lighting, implementation of programming to put computers into standby after 20 minutes of inactivity and

reduction of computer monitor brightness. This was not only beneficial environmentally but economically as savings went up to $2,672 annually. Waste management was done through separation, recycling, reusing and decomposing. This helped divert waste from landfills as well as keeping the environment clean (USGBC, 2012).

The study above clearly shows how sustainability was demonstrated through the green features that were placed in the building. The savings that were achieved as a result of the energy efficiency measures is enough evidence of sustainability. Waste management further helped create a health environment.

Siva (2017) took a different angle by trying to unveil the benefits and limitations of Singapore's sectoral innovation system in spurring energy transition in the building sector, in particular by up-scaling the use of green building technology. According to the study, tools used for data collection were questionnaire while methods were interviews. Her findings were that there were key barriers, namely, the reluctance of building users to change their habits, ineffective stakeholder collaboration and green buildings innovation support coming from the government only and that measures in place were moderately effective.

The gap noticed in the above study is the inappropriate use of data collection tools and method. The use of questionnaire to do interviews was not right. Instead, an interview guide should have been used as questionnaires are meant to be filled in by respondents.

2.3 African context of green building and technologies

In Africa, a number of studies on green buildings have been conducted in different countries. In April 2012, the South Africa Green Building Council (GBCSA) conducted a case study in Cator Manor in Durban, by retrofitting 30 houses. In these 30 houses, green building materials and technologies were added. The essence of the study was to demonstrate the range of social economic, health and environmental benefits which were possible through sustainable designs and resource efficiency interventions in low income houses. The Green building features which were added to these houses include solar installation, solar geysers, energy saving bulbs, rain water harvesting systems, and insulation of roof to naturally control indoor temperatures, storm water upgrade and provision of heat retention/insulation cookers as well as LED bulbs (GBCSA, 2012).

The research used a mixed method which had both qualitative and quantitative data. The study included both pre and post installation surveys. Meaning, the first survey was done before retrofitting and the second was done after retrofitting so that clear observations could be made on the performance of green technologies. The following were the results from the study. Energy use increased after intervention from 300kw before the installation to 600kw after installation while water consumption from municipal source reduced by 6%.It should also be noted that residents were offered an incentive of 9Kilolitre free municipal water use and the charges would only apply to those who exceeded 9Kilolitre.On the insulated ceiling the internal environment shifted from hazardous to very uncomfortable. From the findings, internal temperature reduced while humidity increased.67% respondents indicated that the insulated ceiling actually increased internal temperature and 23% indicated that their homes were cooler (Ibid, 2012).

The gaps realized from the above study are as follows. Concerning the increment in energy consumption, it could have been possible that residents of the study areas observed some savings from the green interventions and bought more electric appliances from the same savings which they could not get earlier. It is not also safe to attribute the reduction in municipal water use to the installed rain water harvesting systems because results could have been compromised by the free 9Kilolitre municipal water incentive given to residents. It is possible that the reduction in municipal water use was as a result of residents wanting to keep within the free 9Kilolitre and not necessarily because of the rainwater harvesting systems. Clear results would have been gathered without the incentive.

Phoya (2018) carried out a study to examine the nature of sustainable construction management practices implemented by contractors during construction phase for the purpose of mitigating environmental impacts in Da res Salaam Tanzania. Using purposive sampling and questionnaires, and analysing using SPSS, the findings were that, the most implemented sustainable practices in construction sites included the reuse of construction materials, separation of waste skips on sites and selection of plants which are more efficient and master switch. The study further reveals that low contractors' level of knowledge on sustainable practices, relaxed regulations and negative perception are common challenges for implementing sustainable practices in construction sites.

The study above can be said to have been well executed. The research design, data collection tools and analysis were well combined.

Christopher (2015) conducted a case study of an energy-plus residential building in South Africa, one of the first of this project type on the African continent. House Rhino combined active and passive features in a modern residential design that has been created as a living lab. Through site observation, interviews with the project team and analysis of on-site project data, the research findings indicated that an Energy-Plus building can be constructed in an African climate environment and that residential biogas generation has challenges in production and usage to make it viable. The results of the research suggested that, although the benefits of sustainable construction are well known, the ability to create viable Energy-Plus buildings using alternative construction techniques can now be proven in a warm climate environment.

A gap is noticed from the study above. It was not indicated clearly what tools were used for data collection how the data was analyzed. This makes it very difficult to judge whether the research was well conducted or not.

Further, a research (Case study) was conducted in Nigeria to find out the benefits of green architecture in Africa by Odebiyi Sunday. The Green architecture in this study was focused on saving energy, production and consumption. While buildings could be the highest carbon emitters, they could equally represent the best means of reducing negative environmental and economic impact as well as energy use. It was indicated in this study that, Environmental protective measures ensure reduction of operational energy in construction (Sunday, 2010).

From the findings of his research, green architecture is beneficial in that, protective measures safeguard as well as minimize environmental impact/hazards. Secondly, healthy in-door and outdoor environment is secured. The thermal insulation, energy saving of green buildings, green roofs and ozone pollution reduction capacities all reduced negative environmental impacts. The results also indicated that extensive use of recycled materials help conserve, restore and preserve the eco-system. Further, Green buildings' waste management ensures resources and energy efficiency. And lastly, the proximity of materials saves cost and reduces pollution by fuel burning through transportation (Ibid, 2010).

The gaps identified in the study above are that, it does not clearly state the data collection tools, sampling technique and how the analysis was done to arrive at the stated results.

Irungu (2016) did a case study in Nairobi. The essence of the research was to find out the green building practices in hospitality in order to put up a model that could be adopted by other lodges/hotels in Kenya. Data was mainly collected through interviews and sampling was purposive mainly because the main champions of green construction in Nairobi were Serena lodges and these were the targets. The findings revealed that green built lodges had the following benefits to the environment. Serena premises were dealing with greenhouse gas emissions mainly by encouraging drivers to switch off engines and encouraging tour companies to car-pool instead of having many almost empty vehicles headed to same destinations. Further, having vigorous tree planting exercises carried out within all the hotels, lodge and resorts ensured that carbon emissions were taken in by trees. To conserve energy, volcanic rocks found within the area were used in the burners for heating rooms. Apart from that, LED bulbs with light sensors were used for lighting and in some lodges, solar for heating water and cooking. Further, waste was managed by separation which was followed by recycling and reusing. Organic waste was decomposed. The various green initiatives help in preserving the environment.

The study above was well conducted. The choice of purposive sampling was the best as green building practices were mainly done by particular lodges/hotels called Serena in Nairobi. However there is one gap realized. In as much as data collection method indicated were interviews, it should also have been indicated that observations were used. The use of observations is evident in photos which were included in the findings of this research.

Slabbert (2013) conducted a case study at Stellobosch in Western Cape South Africa. The aim was to determine the application of green building practices in Stellenbosch. The first objective was to retrieve national and international literature on green building initiatives. The second objective was to discuss three case scenarios in Stellenbosch that practice green initiatives. The third objective was to design two questionnaires, one for building owners and another for architects. The findings of the study revealed that respondents find natural light and air quality to be the most important aspects in an office. Recycling is applied by 93% of respondents. Less than 10% of respondents had installed solar panels, HAVC systems, rain water harvesting or other water management systems. This study revealed that there had been an increase in the

demand for green designs. Unfortunately, building practitioners lack knowledge on green initiatives.

The study above however has a number of gaps. Firstly, the objectives are illogical because every research involves collection of information for a particular topic and also development of tools. Further, there is no proper outline of research methodology. The methodology is part of the objectives for instance, the third objective which is, to design two questionnaires is inappropriate as it is obvious for a every research to design data collection tools.

Marwa (2016) sought to study the factors hindering the adoption of sustainable design and construction (SDC) practices in Dar-es-Salaam, Tanzania. A case study using both qualitative and quantitative methods was carried out in Dar-es-Salaam. Data was obtained through expert interviews, questionnaire surveys, focus group discussions, observation, document reviews and a literature review of previous studies on the factors hindering SDC in developing countries. Findings indicated that a lack of awareness and understanding of the concept of SDC, the absence of building laws and guidelines, a lack of formal training on SDC in higher learning institutions, developer and designer mindsets and egos, perceptions of investment costs, an influx of foreign investors and lack of professional ethics are key factors hindering the adoption of SDC in urban Tanzania. The lack of knowledge of SDC among key stakeholders is a reflection of the absence of SDC concepts in the teaching curriculum in higher learning institutions.

The study above was well conducted. It is indicated that the research used a mixed method. The incorporation of different research methods like focus group discussion, document analysis, interviews and observations enhanced the authenticity of the results. For instance, while some aspects may not have been captured by observations, they may have been covered through interviews or focus group discussions.

Another study was conducted in South Africa by Windapo (2014) under the Department of Construction Economics and Management, University of Cape Town in 2014 to examine green building drivers in the South African construction industry. Amongst the drivers that were discovered in the results, environmental sustainability was one of them. The population from which the study sample was drawn consisted of seven buildings located in the Western Cape Province of South Africa. Interviews were conducted with professional team members

(Architect, Engineers mechanical, electrical, structural and quantity surveyors) who were involved in the construction of each building. A total of 15 participants were interviewed. The study was done using a multi-case study approach. A structured interview and a site visit approach were used in data collection. The data was analysed using a thematic analytical technique. The findings reveal that the key drivers of green building include rising energy costs, the industry's Green Star rating system, competitive advantages and legislation. The study also indicates that the increase in green building had little to do with ecological factors and more to do with economic factors, operational costs and stakeholder demands. Most of the respondents viewed competitive advantage and building codes, operational cost savings along with marketing potential, as major drivers of green buildings. It was clear from the findings that the drivers were more from the economic benefits than the interest in environmental sustainability (Wandipo, 2014).

There is a limitation noticed from the above mentioned sample already. Firstly, interviewing a total of only 15 respondents to generalise the results to the whole nation (South Africa) at large may not have been representative. It should however be noted that the composition of the sample was good in that it comprised of the professionals who worked on the buildings. At the same time, the occupants/tenants of these green buildings should have also been interviewed in order to find out why they preferred green buildings compared to conventional buildings.

2.4 Zambian scenario on green building materials and technologies

In Zambia, the concept of green buildings is still new and in the process of developing. In 2015 the International Labour Organisation (ILO) compiled a document entitled "Annual Impact Report Zambia, 2015." The document was mainly compiled to review the impact brought by the Zambia Green Jobs Project in Zambia. The project main objective was to enhance competitiveness and sustainable business among Macro Small and Medium Enterprises (MSMEs) in Zambia's building and construction sector. Though it sounds more to be job creation cantered, the measures put in place to achieve the green jobs are rooted in good environmental considerations. Activities carried out under the project include the formation of the Zambia Green Building Association (ZGBA) whose aim is to promote environmental sustainability in the construction industry by means of introducing sustainable and

environmentally friendly ways of constricting buildings, promotion of occupational safety and healthy, promoting sustainable forestry and conducting a range of trainings in green construction and business. The green jobs come through different skills used in green construction. For instance, if a green building is being constructed, features like rain water harvesting, solar panels, solar geyser, heat insulating ceilings and recycled building materials will all require skilled personnel. As a result, people working on such would have green jobs created for them. In other words, the more the green buildings, the more the green jobs creation. It does not end there, the green aspect is complemented by social security and occupational safety and health and all these are embedded in the Zambia Green Jobs Programme (ILO, 2015).

By end of 2015, the ZGJP had supported the creation of 2600 new green and decent jobs, in micro small and medium enterprises mainly in the North western, Copperbelt and Southern province in Zambia. This figure excludes the 3600 cases of casual employment (Temporal and part time jobs) (Ibid, 2015).

