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ADAPTATION OF THE SUSTAINABLE BUILDING RATING SYSTEM TO ZAMBIAN CONTEXT

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DECLARATION

I, Anderson Zulu, declare that this dissertation entitled, “Adaptation of the Sustainable Building Rating System to Zambian Context” is entirely my own original composition and that, all errors of interpretation and weakness of analysis in this work are entirely mine. All references made of other authors have been duly acknowledged.

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DEDICATION

This dissertation is dedicated to my wife, Stella, who has constantly shaped my vision and whose encouragement has made sure that I give it all it takes to finish that which I have started. I am truly thankful for having you in my life. To my children Langizya and Lana who have been affected in every way possible by this quest. Thank you, this is meant for you. My love for you all can never be quantified.

This work is also dedicated to my parents, Langton and Gertrude Zulu, who have always loved me unconditionally and whose good examples have taught me to remember where I come from.

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ABSTRACT

Despite playing a key role in most economies, building construction contributes significantly to climate change. Buildings consume energy, water, and raw materials, generate waste, and emit potentially hazardous air emissions during the course of their lives. These facts have prompted the creation of green building standards, certifications, and sustainable rating systems aimed at reducing the direct and indirect social and environmental impacts of buildings through sustainable design. While some developed countries have embraced and promoted these rating systems, developing countries such as Zambia have yet to do so. Therefore, this research sought to identify sustainable building rating system (SBRS) that is well suited to the Zambian setting and adapt that system to Zambian Context. The methodology adopted was a mixed method employing both qualitative and quantitative approaches, with data collected through semi-structured interviews as well as an observation checklist. The respondents considered for this study a total of seventeen respondents purposively sampled from seven green rated buildings across Africa, these included designers, facilities managers, and contractors. The findings revealed that though there are hundreds of sustainable building rating systems, the Green Star South Africa (Green Star SA) rating system would best respond to the Zambian environment because Green Star SA was influenced by the most popular rating systems. Further, Green Star SA is provided by Green Building Council of South Africa (GBCSA) which already have structures for adaptation by African countries. The study, therefore, recommends that the Zambia Green Building Association (ZGBA) to collaborate with GBCSA and submit a local context report for review and approval by GBCSA as a prerequisite for the establishment of Green Star Zambia.

Key words: Adaptation, Building, Rating system, Sustainable, Environment

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LIST OF ACRONYMS

BIM	Building Information Modelling
BMS	Building Management System
BREEAM	Building Research Establishment Environmental Assessment Method
CO2	Carbon Dioxide
DALI	Digital Addressable Lighting Installation
DGNB	German Sustainable Building Council
EBP	Existing Building Performance
EDGE	Excellence in Design for Greater Efficiencies
EWP	Energy Water Performance
FSC	Forest Stewardship Council
GBC	Green Building Council
GBCSA	Green Building Council South Africa
GHG	Greenhouse Gas
GRZ	Government of the Republic of Zambia
G-SEED	Green Standard for Energy and Environmental Design
HDPE	High Density Polyethylene
HQE	Haute Qualite Environnementale
HVAC	Heating, Ventilation, and Air Conditioning
IEQ	Internal Environmental Quality
IFC	International Finance Corporation
LCA	Life Cycle Assessment
LDP	LEED Dynamic Plaque
LEED	Leadership in Energy and Environmental Design
PVC	Polyvinyl Chloride
RS	Rating Systems
SB	Sustainable Buildings

SBRS	Sustainable Buildings Rating System
SDG	Sustainable Development Goals
SHG	Sustainable Housing Guidelines
SIP	Sustainability Integration Process
VOC	Volatile Organic Compound
VRF	Variable Refrigerant Flow
ZGBA	Zambia Green Building Association

CHAPTER ONE
INTRODUCTION

1.1 Background

Buildings are an intrinsic part of our lives. The shelter they provide is enshrined in the Universal Declaration of Human Rights, and those who spend their working lives in offices know that buildings also have a significant influence on productivity, health and contentment. Regrettably, buildings are also responsible for more than one third of global energy use and in most countries, they are the largest source of greenhouse gas (GHG) emissions. The high consumption of energy by buildings is a contributing element to GHG emissions (Jobs, 2016). Sustainable building techniques, on the other hand, have been proven to be one of the most effective technologies for combating climate change. Existing and new buildings can minimize energy consumption if there is a balance in the complex relationship between development and the environment, based on particular standards addressing green construction needs. The construction industry can be encouraged to produce more sustainable buildings as a strategy to decrease the negative environmental consequences if the sustainable rating system is regulated by government entities and legal requirements.

Climate change is expected to have a particularly detrimental impact on Africa, with significant social, environmental, and economic consequences (Jobs, 2016). Climate change is largely caused by increased carbon emissions from human activities and a reduction in the ability of the natural environment to absorb carbon dioxide, leading to an accumulation of greenhouse gases in the upper atmosphere. These gases trap heat leading to global warming and as a result, average temperatures may increase by 5°C by the end of the century (IPCC, 2014). Climate change and the impacts attributed to the built environment mean that it is imperative that built environments address global climate change and respond to local sustainable development requirements. Consequently, the demand for environmental performance in buildings necessitates the development of systems that can assess the environmental impact of buildings (Mtonga & Kaliba, 2021).

In a quest to respond to the global climate trends, The Government of the Republic of Zambia and the private sector founded the Zambia Green Building Association

(ZGBA) in 2015. The Zambia Green Building Association was established to address concerns with green building governance, education and technical training, advocacy, awareness-raising, and green certification that give organizations and buildings a way to be recognized publicly as being green. In 2016, the Government through the Ministry of Local Government and Housing formulated the Sustainable Housing Guidelines (SHG) aimed at addressing global climate change and local sustainable development priorities. This study, therefore, intends to investigate how building developments in Zambia can have their own tailor-made sustainable building rating system to assist in reducing their direct and indirect social and environmental impacts.

1.2 Background to the Case Study Area

The marketplace of the design and construction of high-performance buildings is dynamic and evolving. Professionals throughout the building industry use assessment rating systems to evaluate and differentiate their product or design. World-wide there are hundreds of building evaluation tools that focus on different areas of sustainable development and are designed for different types of projects. These tools include life cycle assessment, life cycle costing, energy systems design, performance evaluation, productivity analysis, indoor environmental quality assessments, operations and maintenance optimization, whole building design and operations tools, and more (Ghaffarianhoseini & Tookey, 2017). Sustainable Building Rating Systems encompasses most of the tools listed above.

For the purposes of this research, ‘Sustainable Building Rating Systems’ are defined as tools that examine the performance or expected performance of a ‘whole building’ and translate that examination into an overall assessment that allows for comparison against other buildings (Fowler & Rauch, 2006).

The Zambian construction industry has not seen much of sustainable building construction principles being put into practice. This is attributed in part to the lack of awareness/training. Besides the need for capacities, technologies and tools, ardent commitment by all players in the construction industry including the government and the public is required in order to achieve sustainable construction in the Zambian Construction Sector (Mtonga & Kaliba, 2021).

Zambia's government buildings are typically built for a 100-year life span following General Construction Standards for Government buildings and the Public Health Act Chapter 295 of the Laws of Zambia. The above legislation does not compel design teams to create the highest quality buildings from the sustainable or green building perspective. However, in 2015, the Urban and Regional Planning Act was revised to provide for development, planning and administration principles, standards and requirements for urban and regional planning processes and systems. Further, in 2016, Sustainable Housing Guidelines were prepared to support the development of housing that addresses global climate change and local sustainable development priorities. The above guidelines were meant to introduce sustainable or green building principles in housing design. Sustainable Guidelines for government buildings are yet to be developed.

1.2.1 Sustainable Building Construction

Sustainability is not synonymous with green. Green building construction is generally used to describe a process which starts well before construction in the planning and design stages, and continues after the construction teams have left the site (Hill & Bowen, 1997). According to the World Commission on the Environment and Development (WCED), sustainability is a form of development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (Kibert, 2016). Sustainability design goes far beyond simply creating products that benefit consumers in terms of better air environment, cost savings and durability, rather, effective sustainable design must illustrate a thorough understanding of a full systems approach of products in their environment and interaction, with other products, as well as the effect on many other factors. Sustainability should be viewed as a process and not just a goal that allows a broader evaluation over time of the environmental, economic and societal impacts of buildings products (E Ojo, 2013). Viewing sustainability as a process is essential for green designs as specifiers are challenged to evaluate the full life cycle of products (E Ojo, 2013). The sustainability aspects in the built environment are generally concentrated on reducing the environmental footprint of buildings. Furthermore, sustainable construction can be qualified as a special case of sustainable development targeting the construction industry; the building contractors, materials manufacturers, and suppliers whose role is to develop, plan design, build, alter or maintain the built environment (Adebayo, 2002).