From the above publication, the gap noticed is that there is more emphasis on the creation of Jobs than on the sustainability of green building materials and technologies.

This study covered this gap by visiting the buildings considered to be green in Lusaka district and collected the information concerning how sustainable the materials and technologies used in these buildings are.

2.5 Major Gaps Identified in Literature Review

Generally, it is observed from both the global and African context that efforts have been made to find out various aspects of green buildings. For instance, trends in green buildings, drivers of green buildings, benefits of green building initiatives, however, the gap is seen from the fact that most studies are not holistic, some aspects of green construction are covered while others are not. For instance, one observation made from most of the studies above is that, there is more focus on sustainable energy initiatives/technologies while other aspects of green construction are dormant. For instance, green construction designs, building on sustainable sites like grey fields, brown fields etc and occupancy wellbeing due to health benefits of green buildings to mention a few. Further, a publication by ILO (2015) covering the local context (Zambia) focuses more on the creation of green Jobs than the benefits of green construction.

The gaps mentioned above were covered by this study as it is holistic. Firstly the study covered benefits of green building materials and technologies/initiatives looking at all aspects, energy efficiency, water efficiency, occupancy wellbeing and innovation in design. It also looked at negative experiences occupants of green buildings have. It further looks at economic benefits of using green building materials (Savings, employment opportunities and money generating activities) as well as stakeholders' perceptions on green buildings. It is finally sealed with a proposal of a sustainability learning guide from the findings.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter gives the detailed description of the study area. It firstly provides information on the location of the buildings where the studies were conducted. This is followed by the institutional profiles of study areas and lastly, data collection methods/techniques.

3.2 Physical characteristics

This study was conducted from five (5) different places located within Lusaka district. The locations of these areas are described below.

3.2.1 Location of study area

Foxdale court is a commercial green building located along Zambezi Road, Roma Park within Lusaka district. Foxdale Court Office Park has GPS co-ordinate points at 15°22'16.58"S 28°19'03.69"E and is located 1.4km from Arcades and 20km from Lusaka International Airport. The second study area is Woodlands B Primary School which is a School located in Woodlands, Lusaka. The school has an extension which used green building materials and technologies. In Woodlands area, Woodland Primary School is next to Dominican Convent. The third study area is Thornpark green house. Thorn Park Construction School green house is located within the premises of the vocational training school which is located in Thornpark area along Wamulwa Road. The fourth study area is Citi Bank. This building is a commercial green building situated at stand 4646 Addis Ababa round about in Elunda 1 area in Lusaka district and the final study area is Levy junction mall which is situated along church road in Lusaka district.The five green buildings are all located within Lusaka district. Lusaka is the capital city of Zambia. It is situated in the central part of Zambia on the Central African Plateau and lies at an altitude of 1280m above sea level. The city's coordinates are 280-10' east of the Greenwich meridian and 150-30' south of the Equator. The surface area of the city is 360 square kilometres (Lusaka City Council, 2017).

3.3. Background of Targeted Entities

It is imperative to give details of the areas mentioned above. Considering that green buildings were selected for this study, institutional profiles for the buildings have to be provided below.

Levy Junction is Zambia's largest, first fully enclosed shopping mall. Conveniently located, it contains 72 stores and boasts many well-known names. The mall's retailers offer products and services ranging from men's and women's wear, to cinemas, restaurants, computers and phones, including their accessories, and banking. Nearby is Southern Sun Stay Easy hotel with 104 compact, stylish rooms and a four-storey office block. This makes Levy mall a place where one can shop, play, eat and work.

Foxdale court is a Commercial Green Building (Shopping complex) located in Roma Park in Lusaka. It has more than 15 tenants renting shops in the same building. Foxdale court is well known for its green buildings attributes which includes water efficiency, energy efficiency and sound waste management practices. It has also hosted a number of green building events from its inception (Foxdale Court, 2016).

Established in 1979, Citibank is a financial institution with an aim to provide unequalled customer experience and deliver products tailored to meet clients' specific requirements and needs. The bank offers a full range of banking products and services in retail, business and corporate banking segments. This is a commercial green building located in Elunda 1 in Lusaka district. The building is currently the only bank which is a green building. It has a number of green building features starting from its design which promote environmental sustainability (Citi Bank, 2016).

Woodlands is a primary school located in woodlands area in Lusaka district. The school has an extension where some green building features were added under the Zambia Green Jobs Programme championed by ILO (ILO, 2015).

The green house at Thornpark construction school was built in 2015 as a green demonstration house under the Zambia Green Jobs Project through funding from ILO. A number of green

building materials and technologies were used during the construction phase. It is currently operating as an office (Ibid, 2015).

3.4 Philosophical Paradigm/Orientation

There are two main philosophical school of thoughts namely positivism and posts positivism. The positivism school of thought is centered on quantitative and universal/objective reality while post positivism is qualitative in nature and holds that there is subjective reality. Each of the school of thoughts divides into two streams namely epistemology (Study of knowledge) and ontology (Study of reality). This research was guided by both the post positivism and positivism school of thought and embraced critical realism as its specific philosophical paradigm. This philosophical paradigm embraces the use of both qualitative and quantitative data collection techniques. It says what we see is only part of the bigger picture. This was very essential in this research because information was not collected based on what was visible only in green buildings but also people's experience. Critical realism also embraces the use of case studies amongst many research designs. This research used both qualitative and quantitative data collection (Ut, 2010).

3.5 Research Design

This study used a multiple case study as its design. According to Creswell (2013), a multiple-case design explores a real-life multiple bounded system through detailed, in-depth data collection involving multiple sources of information. A multiple case study was suitable for this study considering that there were six different sources from which information was obtained to examine sustainability of green building materials and technologies.

3.6 Target Population

This study targeted buildings that are considered to be green within Lusaka district. Lusaka district has green buildings namely Citi Bank, Levy Junction mall, Foxdale court, Woodlands B extension school, The US embassy and Thornpark Construction School. These buildings were the targets for this research.

3.7 Selection criteria

Considering that the research required green building materials and technologies to be examined, information required could only be obtained from buildings which had green building materials and technologies. Levy Junction Mall, Foxdale Court, Citi Bank, Woodlands B extension and Thornpark construction school extension block are known to be green buildings. Levy junction Mall is known for its green initiatives which include water and energy efficiency as well as good waste management systems. Foxdale court has a waste management system, recycling activities, and technologies that promote water and energy efficiency. Citi Bank is known for its green building materials used as well as design. Thornpark green building was built using green building materials and has technologies the enhance natural control of internal temperature, good ventilation and indoor air quality and finally woodlands B primary school extension was built with a number of materials considered to be green. Its design also enhances good indoor air quality, adequate ventilation and natural lighting. The selection was based on the above mentioned features.

3.8. Sample

The sample of this study was Foxdale court, Woodlands B primary school, Thornpark green building, Citi bank and Levy junction Mall. The US embassy was left out because of security restrictions.

There are two main sampling designs used in research and these are probability sampling and non-probability sampling. Probability sampling is a sampling design where every unit in the population has a chance of being selected in the sample while non-probability sampling is any sampling method where some elements of the population have no chance of selection. Non-probability sampling is usually done in situations where information needed for the research can only be found from a specific group of elements with particular similar characteristics or features. Considering that this research required information to be obtained from people who had experience with green building materials and technologies, a sampling design called purposive sampling under the non-probability sampling was adopted. In purposive sampling, the sample is selected with a purpose in mind. Purposive sampling can be very useful for situations where

there is need to quickly reach a targeted sample and where sampling for proportionality is not the primary concern (Singaravelu, 2012).

In this case, targeted people were only those who had resided or operated from the green buildings and also stakeholders who were aware of green building materials and technologies (Ibid, 2012).

3.9. Methods of data collection

The data which was collected include primary and secondary data. Primary data was sourced from the field from the target group while secondary data was sourced from documents with information on green buildings. The methodologies which were used to collecting this data are described in Table 4.1.

3.9.1. Primary data collection

Methods of data collection employed were semi structured interviews and unstructured interviews. Using semi structured interviews meant some questions were open ended while others were closed ended. This was meant to collect as much information as possible as it would allow participants to fully express themselves. Observations were also used to examine the green building features of these green buildings and photos were taken to concretize the information collected (Zikmund, 2003).

Table 3.1 summarizes the techniques that were used to collect data.

Table 3.1: Primary Data Collection Techniques

Ref	Type of data	Methods	Tools	Analysis
1	Benefits of green building materials and technologies in the promotion of environmental sustainability	Unstructured Interviews and observations	Interview guide and observation guide	Thematic
2	Prospects brought by green building and materials and technologies in promoting green economy	Unstructured interviews	Interview guide	Thematic
3	Perceptions of various stakeholders on green building materials and technologies	Semi-structures interview guide	Interview guide	Thematic/ Standard deviation

(Singaravelu, 2012)

3.9.2. Secondary data

Secondary datais the data that has already been collected or recorded by someone else and readily available from other sources. According to Thi (2010: 5), "Sources of secondary data include compact discs, institutional documents, internet and recordings to mention a few."In this case, secondary data was relevant toextract information from previous studies pertaining to green buildings. It was also a source of descriptive information to support this research. Secondary data was collected from the internet by searching the work of various green building councils across the world as well as the mother body which is the World Green Building Council (WGBC). This was complimented by publications done by the International Labor Organization (ILO) under the Zambia Green Jobs Programme where green construction is being championed.

3.10. Ethical considerations

During this study, there were a number of ethical issues which were considered. This was done with an aim of protecting participants and creating a suitable environment for them to participate

in the research. All research participants in this study were informed about the purpose of the study and were free to either participate or decline. As regards the right to privacy of the participants, the study maintained the confidentiality. Participant's identities were protected. Therefore, collective names like 'Participants/respondent' were used in this report. Further, cultures and values of participants were highly respected to enhance willingness and active participation (Crystal, 1997).

3.11. Data validation and Consistency Check

Person triangulation was used to validate data. Since the research was about examining the benefits of green building materials and technologies, the outcome was based on the information the respondents provided from their experiences. Receiving similar responses over and over also helped to know the validity of the data provided. Webb (1966: 67) indicated that "Once a proposition has been confirmed by two or more independent measurement processes, the uncertainty of its interpretation is greatly reduced."

3.12. Data Analysis

Thematic analysis was used to analyse data. According to Kumar (2011: 34), "Thematic analysis identifies themes and patterns in conversations and these patterns may be drawn from direct quotations and/or by summarising general thoughts of the interviewees." Thematic analysis was relevant in this case because. The first objective sought to find out the benefits of green buildings and the benefits formed the following themes. Water efficiency, energy efficiency, waste management, resource use efficiency and promotion of occupancy well being. The second objective which aimed at finding out the economic benefits of green buildings equally formed two themes namely: savings and employment/income generating activities. The third objective which was to find out stakeholders perceptions on green buildings equally formed themes as all answers were either in agreement that green buildings were environmentally sustainable or not (Green/not green). That was the reason why thematic analysis was used. By analysing the themes that emerge from the summarised data, a broad view of the information was formed (Crystal, 1997).

Visual analysis was also used to verify the conditions of green building materials and technologies and link them to their performance.

Further, standard deviation was used to analyse the quantitative part of data. According to Tran (2010: 43), "Descriptive statistics is a brief descriptive of coefficients that summarise a given data set which can either be broken down to measures central tendency and measures of variability."