1.3 Statement of the Research Problem

Zambia and Sub-Saharan Africa (SSA) as a whole are falling behind due to numerous obstacles to the implementation of sustainable construction. Lack of statutory regulations regarding sustainable buildings and inadequate building regulations to promote sustainable practices, are some of the obstacles to sustainability in Zambia (Sambo Lyson Zulu, 2022). The delayed rate of the adoption of sustainable technologies in developing countries may be caused by the lack of local assessment tools. The challenge in Africa is a lack of political and economic drive to create new tools that can adapt to their environment (Aghimien DO, 2018).

Given the challenges associated with achieving sustainable rated buildings in Zambia, the problem statement for this research is therefore that Zambia's lack of a locally developed green rating system presents a barrier to the construction of sustainable buildings in the country.

This study has identified a sustainable building rating system that is appropriate for Zambia that evaluates important technical features of sustainable design, provides a realistic, consistent foundation for comparison, and isn't overly burdensome to implement and communicate.

1.4 General Research Objective

The general objective of this research is to identify and adapt a sustainable building rating system to Zambian context**.**

1.5 Research Objectives

1. To identify all prominent sustainable rating systems in order to select an appropriate one for the Zambian setting.
2. To determine what influences the choice of sustainable rating systems used on various developments.
3. Modify the chosen rating system to make it easy to use and adapt to the changing world.

1.6 Research Questions

1. What are the available sustainable building rating systems in the world and how do they compare with each other?
2. How do developers, designers and authorities choose what sustainable building rating systems to use on various developments?
3. Are the current sustainable building rating systems easy to use and adapting to the changing world?

1.7 Significance of the Study

According to the executive Director United Nations Environment Programme (2011), the building sector is the single largest contributor to global greenhouse gas emissions with one third of global energy use taking place in offices and homes – a figure that is set to double by 2030 unless urgent action is taken. So the design and construction of new buildings – and the refitting of existing ones – represents one of the key, low cost ways of combating climate change while reducing electricity bills and dependence on fossil fuels. Along with green transportation, buildings are thus a central part of a transition to a Green Economy and a sustainable 21st century.

Buildings that are designed sustainably must adhere to guidelines that optimize life cycle costs, enhance quality, and reduce their environmental impact. In order for the country's structures to be compared fairly to other structures throughout the nation, and ultimately the world, the authorities must consistently rate the structures using a single rating system. Utilizing a single sustainable building rating system provides a way to compare and evaluate existing structures and a way to monitor the advancement of the developers’ progress towards designing and operating the best buildings for their occupants.

Therefore, understanding how green building developments are dependent on Sustainable Building Rating Systems will help equip policy makers with adequate knowledge regarding policy advice to render to the Government. Such knowledge can then be used to systematically examine the process of policy formulation, implementation and evaluation. In addition, the data collected, and findings of this research can be used to make recommendations on how the most suitable sustainable rating system can successfully be adapted to Zambian context, and deeper knowledge of the aspects included in the tool has been given for further evolution and growth of the sustainable rating system in Zambia.

Furthermore, academicians in the field of engineering and the built environment, may refer to such studies in their academic work. Findings of this study are useful for academicians as they can be used for the development of more theories in this thematic area.

1.8 Scope of the Study

While there are numerous building developments in the world, this study will focus on three green buildings in the African region and four in Zambia. These include, United Nations building in Nairobi, Kenya, Nedbank Building in Sandton and Vodafone Building in Midrand both in South Africa. The newly constructed Evexia Building in Lusaka along Church Road, Citibank Lusaka at Addis Ababa Roundabout, the American Embassy and Standard Chartered Bank Zambia Head office in Lusaka will be the local case studies. The study further reviewed the process followed by countries interested in collaborating with the Green Rating Building Organization in South Africa (Green Star SA certification) in formulating their own sustainable building rating system.