3.13. Limitations

One of the limitations experienced in this study was the use of unstructured interviews. According to Best (1992: 159), "like the tools in the carpenter box, each is appropriate in a given situation, to accomplish a particular purpose. Each data collecting device has both merits and limitations. However, for effective result each tool has its own significance. It must be used according to the required situations." In this study, the use of unstructured interviews method only collected information based on what the respondents experienced. For instance, if a building is made out of insulated ceiling which naturally controls internal temperatures inside the building and a participant states that the technology is a failure and has not improved indoor air quality and temperature regulations. Using this method alone may lead to a conclusion that the technology is unsustainable. Therefore, to address this limitation, observations were incorporated. Observations helped to see and analyze the condition of the technologies used. (Bad condition of a particular technology can equally lead to its poor performance). According to Ghaffar (2005: 5), "Observation involves observing all relevant phenomena and taking extensive field notes. Observation is usually done for exploratory purposes."

The other limitation was that of lack of full knowledge on green building by some respondents. The green building concept is new in Zambia and very few people have indepth knowledge about it. Others have been operating in green buildings and enjoying the benefits but had no understanding of what a green building is and how it benefits the environment. This limitation was addressed through providing green building information to participants through elaborate explanations. This was done verbally to make them understand and appreciate the research as well as encourage them to take part (ILO, 2015).

3.14 Conclusion

The study areas for this research were buildings that were known to have green features. Thus were purposely selected. Since there were five buildings within Lusaka district, it was appropriate to use a multiple case study. Data was collected using observation guides and interview guides and analysis conducted through thematic analysis and standard deviation. The study observed confidentiality for all participants in order to protect their identities. All the data collection methods, processes and techniques used in this study were blended to bring out the best of what the research required.

CHAPTER FOUR: PRESENTATION OF FINDINGS

4.1. Introduction

This chapter presents the findings of the research which was conducted from five different green buildings. The first part aimed at collecting information concerning the benefits of green building materials and technologies in environmental sustainability. The second aimed at collecting information on economic benefits, while the third part focused on stakeholders' perception on green building materials and technologies. The final part was to come up with a sustainability learning programme. The findings are presented according to each objective.

4.2. Examine the benefits of green building materials and technologies in the promotion of environmental sustainability

This was the first objective. The findings reviewed that the benefits of green buildings in Lusaka District are in five categories namely, water efficiency, energy efficiency, and waste management, resource use efficiency and promotion of occupancy well-being. The findings also revealed that some green building initiatives needed to be improved. The benefits of green buildings are presented first followed by the areas that need improvement.

4.2.1. Benefits of green buildings

Tables 4.2, 4.3, 4.4, 4.5 and 4.6 simply show green building technologies and materials used in Lusaka district and their environmental benefits.

4.2.1.1. Water Efficiency

There were a number of water efficiency technologies revealed by the study in Lusaka district. The technologies varied from building to building and these are presented in table 4.2.

Table 4.2: Water efficiency technologies

Ref	Green Technologies	Environmental benefits	Number and names of buildings using the technology
1	Rain water harvesting system	Preserves ground water making available water from rain	1 (Foxdale Court)
2	Grey water recycling	Preserves ground water by reusing/recycling the very water used in the building	1(Foxdale Court)
3	Aerators in taps	Reduces water coming from taps by mixing it with air	1(Citi Bank)
4	Self-closing taps with valves	Minimise water wastage	1(Levy Junction)
5	Preset Arial irrigation	Minimize water wastage by only watering at preset time	1(Levy Junction)
6	Low flow Self-flashing urinals	Minimizes water used for flashing	1 (Citi Bank)

(Source: Field data)

4.2.1.1.1. Foxdale court

The following are water efficiency technologies employed by Foxdale court.

4.2.1.1.1.1 Rain Water Harvesting System

One of the technologies Foxdale court incorporated to maximise water efficiency was the installation of rainwater harvesting system. The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. Respondents indicated that water is collected from the roofs of buildings and stored in rainwater tanks. At Foxdale court, Gutters were placed at the edge of the roof of the building to collect water during the rainy season. This was evident from observations. During interviews, one respondent explained as follows

"*The roof is 600sqm. Water from the roof falls into the gutters and runs down in pipes that have been connected to the eight 12, 000 L tanks. This water is used for flushing of toilets in the building and also for irrigation in the garden and loans around Foxdale court. During the hot season, the tanks are fed by the borehole*."

Figure 4.2 shows one of the tanks used to store water from the rain water harvesting system.

(Source: Field data)

Figure 4.2: Rain Water Harvesting System

4.2.1.1.1.2 Grey Water Recycling

The other water efficiency technology used at Foxdale Court is the grey water recycling. As explained by the respondents, Grey water is wastewater from any household source other than toilets. Foxdale grey water recycling plantrecycles domestic waste water and the purified water is used for other purposes. One of the respondents stated as follows:

"The water recycled is, kitchen water, cleaning water shower water and wash basin water. This water is purified and used for irrigation in the loans and garden. The purification system used in this water is a combination of bio filtration, aeration,

clarification and ozonation. When the water goes through this process, it is filtered, purified and has bacteria killed."

4.2.1.1.2. Citi Bank

The following were the water efficiency technologies employed by Citi Bank.

4.2.1.1.2.1 Tap Aerators

City Bank being a commercial building used by various people has employed a number of technologies to ensure that usage of water is prudent and wastage is minimised. Firstly, the respondent explained that aerators were placed in taps used in the building to minimise water flow. He explained as follows

"*A faucet aerator (or tap aerator) is often found at the tip of modern indoor water faucets. Aerators can be simply screwed onto the faucet head, creating a non-splashing stream and often delivering a mixture of water and air Aerators reduce the water coming through the facets by mixing it with the air. The aerators work like a sieve by separating a single flow of water into many tiny streams. Because of the nature of this operation, the introduction of air reduces water flow*."

4.2.1.1.2.2 Low flow plumbing urinals

It was further revealed that the building also has low flow flashing urinals. The low flow plays a big role in conserving water. He stated as follows:

"*The building has self-flashing urinals that have low flow. These operate with motion sensors. The sensors are able to pick motion when one gets close and uses them and when one walks away. The moment one walks away, they automatically flush with very low flow only to clear the urine. The low flow helps in conserving water*."

4.2.1.1.3. Levy Junction Mall

The following are the water efficiency technologies employed by Levy Junction Mall.

4.2.1.1.3.1 Self-closing taps

At Levy Junction mall, it was revealed that the mall has self-closing taps that are valve regulated and this has helped to reduce water wastage. During interviews, the respondent explained as follows:

> "*Conventional taps can be left running for much longer than necessary. The self-closing taps considerably reduce water wastage, with the time delay mechanism that automatically shuts off which helps to avoid flooding. When taps are opened, only a specific amount of water will come out. Water collects in a valve and when the tap is opened, only water in the valve will be released. When the water finishes the taps automatically closes. This operation can be likened to that of flashing of water in the cistern tank. Water collects in the cistern tank and when it is flashed, the cistern has to be filled again for the toilet to flash. In the same way, valves only release water that has collected."*

4.2.1.1.3.2 Arial Irrigation

It was also revealed that, an Arialtimed irrigation system is used for watering the loans. According to the respondent, this Arial irrigation is pre-set and timed. This system makes it possible for the sprinkler to water the loans without having any wastage of water. He stated

> "*Pre-setting of time to water the loans helps reducing water wastage by using only water that is enough for the loans and preventing excessive watering."*

4.2.1.2. Energy Efficiency

Energy efficiency technologies used in Lusaka district are presented in table 3. These vary from building to building.

Table 4.3: Energy efficiency technologies

	Green Technologies	**Environmental benefits**	**Names of buildings using the technologies**
1	Solar power	Clean source of energy/source of energy always available and natural/does not lead to any pollution	Foxdale Court , ThornPark
2	LED bulbs	Use less energy for lighting	Citi Bank
3	Energy serving bulbs	Use less energy for lighting	Foxdale Court Woodlands B primary School Thornpark construction school Levy Junction
4	Motion sensors in the lighting system	Avoid unnecessary lighting when the room is vacant	Foxdale Court
5	Occupancy sensors in the lighting system	Prevents usage of lights when room is not occupied	Citi Bank
6	Sustainable glazing/ Allowing enough natural light	Allows natural light, reducing need for lighting especially during day	All buildings
7	Temperature regulating tinted windows	Regulates temperature and lessens need for heating and cooling rooms	Citi Bank
8	External double wall construction with vacuum	Acts as insulator are regulates temperature in internal areas	Levy Junction
9	Insulated ceiling with sand bags	Temperature regulation/reduces need for heating and cooling room	Woodlands B primary
10	Building Management System	Monitors energy consumption and ensures less is used	Levy Junction

(Source: Field data)

4.2.1.2.1. Foxdale Court

The following are the energy efficiency technologies employed by Foxdale Court.

4.2.1.2.1.1 Solar Energy

According to the findings of this study, Foxdale owns Zambia's biggest solar system which is 100 KVA. The solar system was officially launched on 3rd June, 2016 and has been in operation since then.

4.2.1.2.1.2 Energy serving bulbs/motion sensors

Secondly, interviews with the occupants revealed that the building has installed energy serving bulbs. These use less power compared to incandescent bulbs when they are in use. Further, bulbs are connected to motion sensors mainly in the bathrooms and corridors. One of the respondents explained as follows:

> "*The sensors are able to pick any motion and when that happens, lights automatically go on. The sensing of motion makes it possible for light to be used only when one has walked into the corridors or ablution blocks. Without this, it is likely that lights can be left on by negligent people especially that it is a commercial building used by different people. Facilities use by many people often tends not to be cared for by users as they may feel that they have nothing personal to lose."*

4.2.1.2.2. Citi Bank

The following are the energy efficiency technologies employed by Citi Bank.

4.2.1.2.2.1 Occupancy sensors

It was revealed during interviews that Citi Bank has occupancy sensors in its lighting systems to ensure that there is no wastage of energy in the building. The sensors are connected to both air cons and the lighting system. The lights and air cons only go on when ones presence is sensed. The respondent stated as follows:

"Employing the use of occupancy sensors is one of the foremost ways of creating an energy efficient environment. They contribute to the overall efficiency of the building. Occupancy sensors for instance ensure that lights and aircons are not at work when no one is occupying the rooms. This actually acts as an advantage compared to motion sensors as motion sensors are likely to go off when one is still(not in any sort of motion) for some time. When using lights without sensors, there are many instances where users of the building may forget to switch off the lights or aircons. Sometimes it may be because they do not care about high energy consumption of the building."

4.2.1.2.2.2 LED lights

As explained by the respondent, the lights used in the building are also LED meaning they use very little energy as they are working. Other than that, the building has a design that minimises the use of lights during day time. The building has large windows which allow enough natural light to penetrate into the building. This was evident from observations. It was also indicated by the respondent that the availability of natural light reduces the need to switch on lights during day time.

4.2.1.2.2.3 Tinted windows

Further, this study revealed that Citi bank has tinted windows that have a temperature regulatory feature. The respondent explained as follows:

"The tint on windows works in such a way that, when the sun hits the window, heat is reflected back into the air. This helps in keeping the rooms warm in winter and cool in summer. Further, the tint absorbs ultra violet rays. In other words, it also protects the occupants from coming into contact with the harmful sun rays. Window tints reflect light and this keeps the offices cooler and reduces the need to heat and cool the room, thus saving energy."

4.2.1.2.3. Woodlands B Primary School

The following are the energy efficiency technologies employed by Woodlands B Primary School.