1.9 Methodology

The study was mixed in nature, it employed qualitative method through semi structured interviews with Designers/Architects, Contractors, Facilities Managers, and Property Developers from the selected building developments. These experts were chosen through purposive sampling method. Secondary data was collected through personal observations using a checklist, and from extensive review of literature, policy documentation, drawings, and specifications. The inductive approach to qualitative analysis was then used to analyze the data collected for the purpose of this research.

1.10 Chapter Synthesis

The chapter profile of this research is as follows:

Chapter 1 introduces the Research and outlines the background to the study and research problem.

Chapter 2	reviews literature by other researchers and scholars.
Chapter 3	outlines the research design and provides further details on the mode of data collection and analysis.
Chapter 4	presents the findings and analysis of the research.
Chapter 5	presents a discussion of the research findings.
Chapter 6	draws the research conclusion, recommendations, and proposed research to be carried out in the future.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant literature relating to sustainable building concept. The review firstly discusses the concept of sustainable building and the significant role it plays in climate change mitigation. Thereafter, it has briefly discussed the Sustainable Housing Guidelines formulated by the Government of the Republic of Zambia (GRZ), through the Ministry of Local Government and Housing; it has also done a comparison of popular sustainable rating systems (SBRSs). Lastly, it reviewed empirical literature relating to the sustainable development goals (SDGs) that has shaped the development of SBRSs.

2.2 Sustainable Building Concept

Sustainable Building concept is an integrated process that focuses on a relationship between the built environment and the natural environment (Howe, 2010) while incorporating the social and economic implications. Buildings can influence the area they are in, the people who live there, and their surroundings in both positive and negative ways. A technique called life cycle assessment (LCA) illustrated in figure 2.1 below is used to evaluate how items used in construction affect the environment from raw materials through processing, transportation, usage, and end-of-life disposal or recycling.

Figure 2.1-1 The **Life Cycle Assessment of Sustainability**

Source: (Petarčić, 2016)

2.3 Sustainable Buildings

A Sustainable building is one that has been constructed in an environmentally conscious manner, making efficient use of all the natural resources available and being always mindful of the environment. The design, building construction, general building operations, ongoing maintenance, renovation, and demolition of the building are the different stages in the development of a green building. These stages of construction can be classified into broad categories that are essential for qualifying as a sustainable building. The broad categories include site selection and planning, water management, energy efficiency of the building, creating a health indoor environment, building materials and resources, and innovation (Montserrat, 2019). The above are the fundamental components used in developing the sustainable building rating systems.

2.3.1 Site Selection and Planning

Where a building is located has a direct effect on many of the other aspects of the building‘s performance, the local climate, solar access, shading, the form and orientation of the the building on a site, all have a direct impact on the building’s ventilation, energy and lighting needs (BigRentz, 2021). The majority of rating systems recommend putting a building on a contaminated brownfield site to improve the environment through environmental cleanup. Grey field come second, these are sites that have been developed with over 20% impevious surfaces and infills, vacant lots with impreviously built areas. All these types of sites restrict the spread of the built area into the green fields- lands not previously developed, forests and protected natural areas or near to wetlands where rain water runoff from the built environment.

While planning, all the trees and natural vegetation should be preserved at the site. Trees should be integrated within the design of the building. Passive architecture techniques should be integrated within the design of the building. To illustrate, the building and all windows should be oriented according to the position of the sun and the direction of the wind.

2.3.2 Water Management

Typical water management process is depicted in figure 2.2. According to Prof. A. Balasubramanian, fresh water makes up just 2.5 percent of the water available on our planet with even a smaller percentage (0.014%) easily accessible for human consumption (Balasubramanian, 2015). With the earth’s population growing and the water becoming more scarce, the ability to effectively use water becomes extremely important.

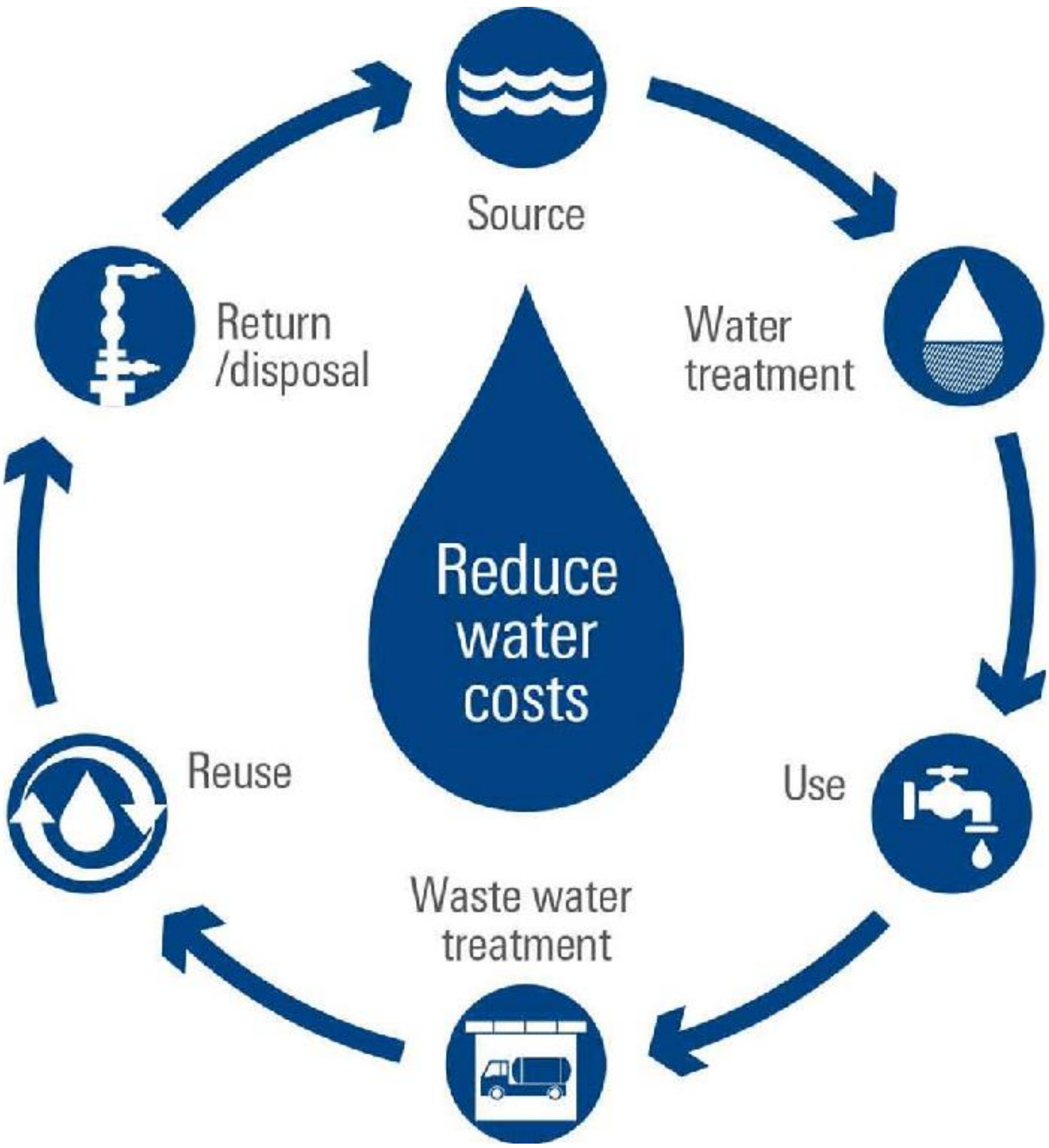

Figure 2.1-2 Water Management Process

Source: (Razmjoo, et al., 2020)

The overall consumption and wastage of water should be reduced by using efficient methods. This can be done by using water efficient plumbing fixtures in the bathrooms and kitchens of the building (Keeler & Vaidya, 2016). A good rainwater harvesting system should be incorporated within the roof and the outdoor areas of the building. The design should incorporate recharge trenches or recharge pits that can divert the rainwater into the ground water table. The wastewater recycling plant should be installed within the building premises to recycle the wastewater instead of releasing it directly into the sewer (Ministry of Local Government and Housing, 2015). The recycled water can be used for gardening and for flushing the toilets.