4.2.1.2.3.1 Insulation of ceiling with sand bags

Interviews conducted from Woodlands B Primary School revealed that, energy is conserved in two ways. Firstly, the ceiling of the four classroom blocks were insulated with sand bags which help in temperature regulation. It was reported that this technology helps in keeping the rooms cool when its hot and warm when cold. This was confirmed by all respondents during interviews. One of the respondents explained as follows:

> *"There is a very big difference between the extension classroom and the old classrooms in terms of temperature. The extension classrooms were insulated with sandbags in the ceiling. As a result, they are cool during summer and warm during winter. Most teachers actually prefer to teach from the extension classroom"*

4.2.1.2.3.2 Sustainable glazing

Further, it was revealed through interviews as well as observations that the glazing of the classrooms equally supports energy efficiency. The two blocks face each other and the inside parts are entirely made out of glass. The design optimises the use of natural light which lessens the need for lighting during day time.

(Source: Field data)

Figure 4.3: Glazing at Woodlands B primary allowing adequate natural light.

4.2.1.2.4. Levy Junction Mall

The following are the Energy efficiency technologies employed by Levy Junction Mall.

4.2.1.2.4.1 Double wall insulation

At Levy junction, it was reported during the interviews that the external walls of the shopping mall were doubled to regulate internal temperature. The respondent explained as follows:

> *"The doubling of the wall was meant to create a vacuum in between the two walls. This vacuum acts as an insulator and operates as a temperature regulator. Because heat hardly passes through a vacuum, the internal areas of the mall are warm during winter and cool during summer. This reduces the need to use air cons/fans for heating and cooling purposes which in turn reduces energy use in the building. Further, energy serving bulbs are used to reduce energy consumption when lighting is needed."*

4.2.1.2.5. Thorn Park

The following are the Energy efficiency technologies employed by ThornPark.

4.2.1.2.5.1 Solar Energy

It was reported during interviews that Thorn park demo green house has 150 watts solar panels. This was installed in the building for use in electric appliances like lighting and computers. Secondly, like indicated by respondents as well as observations made, the building has a lot of openings that allow enough natural light into the building. This makes it unnecessary for the lights to be switched on during day time.

4.2.1.2.5.2 Dry wall petitioning

It was also reported that the building has a dry wall petitioning which has a temperature regulatory feature as it keeps the rooms cool in hot season and warm in cold seasons. As a result, energy is conserved.

4.2.1.3. Waste Management

Good waste management practices were identified in two buildings and these are presented in table 4**.**

Table 4.4: Waste management initiatives

	Green Technologies	**Environmental benefits**	**Names of buildings using the technology/initiative**
1	Waste separation	Enables recycling companies to collect and recycle the waste. Waste is diverted from landfill	Foxdale Court Levy Junction Mall

(Source: Field data)

Good waste management practices were identified in two green buildings namely Foxdale court and levy junction mall.

4.2.1.3.1. Foxdale Court

The following are the waste management initiatives employed by Foxdale Court.

4.2.1.3.1.1. Waste separation and food waste decomposition.

It was indicated by respondents that waste management starts right from the rooms/offices. Each room had four different bins labelled, paper, plastic, food waste and other. This was evident from observations. It was also indicated that Tenants are advised to separate waste right from the rooms. Figure 5.4 shows the labelled bins used for disposing waste placed in tenant's rooms.

(Source: Field data)

Figure 4.4: Bins placed in all rooms for Waste Separation

As reported by respondents, this separated waste is then taken to the waste management area where there are bigger compartments. The compartments are equally labelled thus waste is not mixed but emptied in designated compartments.

(Source: Field data)

Figure 4.5: Show Compartments Holding Separated Waste

It was also revealed during interviews that Foxdale court partnered with recycling companies to champion good waste management practices. One of the respondents explained as follows:

> *"The paper waste is collected by Zambezi mills and recycled into new paper products. Plastic bags and bottles are collected by Habib enterprises and recycled into plastic bottles. Printer ink cartridges collected by green cartridges. Food waste is decomposed using JK series units and used in the gardens around foxdale court."*

(Source: Field data)

Figure 4.6: Food Waste Decomposition Compartments

4.2.1.3.2. Levy Junction Mail

The following are the Waste management Initiatives at Levy Junction Mall.

4.2.1.3.2.1 Waste separation

It was revealed during interviews that Levy junction mall equally has good waste management systems. This begins with the Waste separation. When this waste is separated, other companies collect them for recycling. For instance, papers are collected by Zambezi paper mill and recycled into other paper products.

4.2.1.4. The use of local/non-harmful building materials

The findings also revealed that green buildings use local and non-harmful building materials. It was revealed by respondents that use of local building materials is one of the ways of being environmentally sustainable because it cuts down on time of transportation, thus reducing pollution. Other than that, non-toxic materials are also considered green as they protect the natural environment as well as humans. Table 4.5 presents the local and non-harmful materials which were used in green buildings in Lusaka district.

Table 4.5: Local non-harmful building materials

	Green and non-toxic materials	**Environmental benefits**	**Number of buildings involved**
1	Stabilized earth blocks	Use local soils and labour/cuts transportation of sand and labour	Thornpark Woodlands B
2	Lime	Natural product, locally available/cuts on need to transport	Thornpark Woodlands B
3	Kalulushi clay bricks	Use local soil and labour/ cuts transportation of sand and labour	Levy Junction
4	CFC free gases for aircons	Prevent ozone layer depletion	Citi Bank
5	Non-toxic paints	Prevents intoxication	Citi Bank
6	Timber	Renewable	Woodlands B

(Source: Field data)

4.2.1.4.1. Citi Bank

The following are the non-toxic materials used at Citi Bank

4.2.1.4.1.1 Non-toxic paints and CFC free air-conditioning gases

At Citi bank it was reported during interviews that the two green materials mainly used in the building are non-toxic paints (low VOC) and non CFC free aircon gases. The respondent explained as follows:

> "*The building used non-toxic (low VOC) paints and these enhance occupants' well-being by reducing chances of illnesses caused by VOCs. Further, CFC free gases in aircons were used and these help a lot in the preservation of the environment."*

4.2.1.4.2. Woodlands B primary School

The following are the local materials used at Citi Bank.

4.2.1.4.2.2 Earth blocks and Lime

The local building materials used at Woodlands B primary school are stabilised earth blocks, lime and wood. It was revealed by respondents that the use of lime for plastering is very green in that lime is a building material that is naturally available and can be sourced locally. Unlike cement which is imported. Lime substitutes cement in plastering. One of the respondents explained as follows:

> "*Cement is well known for not being green in that, the process used in making it requires a lot of energy. During its manufacturing, it is heated beyond 1400 degrees Celsius. In other words it is energy intensive. The manufacturing process also releases carbon dioxide in the atmosphere which is one of the most persistent greenhouse gases responsible for global warming and climate change. Further, it requires transportation from the manufacturing area to the construction site. It also has harmful effects to humans when excessively inhaled. Cement has ability to cause a number of respiratory problems. Thus it is said to also compromise the workers wellbeing. It is for this reason why the use of lime as a local product is considered green*".

Further, respondents explained that stabilised earth blocks used in the building were equally very sustainable in that, they required very little water to make during the process (This promotes water efficiency). It was also explained that, the blocks use ordinary and local soil (Even sand

from the dug foundation can be used). Thus cutting the transportation of sand from different places to construction site like is the case with cement blocks. Both the cement and sand are usually transported from specific sites to the construction site.

4.2.1.4.2.3 Use of Timber Ceiling

Furthermore, it was explained that the use of wood in the ceiling is sustainable in that, timber is a renewable product. In other words, it can be grown. As a result, the use of timber does not lead to deforestation as trees are replaced.

4.2.1.4.3. Thorn Park Green Demo House

The following were the local materials used at Thorn Park.

4.2.1.4.3.1 Stabilised Earth blocks, Lime and Timber

Almost similar to woodlands B primary school, Thornpark School equally used stabilised earth blocks for construction, lime for plastering and wood for window frames. The wooden window frames were used in place of iron frames. Environmental benefits are similar to those explained on Woodlands B primary school.

4.2.1.4.4. Levy Junction Mail

Below is the local material which was used at Levy Junction Mall.

4.2.1.4.4.1 Use of Local Clay bricks

It was revealed that during the construction process of Levy junction mall, kalulushi clay bricks were used. The bricks use clay soil which is locally available.

4.2.1.5. Promotion of occupancy wellbeing

The promotion of occupancy well-being is another aspects of green buildings found in Lusaka district. It was revealed from the study that green buildings do not only favor the natural environment but also enhance the wellbeing of people that occupy the buildings. The wellbeing

talked about can either be in terms of comfort or health. Table presents the aspects of green buildings in Lusaka district that enhance occupancy wellbeing.

Table 4.6: Promotion of occupant's wellbeing

	Green Technologies	**Environmental Benefits**	**Buildings involved**
1	Large or many openings (Windows and doors)	Allow adequate ventilation	Citi Bank Levy Junction ThornPark Construction Woodlands B primary Foxdale Court
2	Temperature Regulating glazing	Creates favorable temperature to work from	Citi Bank
3	Double wall system	Creates favorable temperature to work from	Levy Junction Mall
4	Glazing that favors adequate natural light	Enable occupants to see well during working hours	Citi Bank Levy Junction ThornPark Construction Woodlands B primary Foxdale Court
5	Low VOC paints	Prevents inhaling toxic gases	Citi Bank

(Source: Field data)

Occupancy wellbeing is one of the themes that came out from the research findings. It should be noted that humans are part of the environment. The study revealed features from the five buildings which enhance occupancy well-being and these are presented below.

4.2.1.5.1. Citi Bank

The following are the measures taken by Citi Bank to promote occupancy wellbeing.

4.2.1.5.1.1 Ultra Violet Rays Filtering Windows

Citi Bank has windows with a tint that filters ultra violet rays from the sun according to what the respondent explained. The tint is evident from the outside view. During interviews, the respondent explained as follows:

> *"The tint on the windows does not only regulate temperature but also filters Ultra violet rays that are known to be harmful to humans as they cause cancer. The temperature regulations achieved through the tint of the window has a great role in promoting occupants wellbeing because internal temperatures become favourable which in turn leads to high levels of productivity among worker."*

4.2.1.5.1.2 Ventilation

It was further revealed that large windows also allow ventilation or adequate air flow. This improves occupants well-being by lessening chances of quick spread of airborne diseases as well as intoxication if at all there are any harmful gases. The building also used non-toxic paints. This also protects occupants.

4.2.1.5.2. Woodlands B Primary School

The following are the measures taken by Woodlands B Primary School to promote occupancy wellbeing.

4.2.1.5.2.1 Adequate Natural Light and Ventilation

It was reported by respondents at Woodlands B primary school that, the wellbeing of occupants is facilitated by the natural light that comes through large glazing area which enables both pupils and teachers to see clearly during class activities. As a result, pupils and teachers do not stress their eyes to see. Other than that, it was reported that the design also facilitates adequate ventilation.

4.2.1.5.2.2 Temperature Regulation through Insulated Ceiling

Further it was indicated that the temperature of the building is regulated through the insulated ceiling. One of the respondents explained as follows:

> "*The insulated ceiling aids in keeping desirable temperatures during working hours. This improves productivity of both pupils and teachers."*

It was clearly indicated by 100% of the respondents from this building that they found the building more comfortable than the blocks that were built traditionally. When asked which building they preferred between the extension with green materials and technologies and the ordinary blocks, all respondents indicated that they preferred the green building extension. It came out very clear that temperature regulation which was as a result of the insulated ceiling was highly appreciated by the respondents.

4.2.1.5.3. Thorn park construction school

The following are the measures taken by Thorn Park Construction School to promote occupancy wellbeing.