2.3.3 Energy Efficiency of the Building

Energy efficiency and consumption areas are the main focus of all sustainable buildings. By reducing energy consumption and generating onsite energy, a building can achieve a net zero or even a net positive energy consumption (BigRentz, 2021). Therefore, a building should be energy efficient with low operating costs, air conditioning costs and overall maintenance costs. The renewable energy source includes adequate natural lighting that lights up the interiors for most of the day. This helps in reducing the overall electricity costs. It is essential to install solar heaters, these use solar energy to heat the water (Ministry of Local Government and Housing, 2015). Solar panels should be incorporated within the roof over the building to harness solar power. To prevent indoor heat again, the building should be insulated by using hollow bricks for construction. A reflective roof coating or roof garden can keep the building cool in summer. Water bodies should be integrated within the indoors and outdoors because they keep the surroundings cool with the process of evaporating cooling. Keep an adequate number of plants within the indoors and outdoors because they cause cooling by transpiration. Water vapour is released by the leaves which cool the surrounding temperature.

2.3.4 Creating a Health Indoor Environment

Green building ensures good comfort levels along with the well-being of its occupants. The position of all the windows is designed to ensure cross ventilation and some designs incorporates courtyards to allow cool air to flow within the building (Keeler & Vaidya, 2016). The kitchens, bathrooms and basements should have exhaust fans to extract dampness, indoor air pollutants and foul odours from these areas. Only Low volatile organic compound (VOC) sealants paints and adhesives should be used for the construction of the building. This is because they do not cause indoor air pollution and do not emit toxic gases. The indoor and outdoor noise levels should be within acceptable limits as per the local byelaws of that particular area. In addition, there should be good accessibility for people with disabilities. The bathrooms, ramps and elevators have to be wheelchair- accessible.

2.3.5 Building Materials and Resources

The types and amounts of material used in construction can have a huge impact on the environment (Keeler & Vaidya, 2016). A green building is constructed with sustainable building materials like bricks, bamboo, terracotta, wood of fast-growing trees and rammed earth to name a few. These materials are locally sourced, are easily available and cost-effective because of the low cost of transportation. Green buildings are also constructed with recycled materials like recycled metal, fly- ash which is a byproduct of thermal power plants and by reusing building blocks made using materials such as wood which are salvaged from old building structures. Another criterion is that during construction, minimum amount of wastage should be produced at site (Ministry of Local Government and Housing, 2015). After construction, all the building construction waste should be efficiently segregated in different categories like wood, plastic, brick and mortar, concrete, steel, soil etc. and should be sent to the construction and demolition waste recycling facility.

2.3.6 Innovation

Green building must also use innovative technology systems that can reduce the overall carbon footprint of the building. Low emissivity coated glass can be used for the building to prevent indoor heat gain through the windows or structural glazing. The use of energy efficient air conditioners is a very important part of innovative green building design.

A building qualifies as a green building if these parameters are taken into account of while planning, designing and construction of the building this design parameters make the green building sustainable, energy efficient with a low carbon footprint and highly responsible towards the environment.

2.4 The Sustainable Housing Guidelines- Zambia

The Sustainable Housing Guidelines were formulated to support the development that addresses climate change and sustainable development at a local level. They describe design strategies, management processes, technologies and techniques that are useful in developing sustainable housing in Zambia. The objectives of the guidelines include the following (Jobs, 2016):

i. To improve the understanding and awareness of sustainable housing by key stakeholders involved in the housing development sector.
ii. To provide guidance on the design of sustainable housing.
iii. To support sustainability performance monitoring and evaluation of housing.
iv. To provide a basis for the development of regulations and standards to promote sustainable housing development.

According to the Sustainable Housing Guidelines (SHG), the construction industry, which is a major consumer of natural resources, is regarded as one of the enablers of economic growth in Zambia. As a result, Zambia needs to develop mitigation and adaptation strategies. The construction sector, in particular, offers tremendous opportunity to combat climate change and advance a green economy.