4.2.1.5.3.1 Favourable Temperature, Ventilation and Natural Light

As explained by the respondents at Thorn park construction school, occupancy well-being is promoted by the temperature regulation which is facilitated by the dry wall petitioning. This keeps the room favourable to work from. Further, the rooms have adequate openings that allow airflow and natural light. As such, the rooms are well ventilated.

4.2.1.5.4. Levy Junction Mall

The following are the measures taken by Levy Junction Mall to promote occupancy wellbeing.

4.2.1.5.4.1 Temperature Regulation through double wall

It was reported that the double walls at Levy Junction regulate internal temperature. This makes the environment more suitable and conducive to operate from.

4.2.2. Green building technologies/materials that need improvements

As stated earlier, the study did not just focus on the positive aspect of green building materials and technologies. The findings actually revealed that there were areas that needed to be improved. The research also looked at the negative experiences occupants of green buildings had in the five green buildings and these are explained below

4.2.2.1. Woodlands B Primary School

The following are the areas that need improvements at Woodlands B Primary School.

4.2.2.1.1 Ticks Introduced by Open Ceiling

It was reported during interviews that design of ceiling used in the extension caused some discomforts to occupants. The building like mentioned earlier used wood for its ceiling. Between the ceiling and the roof, a gap was left open during construction. Unfortunately, the opening was reported to have attracted birds. The birds in turn introduce ticks that have been biting the occupants. In other words, the design compromises occupants wellbeing Figure 4.7 shows the space which attracts birds.

(Source: Field data)

Figure 4.7: Space in between the roof and ceiling which attracts Birds

4.2.2.1.2 Breaking of Lime

Secondly, it was reported that the use of lime for plastering did not work as expected. During the interviews, interviewees were asked which green material/technology was not working as expected. All respondents indicated that lime was not as strong as cement when used in plastering. One of them explained as follows:

> *"Lime is not very good for plastering. The walls have been breaking. I think if cement was used, it was going to be better."*

The breaking of the walls was actually evident from observations. Figure 4.8 shows the broken lime which was used for plastering.

(Source: Field data)

Figure 4.8: Broken and Cracked Lime Plastering

4.2.2.2. Foxdale Court

The following are the areas that need improvements at Foxdale Court.

4.2.2.2.1 Use of Ordinary Bins and importation of Solar Panels

Foxdale equally had green initiatives that needed to be improved. During interviews, respondents were asked which green initiative they thought was not as green as it should be. The explanation from one of them was as follows:

"Bins used for waste separation could have been made from recycled materials which would have made waste management initiative even greener. Further, the solar panels were not locally sourced. They were actually imported from SA. It is a well-known fact that transportation cannot occur without pollution. Other than that, labour to install the panels was equally imported from SA because there was no local expertise to do the work. In as much as the installation of solar panels is a green initiative, it is compromised by the importation of the resource and labour."

4.2.2.2.2 Poorly Designed Rain Water Harvesting System

It was further revealed that the initial design which was used for the rain water harvesting system did not work as expected. The respondent explained as follows:

"The initial design was in such a way that pipes from the gutters ran under ground and curved up to the tanks. In other words, the pipes formed a u shape which was leading to the tank for collection of water. Because of the nature of the design, at a particular point, water could not move through the u shaped part of the pipes, it kept collecting in the upper part of the pipes until the pipes was full and began overflowing and water started running down the building. This called for a shift in rainwater harvesting design. The second design did not have U shaped pipes but rather, pipes ran from the roof, straight to the meddle part of the tank. This solved the initial problem. Further, the tanks collecting water are ordinary and not green because they are not from recycled materials."

4.2.2.3. Citi Bank

Below is the area that needs improvement at Citi Bank.

4.2.2.3.1 Imported LED Bulbs

Despite, the great green initiatives used at Citi bank, there was one aspect reported to have compromised the green standards. It was reported during the interviews that the LED lights installed in the building were not manufactured within Zambia, they were imported from SA. Like mentioned above under Foxdale court, importing building materials involves transportation

which is one of the major pollutants. If resources can be sourced locally, transportation time can be lessened thus reducing pollution.

4.2.2.4. Thorn Park Building

Below is the area that needs improvement at Thorn Park.

4.2.2.4.1 Breaking of Lime

At Thornpark, there was a similar situation to that of woodlands B primary school extension block. This building equally used lime for plastering mainly inside the building. It was reported by the respondent that lime was not very strong as it was breaking. He stated as follows:

> *"Lime is known to be a green material as it is naturally available, and since it is not manufactured, there is no pollution like is the case of cement during production. However, it has proven not to be strong, as it keeps breaking. The corner right at the door broke and we had to put a little cement to plaster that part."*

This, like the case at woodlands primary school was very evident by observation. In fact, right at the table where the interviews were taking place from was a broken piece of lime.

4.2. Determine prospects brought by green building materials and technologies in promoting a green economy

This was the second objective. To collect information for this objective, the study sought to find any economic benefits of using green building materials and technologies. The study reviewed that green building materials and technologies play a vital role in promoting a green economy. This is mainly from savings that accumulated as a result of using green building materials and technologies. The study reviews that using green building materials and technologies can have upfront costs that maybe slightly higher but are still considered cheap because of long life benefits. Other than that, green construction also benefits local people in terms of jobs.

The savings can lead to a green economy in that resources can be diverted to other developmental projects which can improve people's wellbeing. Employment can equally empower members of the public and reduce poverty levels. Table 4.7, 4.8, 4.9, 4.10, 4.11 and

4.12 show the prospects brought by green building materials and technologies in promoting a green economy (savings, employment and money generating activities which were as a result of green buildings). These are outlined per building.

Table 4.7: Foxdale Court

Ref	Green building materials/technologies	Savings	Income generation/ employment
1	Energy efficiency	From energy saving bulbs/motion sensor lighting and solar system. (Less zesco bills)	
2	Water efficiency	From grey water recycling and rainwater harvesting system	
3	Waste management	Partnership with companies to collect waste for recycling which reduces the frequency of waste collection. The charge is k1,200 per collection	Expansion of companies collecting waste. Employment of recycling manager at Foxdale court

(Source: Field data)

4.2.1. Foxdale Court

At foxdale court, it was reported that water efficiency initiatives yield many savings. The savings on water usage are as a result of the grey water recycling and rain water harvesting system. The two water efficiency measures help to avoid sourcing water from municipal water supply which is billed. Further, respondents explained that since most of the waste is collected by recycling companies, the frequency of garbage collection to be taken to the dumpsite is reduced. One of the respondents disclosed as follows:

> "*Every collection of waste by the council is K1, 200 and waste is collected only once in a week. If not for the recycled waste that is diverted from the landfill, the frequency for collection would have been higher."*

Other than that, recycling activities have created employment for local people in the recycling companies. A respondent disclosed as follows:

"Waste separation done here at Foxdale court has facilitated the formation of some recycling companies which have in turn employed local people. Right here at Foxdale court, a recycling manager was employed to take care of all waste management affairs. The savings and employment created are both indicators of a green economy."

The savings also come from energy saving bulbs/motion sensor lighting and solar system which lead to less ZESCO bills.

Table 4.8: Levy Junction

	Green building materials/technologies	**Savings**	**Income generation/ employment**
1	Water efficiency	From preset sprinkler and self-closing taps. Less wastage of water. About 15% servings	30-40 percent of local people were engaged in every stage of construction. They benefited in terms of employment.
2	Energy efficiency	From LED lights, double wall thermal regulation. About 5% servings	
3	Use of local building blocks	Cheaper to buy	Promotion of local market by purchasing kalulushi clay bricks.
4	Waste management	Reduction of waste collection bills	Income generation from selling separated waste to companies.

(Source: Field data)

4.2.2. Levy Junction

At Levy Junction mail, economic benefits of green building materials and resources reflect in the savings and employment opportunities. It was revealed during the study that, the construction phase used 30-40 percent of local people who benefited in terms of employment at each stage of construction. The use of locally produced bricks (kalulushi clay bricks) also promoted the Zambian market. Further, it was revealed that, waste at Levy junction is separated and sold to recycling companies. That as well is a benefit economic wise. Instead of taking huge amounts of waste to the landfill, it actually turns out to be a source of income.

Table 4.9: Woodlands B Primary School

	Green building materials/technologies	Savings	Income generation/ employment
1	Energy efficiency	From glazing that allows natural light. No use of lights all day.	About 50 local people employed during the construction of the building.
2	Use of local labor	Cheaper than imported labour	
3	Use of Stabilized earth blocks	Cheap and locally available compared to cement bricks that are far much expensive.	

(Source: Field data)

4.2.3. Woodlands B

At Woodlands B primary school, it was clearly indicated that there were tangible servings mainly as a result of the design of the building which allowed adequate natural light. It was confirmed by all teachers that it is actually unnecessary to switch on the lights during day time as there was more than enough natural light from the sun. Because of this, bulbs are never switched on during day time thus reducing electricity bills.

There were also savings realised from the use of stabilised earth blocks as they used local soils which were cheap. From the interviews, it was indicated as follows:

> *"During the construction of the building about 50 local people benefited in terms of employment."*

Like mentioned earlier, Woodlands B primary school used stabilised earth blocks in the extension. The use of these blocks also facilitated employment opportunities for local people as they were locally made.

Table 4.10: Thornpark Construction School

	Green building materials/technologies	**Savings**	**Income generation/ employment**
1	Energy efficiency	From glazing that allows adequate natural light and solar/ energy serving bulbs. No lighting used during day because of adequate light. Appliances use solar.	
2	Use of Stabilized earth blocks	Cheaper because they use local soils that are cheaper.	Empowerment of students in block making skills.

(Source: Field data)

4.2.4. ThornPark Construction School

The situation at Thornpark Construction School is similar to that at Woodlands B primary school. The block used interlocking blocks which were cheaper and provided employment for local people. Further, there are savings from the efficient use of energy. The design allows enough natural light in the rooms which makes it unnecessary to light the rooms during day time. This is backed up by solar power which is used in other appliances like computers.

Table 4.11: Citi Bank

	Green building materials/technologies	**Savings**
1	Energy efficiency	Glazing that allows enough natural light, LED lights, occupancy sensors, 50% servings.
2	Water efficiency	From aerated taps, water flow control, 25% servings, Self-flashing urinals with sensors

(Source: Field data)

4.2.5. Citi Bank

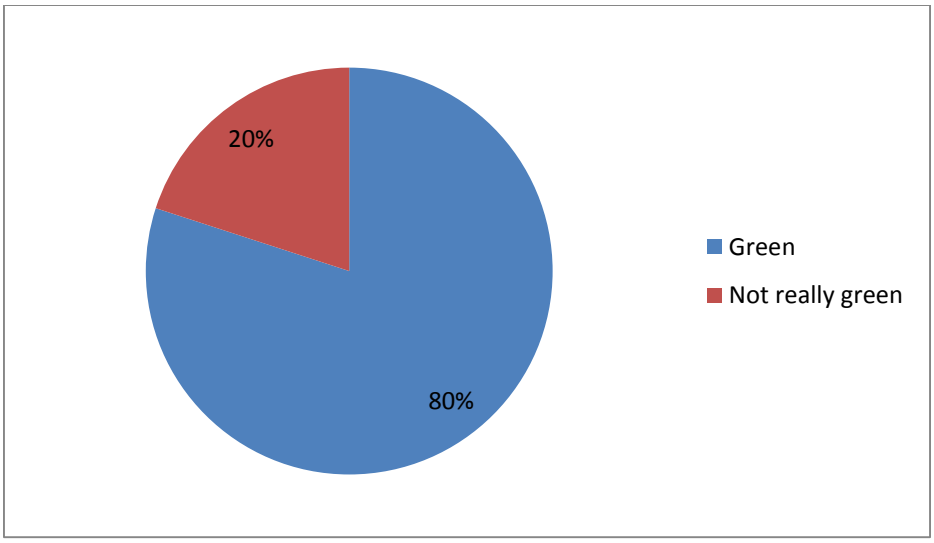
Citi bank has savings resulting from the water and energy efficiency. The respondent revealed that the energy savings in the building was 50% and water consumption 25%. This implies that the efficient use of water and energy does not only have an environmental benefit but also an economical benefit. Less money is used on the water and electricity bills. This helps the company to divert the resources to other activities that help it grow and expand,

4.3. To investigate stakeholder's perceptions on green building materials and technologies.

The third objective was to find out stakeholders perception on green building materials and technologies. Stakeholders were selected purposively. The people targeted were people who were involved in the construction sector and have knowledge on green building materials and technologies. That is the reason why stakeholders were selected purposively.

80% of the stakeholders indicated that green building materials and technologies were indeed environmentally friendly, while 20% indicated that green building materials and technologies were not really green.

The figure 4.9 shows the pattern of responses from all stakeholders.



(Source: Field data)

Figure 4.9: Pattern of responses from stakeholders

Table 4.12 shows the responses from the 80% that indicated that GBMT were environmentally friendly. It shows reasons explained by the stakeholders as to why they thought GBMT were environmentally sustainable.

Table 4.12: Stakeholder's perceptions on green building materials and technologies

REF	GREEN MATERIALS/TECHNOLOGIES	REASON
1	Timber	Available and can be grown/renewable
2	Solar power	Clean source of energy
3	Stabilised earth blocks	Use local soils which cuts the transportation of sand
4	Dry wall petitioning	Regulates temperature and cuts off use of fans and air cons
5	wood	Available and renewable because it can be grown
6	Grass for thatching	Available and is renewable because it can be grown
7	Water recycling	Water is reused thus preserving underground water tables
8	Rain water harvesting system	Rainwater is used instead of ground water which preserves water tables
9	LED lights	Use less energy compared to the traditional bulbs
10	Motion sensing in lighting	Allows lights only to go on when one is using the room, thus avoiding unnecessary usage of energy
11	Kalulushi clay bricks	Made from local soil (Clay soil) and burnt using sawdust
12	Solar geyser	Use solar as source of energy which is clean
13	Waste recycling	Diverts waste that should be taken to the landfill
14	Ceiling insulation	Regulates temperatures and lessens need for heating and cooling the room, thus using less energy
15	Design with openings allowing light and ventilation	Provides good ventilation for occupants and lessens the need to switch on the lights

(Source: Field data)

Meanwhile, 20% of stakeholders indicated that green building materials and technologies are not completely green. One of the respondents stated as follows:

> "*Green building materials and technologies are environmentally friendly but there is need to improve them. To be specific, am concerned about LED lights. A few months ago, I bought an LED floodlight and it lasted two months and just stopped working instantly. I replace it with another LED floodlight which equally lasted two months and stopped working. As I speak, it is replaced with a new one. These LED floodlights come as a fitting and my concern is electronic waste being produced.*"

Surprisingly, this concern did not just come from one person. Another stakeholder indicated something similar. And this was his statement.

> *"Green building materials and technologies are beneficial to the environment but not all green building materials and technologies are really green. For instance, not all LED lights are eco-friendly. I shifted in an apartment where new LED lights were fixed in all rooms. I only used them for three weeks and they couldn't work anymore. This also has to do with price; the cheaper ones are not durable and they actually become more expensive than the high priced ones when one keeps replacing them. I replaced them with LED lights that costed more than k200 per bulb and these worked for more than a year. I actually left the place and the person who occupied the house continued using them."*

Another respondent stated that green building materials and technologies are eco-friendly, except there was need to do more studies and research on stabilised earth blocks. He stated as follows:

> "*The climate has to be studied so that we know the best way to make stabilised earth blocks durable in all seasons. I have heard of bricks breaking because of fluctuation of whether. The bricks expand during hot season and contract during cold season as a result some of them break."*

Another respondent explained that some green building materials and technologies were not very green. He indicated that processes of manufacturing the green building materials has to be improved as well and not just focusing on the final product. He explained as follows:

> "*Even recycled materials that need industrial processes to be transformed to new products are usually not very eco-friendly. This is because of the processes involved during recycling. Sometimes pollution still occurs in the process of transforming the items and most of these processes also require a lot of energy. At the end of the day, it's like we are trying to solve a problem but in the process of solving it, were creating another problem in a different form."*

When stakeholders were asked if green building materials and technologies were worth incorporating in future buildings, 100% indicated that they were. Despite the concerns raised by a few, the response was still positive with emphasis that improvements needed to be considered.

4.4. To come up with a sustainability learning guide in enhancing green building materials and technologies in the growing green economy.

This was the fourth and last objective. From the findings of this research, a sustainability learning guide was produced. Figure 10 shows the learning guide which was created from the findings.

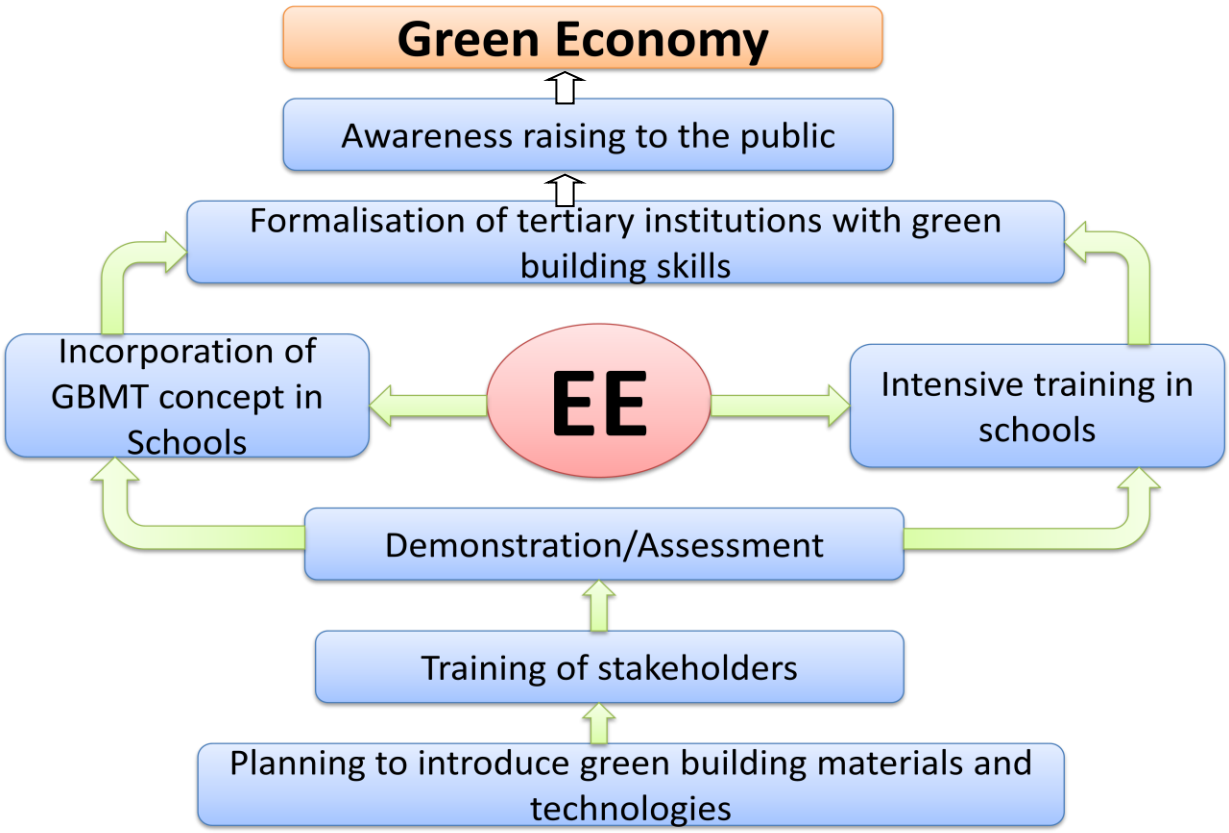


Figure 4.10: Sustainability learning guide

The learning guide in figure 5.10 shows the importance of environmental education in the promotion of GBMT for a sustainable environment. The interpretation of the learning guide from the bottom is as follows.

Planning of introducing green building materials and technologies should have environmental education component. The next stage involves stakeholders involved in construction these are contractors, engineers, architects, and settlement planners. These should be engaged in a training of green building materials and technologies and benefits that should be expected must be highlighted in the training. This should lead to the third stage which is demonstration. This should involve constructing a demonstration house with green building materials and technologies then allow it to be occupied and used in order to observe the performance of these green building materials and technologies in a period of about 3 years. Evaluation should be conducted annually. This would help to know the performance of the materials and technologies in all seasons. At this stage, there is need for another conference to educate stakeholders on pros

and cons of green building materials and technologies based on observations from the demonstration house. This would help in improving future green buildings. This stage then leads to two other stages. One which involves trainings done in schools using non-formal education (workshops and seminars) to educate pupils/students on environmental benefits of green buildings, the other stage which involves the collaboration of stakeholders with the ministry of education in incorporation the concept of green building materials and technologies in the school curriculum. The two stages then lead to the collaboration of stakeholders and ministry of education into formulating syllabi and institutions that offer GBMT trainings and finally this should lead to various awareness activities to members of the public which should include (Poems, songs, formation of clubs, workshops seminars etc). If the members of the public are aware of the benefits of green building materials and technologies, this would influence their choice of buildings. The more the green buildings, the more the servings, the better the settlements and the more development is expected. This will eventually help achieving a sustainable environment and green economy.

4.5 Conclusion

The findings clearly revealed that green building materials and technologies in Lusaka district have environmental benefits. In as much as there were a few concerns from negative experiences, the benefits outweighed the negatives. The benefits of great buildings are quite broad as they include water efficiency, energy efficiency, resource use efficiency, occupancy's well-being as well as massive savings. The stakeholders engaged in the study equally indicated that green buildings had numerous environmental benefits but it was also clearly stated that some improvements were needed in some materials and technologies. The findings were summed up by a sustainability learning guide.

CHAPTER FIVE: DISCUSSION OF FINDINGS

5.1 Introduction

The study clearly reveals that green building materials and technologies have significant environmental benefits. It is also important to elaborate how this study is connected to its theoretical framework. The theoretical framework for this study was called ecocentrism. According to this theory, ecosystems matter in their own rights and individuals have value determined by how positively they contribute to the wellbeing of the ecosystems. There is a great link to this study in that, the promotion of GBMT focuses on how best buildings can be constructed with the most possible minimal harm to the environment. The water efficiency measures are meant to preserve water which is a habitat for lots of species. Energy efficiency measures are equally meant to preserve natural resources for instance, the use of coal to generate electricity depletes fossil fuels as well as polluting the air. Cleaner sources of energy like solar, wind and many other renewable sources are recommended in green buildings. Waste management in terms of recycling equally helps reducing land pollution. In short, the whole concept of GBMT is to preserve the environment as much as possible just like the ecocentrism theory suggests.

5.2 Discussion of findings in relation to other research findings

As mentioned in the presentation of findings that the usefulness of green building materials and technologies in promoting environmental sustainability formed themes namely, water efficiency, energy efficiency, resource use efficiency, good waste management practices and promotion of occupants wellbeing. Further it was realised that green buildings also enhance massive savings.

This chapter will now discuss the findings of this study in relation to other findings from the global, African and local (Zambian) contexts. The findings of this study revealed that in Lusaka district, green buildings have achieved water efficiency through the following technologies. Installation of rain water harvesting, installation of aerators in taps, grey water recycling, pre-set sprinkler, and the use of self-closing taps. Occupants of green buildings with these technologies confirmed the high water efficiency that comes with these technologies. Foxdale court has achieved its water efficiency through rain water harvesting systems. The GBCSA 2012 equally

confirms the achievement of water efficiency through rain water harvesting systems from findings of the case study conducted in Catormano Durban, South Africa. Foxdale Court may not have revealed percentages of efficiency. However, the GBCSA revealed a 6% reduction of municipal water use after the installation of rain water harvesting systems.

Green building features in Lusaka district also include energy efficiency technologies from the findings of this research. These include the use of LED bulbs, installation of motion sensors in the lighting system, use of temperature regulatory glazing, large windows for natural lighting, occupancy sensors, solar power, insulation of ceiling and double wall system. It was evident from the study that these interventions highly enhance energy efficiency. Similarly, Harvard University,(2017) indicated the achieved energy efficiency from the many energy efficiency technologies installed in the Harvard University building. The technologies equally included the installation of motion sensors and the LED bulbs amongst the other technologies. The use of occupancy sensors is evident at Citi Bank and the use of LED bulbs at both Foxdale Court and Citi bank in Lusaka district. In both studies it is evident that energy efficiency was achieved.Further, the findings of Irungu 2016 in her case study equally highlighted the achievement of energy efficiency through the usage of LED bulbs.

Similar to the situation in Lusaka, The WGBC (2017:2) found large openings/windows very essential in reducing energy use as they reduce the need for lighting during day time. In Lusaka, this is evident in all green buildings where the study was conducted. Solar was equally found to be environmentally friendly as it is a clean source of energy. The use of solar as a clean source of energy is also highlighted by the World Green Building Council in its case study at University of Nottingham. Just like is the case at Foxdale court and Thornpark construction school according to the findings of this research.

Contrary to the findings of this study which revealed that energy efficiency measures in Lusaka district resulted in less energy use, a case study conducted by the GBCSA (2014) in cator manor showed a rise in energy use after putting energy efficiency interventions. The Green building features which were added to these houses include solar installation, solar geysers, energy saving bulbs and use of wonder bags for cooking. The highest energy use amongst the households prior to the intervention was 300kwand it went up to 600kw after intervention. There is however need

to do a further investigation to understand why there was a rise in energy use after adding energy efficiency technologies.

Further, this research revealed that green buildings have good waste management systems through recycling, reusing, decomposing, and reducing In Lusaka district. During this study, it was revealed that in Lusaka district, two of the green buildings namely, Foxdale Court and Levy junction mall, separate their waste for instance, paper, plastics, food waste, boxes and other types of waste in readiness for recycling/reusing/decomposing. As a result, the environment is totally clean. Other than that, a lot of waste is diverted from the landfill as it is reused/recycled/decomposed. These findings are similar to those of Irungu (2016) whose research focused on finding out the green building practices in the hospitality industry in order to put up a model that can be adopted by other lodges/hotels in Kenya. Sunday (2014: 34), equally indicated in his research findings that extensive use of recycled materials help conserve, restore, and preserve the eco-system. Further, Phoya (2018), in her research findings stated that "Most implemented sustainable practices in construction sites include reuse of construction materials and separation of waste skips on sites" The essence of her research was to examine the nature of sustainable construction management practices implemented by contractors in Dar es Salaam Tanzania.

Further, in a research conducted by the USGBC (2012), at Harvard University, the building which was retrofitted had bins meant to separate different types of waste in order to effectively manage waste. The categories included metals, plastics, compostables, landfill waste and so on. According to the USGBC, 42% of the total waste by weight was properly diverted from the landfill. In other words, green buildings that separate waste, recycle, reuse and decompose have achieved a clean and health environment and also preserve the environment.

The findings of this research further revealed that green buildings in Lusaka district enhance occupancy well-being. The features of green buildings that enhance occupancy well-being are as follows. Glazing that favors Ventilation (Large/enough openings), temperature regulating glazing (Keep indoor temperatures desirable), Double wall system (acts as insulator and keeps indoor temperatures desirable), Glazing that favors adequate natural light (Lessens stress to see), Low VOC paints (Lessens toxicities from the evaporating gas). A number of green buildings Case studies done across the world equally review high levels of occupancy well-being achieved

from the various green building interventions. Harvard University (2017) indicated in its case study that the retrofitted building achieved occupancy well-being by mainly improving its indoor air quality. This was achieved through the use of low VOC adhesives, sealants, paints, coatings, primers, and flooring systems. All wood and agrifiber products were also free of urea-formaldehyde. Additionally, all systems furniture selected for the project was either Green guard certified or BIFMA level certified and free of chemical flame retardants.

Equally, the U.S. Department of Energy (2012) highlighted the achievement of occupancy well-being though retrofit by adding the following features in a building. Shaded High Performance glazing which reduces heat gain through windows, well insulated exterior walls and roof which reduces heat gain through exterior wall and low volatile organic compounds finishes which provides a healthier indoor environment. It is a well-known fact that temperature plays a vital part in creating an environment for productivity. Too hot an environment makes occupants very inactive. Too cold equally slows down workers morale to work.

The findings of this research further revealed that green buildings in Lusaka district yield lots of savings. The savings are achieved through different interventions which include water and energy efficiency as well as good waste management systems which enable companies to sell waste. For instanceat Citi bank, glazing that allows enough natural light, LED lights and occupancy sensors yield 50% servings. From aerated taps and water flow control their savings are 25%. Even if percentages of savings were not indicated in other buildings, it was confirmed that there were massive savings. Further, Foxdale has had savings from waste management practices. Because of waste that is recycled, the frequency of waste collection to be taken to the landfill is reduced (Payment is done per collection). Levy junction equally separates waste and actually generates money from the collected waste by selling. Other case studies done across the world equally confirm the aspect of savings that come with green building features.For instance, (USGBC, 2012) achieved savings up to $2,672 annually from the energy efficiency features incorporated in the building that was retrofitted. The U.S. Department of Energy (2012) indicated in their case study that Renewable electricity produced by sunlight hitting the roof, hot water Solar Panels and water heating minimizes electric bills. In another study done by the Smart Market (2016), it was indicated clearly that, green buildings would have 14% savings in operational costs over five year and 13% savings in operational costs over five years for green

retrofit and renovation projects. Building owners also reported that green building, whether new or renovated command a 7% increase in asset value over traditional buildings (Smart Market, 2016).

5.3. Conclusion

It can be concluded that green buildings across the world have been essential in enhancing environmental sustainability. It is realized from the comparisons of findings that green buildings lead to energy efficiency, occupancy well-being, water efficiency and good waste management systems. Further, it leads to massive savings.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

Below are the conclusions and recommendations from this study.

6.1. Conclusions

It can be concluded that green building materials and technologies play a vital role in promoting environmental sustainability. Encouraging the use of these materials and technologies would benefit not only the contractors and occupants but the country as a whole. Environmental education has to be at the centre of all activities. The gap in awareness was noticed during the study. This was because some occupants of these green buildings were actually not aware that the buildings were green or that the initiatives used in the buildings had some environmental benefits. This implies that very few people involved in construction are actually aware about these technologies. If environmental education is done intensively it can influence people on what kind of houses they would like to build in future. Knowing the benefits would help them have the right choice that enhances environmental sustainability. Baring in mind that the concept is quite new in Zambia, there is need to do intensive awareness raising so as to let members of the public know the importance of green buildings.

In as much as there are areas that need improvements, it cannot be ignored that there is also need for further observations. Realising the need to promote environmental sustainability should propel the use of these materials and technologies. The government together with all ministries should join hands in embracing these new initiatives. Knowing well that EIA guidelines were already formulated and implemented by the ministry of local government and housing, the use of these guidelines should drive the Zambian economy to a greener economy. Further, intensive trainings are needed for more people to have skills required to install these technologies that are new. Exportation of labour should not be encouraged as this would compromise the economic and environmental benefit of this concept. Instead, local people should be trained and benefit in terms of employment. This can also work as one of the ways to eradicate poverty. Green buildings and technologies if taken seriously can improve our settlements. Considering that local materials and labour are cheaper, this would help Zambians have decent accommodation with not much money used. This can also reduce the peri urban area/shanty compounds where accommodation is very poor. These areas are actually prone to disease outbreaks, unsanitary

conditions and poor access to water and energy. Green buildings can act as a response to such problems.

6.2. Recommendations

The study makes the following recommendations:

- Carry out intensive awareness raising – Bearing in mind that the concept is quite new in Zambia, there is need to carry out intensive awareness raising spearheaded by ILO so as to let members of the public know the importance of green buildings. ILO in conjunction with its stakeholders, NCC, ABCEC and NAMSSEC have conducted provincial workshops engaging contractors as well as engineers, architects and planners under the Ministry of Infrastructure Housing and Development (MIHD) to sensitise them in green construction as they are directly involved in construction of settlements in the country. However, this concept is very important for all to know not only people directly involved in construction.

- Government should take a lead in the use of green building materials and technologies – The Government together with all ministries should join hands in embracing these new initiatives. Knowing well that EIA guidelines were already formulated and implemented by the Ministry of Local Government and Housing, the use of these guidelines should drive the Zambian economy to a greener economy.

- Intensive skills training – Intensive trainings are needed for more people to have skills required to install these technologies that are new. Exportation of labour should not be encouraged as this would compromise the economic and environmental benefit of this concept. Instead, local people should be trained and benefit in terms of employment. This can also work as one of the ways to eradicate poverty. Green buildings and technologies if taken seriously can improve our settlements. Considering that local materials and labour are cheaper, this would help Zambians have decent accommodation with not much money used. This can also reduce the peri urban area/shanty compounds where accommodation is very poor. These areas are actually prone to disease outbreaks, unsanitary conditions and poor access to water and energy. Green buildings can act as a response to such problems.

- Incorporating the concept of green buildings and technologies in school curriculums – In as much as this concept sounds to be building related, it is quiet broad and covers alot of sustainability issues for instance, resource use efficiency, energy and water efficiency, occupants well-being (comfort and health), waste management, use of local resources and labour. It opens new opportunities for jobs for local people. This concept therefore should be incorporated in primary and high schools as well as tertiary institutions. If these practices are incorporated in our daily lives, then there would be less problems like load shedding, unavailability of water in some areas, dumping of garbage in the streets and many more problems being faced currently in Zambia.

- Encouraging the use of green building technologies and materials – In terms of energy serving bulbs, people should be encouraged to use heat dissipation bulbs. Most of the LED bulbs that do not last are interrupted by the heat that keeps accumulating as they are in use. According to Soni (2018: 45), "LED bulbs have many components inside to change the high voltage electricity from your home or building to the lower voltage that the LED chips need to run. Because of this, they are much more sensitive to heat than incandescent or halogen sources. You will frequently find that many low cost LED bulbs carry a warning that they should not be placed in fully enclosed fixtures. The reason for this is that this heat buildup can shorten the life of the components inside of the LED bulb. Only use fully enclosed rated LED bulbs in fixtures of this type or you may void the warranty". The use of self-charging bulbs should also be encouraged. These are bulbs that charge as they are in use. As a result when there is a power cut, they still provide light for a while before actually cutting completely.

REFERENCES

Allen, C.& Crafford, K. (2016). African Energy-Plus Construction – A Case Study of House Rhino. In *Sustainable Ecological Engineering Design* (pp. 95-109). Springer, Cham.

Bahnemann, D. (2004). Photocatalytic water treatment: solar energy applications. *Solar energy*, *77*(5), 445-459.

Bernstein, H.M. (2008). *Global Green Building Trends: Market Growth and Perspectives from Around the World*. McGraw-Hill Construction: New York.

Best,J.W.(1970).*Research in Education(2nded) Printice*. Hall,INC. Englewood Cliffs: New Jersey

Chaiyapinunt, S., Phueakphongsuriya, B., Mongkornsaksit, K., &Khomporn, N. (2005). Performance rating of glass windows and glass windows with films in aspect of thermal comfort and heat transmission. *Energy and Buildings*, *37*(7), 725-738.

Chin, M., Diehl, T., Ginoux, P., &Malm, W. (2007). Intercontinental transport of pollution and dust aerosols: implications for regional air quality. *Atmospheric Chemistry and Physics*, *7*(21), 5501-5517.

Center for Climate and Energy Solutions (2015).*21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change*. Paris/france.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.

Crystal, J. D. (1997). Systematic Nonlinearities in the Memory Representation of Time .*Journal of Experimental Psychology: Animal Behavior Processes, 23, 267–282.*

Doeringer, W. A., Dykeman, D., Kaiserswerth, M., Meister, B. W., Rudin, H., & Williamson, R. (1990). A survey of light-weight transport protocols for high-speed networks. *IEEE Transactions on Communications*, *38*(11), 2025-2039.

ERB (2016).*Laodshedding in Zambia,* ERB: Lusaka.

Foxdale Court. (2016).*World Environment Activities-2016.*Foxdale Court: Lusaka.

Garg, V, & Bansal, N. K. (2000). Smart occupancy sensors to reduce energy consumption. *Energy and Buildings, 32*(1), 81-87.

GBCSA. (2012).*Improving Lives by Greening Low-Cost Housing.* GBCSA: Capetown.

Ghaffar, S. (2005). *Research in Education and Social Sciences*. The printman; Peshawar

Hubert, W. W. (1964). *U.S. Patent No. 3,127,786*. Washington, DC: U.S. Patent and Trademark Office.

ILO. (2015).*Annaul Impact Report*. ILO: Lusaka.

Kappstein, I. Grundmann, H., Hauer, T. and Niemeyer, C., (2000). Aerators as a reservoir of Acinetobacterjunii: an outbreak of bacteraemia in paediatric oncology patients. *Journal of Hospital Infection*, *44*(1), pp.27-30.

Kotze, C. (2008).*Sustainable Construction In Africa School of Architecture, Planning and Housing University of Natal.* King George V Avenue: Durban.

Kroeze, C., &Reijnders, L. (2007). Halocarbons and global warming. *Science of the total environment*, *111*(1), 1-24.

Kumar, R. (2011).*Research Methodology: A step by step guide for beginners.* SAGE Publications: Singapore,

LEEDS (2009).*Benefits of green building.* LEEDS: England.

Lewis, N. S. (2007). Toward cost-effective solar energy use. *Science*, *315*(5813), 798-801.

Li, F., Wichmann, K. and Otterpohl, R., 2009. Review of the technological approaches for grey water treatment and reuses. *Science of the Total Environment*, *407*(11), pp.3439-3449.

MarwaHeilman, V. (2016*). Factors hindering the adoption of sustainable design and construction practices*: the case of office building development in Dar es Salaam, Tanzania.

Mpakati-Gama, E. C., Wamuziri, S. C., & Sloan, B. (2012, September). Green Building Challenges: Evaluating the Operation of Adopted Building Assessment Tools-Case Study. In *Procs28th Annual ARCOM Conference* (pp. 3-5).

Odebiyi Sunday, O., Subramanian, S., & Braimoh, A. K. (2010). Green architecture: merits for Africa (Nigerian case study). *Journal of Alternative Perspectives in the Social Sciences*, *2*(2,746-767).

Phoya, S. (2018). Sustainable Construction Sites in Tanzania: Contractors' Practices and Their Perspectives, *International Journal of Construction Engineering and Management*, Vol. 7 No. 2, pp. 88-96. doi: 10.5923/j.ijcem.20180702.05.

Pongrass, R.G. and Rutter, C.C., Pongrass Robert G and Rutter Christopher C, 1983. *Self-closing fluid dispensing valves*. U.S. Patent 4,421,297.

Rahman, A., Keane, J. and Imteaz, M.A., 2012. Rainwater harvesting in Greater Sydney: Water savings, reliability and economic benefits. *Resources, Conservation and Recycling*, *61*, pp.16-21.

Roux,P.(2009).*Sustainable Building Materials*, Cape Town Press: Cape Town.

Shen, L. Y., Tam, V. W., Tam, C. M., & Drew, D. (2004). Mapping approach for examining waste management on construction sites. *Journal of construction engineering and management*, *130*(4), 472-481.

Singaravelu. G. (2012).*Sample &Sampling Design.* Bharathiar University: Coimbatore

Siva, V., Hoppe, T., & Jain, M. (2017). Green Buildings in Singapore; Analyzing a Frontrunner's Sectoral Innovation System. *Sustainability*, *9*(6), 919.

Skellenger, D. P. (1907). *U.S. Patent No. 851,999*. Washington, DC: U.S. Patent and Trademark Office.

Slabbert, G. (2013). *The emergence of green building practices: case study of Stellenbosch* (Doctoral dissertation, Stellenbosch: Stellenbosch University).

Smart Market. (2016). *World Green Buildings Trends, Dodge Data &Analytics*, Smart Market: Bedford.

Soni, V., Singh, P., Shree, V., & Goel, V. (2018). Effects of VOCs on Human Health. In *Air Pollution and Control* (pp. 119-142). Springer, Singapore.

Springer, J., Roxwell International Ltd, 1999. *Double walled insulated tubing and method of installing same*. U.S. Patent 5,862,866.

Sutherland, A.A., 1912. *Closet-flushing device*. U.S. Patent 1,048,228.Thousand Oaks, CA: Sage

UNEP. (2012). *Building Design and Construction: Forging Resource Efficiency and Sustainable Development.* UNEP: New York.

US Embassy. (2015).*Green Building Materials and Technologies at US Embassy-Zambia*. US Embassy: Lusaka

UGBC, (2012). Blackstone South Office Building Leed for Existing Buildings V346Blackstone South Office Building Blackstone Street, Cambridge: UGBC

USGBC. (2008).*A National Green Building Research Agenda November 2007.USGBC Research Committee.* USGBC: New York.

UN (2019)*Sustainable Development Goals | The Role Of Business Action | CDP.net* UN: England.

Ut Tran Thi (2010).*Participatory Action Research*, Handout, Hong Bang University

WGBC (2015).*World GBC Annual Report*. WGBC: London

Windapo, A. O. (2014) *Examining Green Building Drivers.* Capetown Publishers: Cape Town.

York, D., Neubauer, M., Nowak, S., & Molina, M. (2015, January). Expanding the energy efficiency pie: Serving more customers, saving more energy through high program participation. In *American Council for an Energy-Efficient Economy*.

ZEMA. (2012).*State of Environment Outlook Report*. ZEMA: Lusaka

ZGJP (2015) *Annual Impact Report,* ILO: Lusaka

Zhang, T., Zhu, H. and Croue, J.P., 2013. Production of sulfate radical from peroxymonosulfate induced by a magnetically separable CuFe2O4 spinel in water: efficiency, stability, and mechanism. *Environmental science & technology*, *47*(6), pp.2784-2791.

Zikmund, W.G. (2003). Business *Research Methods*. Thomson South-Western, USA

APPENDICES

Appendix 1: Consent Letter

Dear participant,

My name is Chipo Moonga a Zambian female student at the University of Zambia pursuing a master's degree in environmental education under the school of education.

This research I am conducting is part of my academic requirement. The main objectives of carrying out this study is to examine the effectiveness of Green building material and technologies in the promotion of environmental sustainability, determine prospects brought by green buildings materials and technologies in promoting a green economy and to determine the role of sustainability in enhancing green building materials and technologies in the emerging green economy.

There is no direct benefit to you anticipated from participating in this study. However, it is hoped that the information gained from the study will help in adding knowledge and literature on the sustainability of the green buildings in Lusaka district. Other than that, this study will review areas that may need improvement where green buildings and technologies are concerned. This will eventually lead to a green economy, which will promote environmental sustainability. Generally this will help the country to develop economically while conserving the environment, saving costs and living in a healthier environment.

Kindly be assured that your identity in this study will be kept confidential. No name or any of your personal details will be disclosed, therefore to explain on the findings, the term "participant" will be used.

Further, your decision to participate should be done out of your willingness to contribute to this study. In an event where you are uncomfortable to participate in this research, you have the right to decline or withdraw from participating at any time without penalty. By signing this form, you are agreeing to be part of the study.

Your truthfulness in your responses will be of great importance to this study as it will enhance accuracy in the findings.

If you wish to participate in this study, please sign below**.**

Participant's Name	Date	Signature
Researcher's Name	Date	Signature

Appendix 2: A semi structured interview guide

SECTION A: BACKGROUND CHARACTERITICS

i) Name:

ii) Occupation:

iii) Professional Qualification:

SECTION B: BENEFITS OF GREEN BUILDING MATERIALS AND TECHNOLOGIES IN PROMOTING ENVIRONMENTAL SUSTAINABILITY.

iv) What green building features does your building have?

v) How can you rate the performance of the above mentioned materials and technologies in terms of percentage?

vi) How effective have these materials been in promoting environmental sustainability?

vii) Are you aware of any features/characteristics of these green building materials and technologies that compromise their effectiveness?

viii) If this building was not green, do you feel you would have been facing any negative impacts? If yes what are they? And if no why do you think so?

ix) Have you ever had any bad experience with any of the green building material /technology?

SECTION B:DETERMINE PROSPECTS BROUGHT BY GREEN BUILDING AND MATERIALS AND TECHNOLOGIES IN PROMOTING GREEN ECONOMY

x) From your observations and experience, what would be your preference given an option to choose between a conventional building and green building?

xi) What advantages have you observed in green buildings that may not be present in conventional buildings?

xii) In what ways do you think green buildings can enhance development in our country?

xiii) In what ways do you think green buildings can lead to a green economy?

xiv) Are there any servings you have observed from the use of green buildings materials and technologies?

xv) Do you think the building materials and technologies considered to be green are truly green?

xvi) What makes the materials and technologies qualify/not qualify to be green?

xvii) What measures would you suggest to either improve them or make them green

Observation guide for the sustainability assessment of green building materials and technologies in Lusaka District.

Ref	Description	Comment
1	Visible Green building materials and technologies	
2	Condition of green building materials and technology	

STAKEHOLDERS INTERVIEW GUIDE

SECTION C: INVESTIGATE THE PERCEPTIONS OF VARIOUS STAKEHOLDERS ON GREEN BUILDING MATERIALS AND TECHNOLOGIES

SECTION A: BACKGROUND CHARACTERITICS

i) Name:

ii) Occupation:

iii) Professional Qualification:

SECTION B: PERCEPTIONS ON GREEN BUILDING MATERIALS AND TECHNOLOGIES

iv) What do you understand by green building materials and technologies?

v) What green building materials and technologies are you aware of?

vi) Do you think green building materials and technologies green as they are intended to be?

(a) Yes they are green

(b) They are not really green

Give reasons.

vii) Do you think they can be improved in any way to make them more functional for their purpose?

viii) Do you think they are worth adopting in future buildings?

ix) Are there any green building materials and technologies you feel should be done away with? If yes, why?