In addition to linking housing to climate change and sustainable development, the SHG's objectives also establish specific criteria to be followed when implementing housing. However, the criteria and objectives by themselves are insufficient to achieve sustainability, therefore, the SHG outlines an integration process called the Sustainability Integration Process (SIP). This is summarized in Table 2.1

Table 2.1-1 The Sustainability Integration Process

Lifecycle Stage	**Sustainability Integration Process**	**Sustainability Integration Questions**
Planning	Strategically review and assess the needs of the client and potential sites to ensure the most sustainable options are chosen	Is the building necessary? Has the site been assessed in terms of sustainability considerations?
Design	Developing strategies that achieve sustainability targets such as material selection, building design and construction methods. Conduct a full assessment to verify compliance with sustainability targets.	Has sustainability been achieved in the concept design? Has sustainability assessment of the design been conducted?
Construction	Ensure the contractor is briefed on sustainability requirements and processes. Monitor and ensure that sustainability targets in the construction process are met and take corrective action where necessary	Does the contractor have a good understanding of the sustainability requirements and how they are to be accomplished? Is monitoring of sustainability of the construction process in place?
Operation	Monitor operational sustainability targets. Ensure user awareness systems are in place.	Is sustainability performance being monitored and evaluated regularly? Are the building users aware of sustainability processes?
Reuse/ Demolition	Upgrade sustainability performance in buildings that are being reused. Minimise the generation of waste during demolition by reusing and recycling materials	Can the building be reused instead of demolishing it? Where demolition is unavoidable, plans to maximise reuse and recycling in place?

Source: Sustainable Housing Guidelines (2015)

2.5 Sustainable Building Rating Systems

The widespread recognition of the significant negative effects that the construction industry has on the environment has led to the widespread adoption of tools (rules, regulations, voluntary rating systems) that can be used to control and direct construction projects in the path of environmental sustainability. In this shared vision, the natural environment is essentially seen as a resource that needs to be safeguarded. But nature is not only something that should be protected; it is also a key reason to improve the quality of our built environment.

An object can be categorized using a Rating System (RS) depending on how well it complies with one or more relevant requirements. Relevant requirements are those that have an impact on the performance of the object, whose level the system is meant to evaluate. When determining a building's level of sustainability, a RS must consider a number of criteria and determine how each one performs in relation to a shared baseline, which could be statutory levels or a benchmark for comparison with comparable structures. A RS scores or rewards relative levels of building performance or their compliance with specific environmental goals and criteria. (Lia Marchi, 2021)

Both in literature and practice, the tools that assess the impact construction has on both its local surrounding and the broader environment go by a variety of titles. Among the most popular are Green Building Rating Systems, Sustainable Building Rating Systems, Sustainable Rating Tools, Green Building Assessment systems, certifications, and protocols. Each of them differs in a few ways and uses different techniques, methodologies, and applications that are found within the same family of tools. Consequently, it is challenging to provide a comprehensive characterization of these instruments.

2.5.1 Components of Sustainable Building Rating Systems

Green Building Rating Systems are performance credit systems that provide ‘green’ certifications and ratings to buildings. The systems allocate points to specific ‘green’ criterions. The addition of all those points provides the basis for the “green building” certification.

2.5.2 Development of Sustainable Building Rating Systems (SBRS)

The need for the built environment to adopt environmentally and socially responsible practices has long been acknowledged because it is one of the primary causes of socioecological problems, most notably climate change. The need to deal with growing global challenges is the context in which Sustainable Building Rating Systems (SBRS) have been developed. According to (Ding, 2008) even though the evaluation of a building's environmental attributes, such as air quality and indoor comfort, had started earlier, it wasn't until the development of multi-criteria assessment schemes (such as SBRS) that the issue was approached holistically rather than one topic at a time using separate indicators and criteria. In this context, SBRSs appeared as a more comprehensive, user-friendly, and informative way of spreading sustainable construction, as compared to the more precise but time-consuming and highly technical methods like Life Cycle Assessment (LCA) and comparable frameworks that employ several intricate indicators.

Further, voluntary sustainable building rating systems tries to fill the gap between mandatory building codes and designing and constructing a building that has a least impact on the natural environment. They not only consider the building's impact on its inhabitants and the natural environment, but also building's ongoing ecological footprints, educating building's inhabitants and some SBRSs even look into the social and equitable implications of the building. In an ideal world, the mandatory building codes would fully mitigate any environmental impact, however, building codes are far from addressing the full needs of the natural environment.

Sustainable Building Rating Systems began back in 1993 with the launch of the British Building Research Establishment Environmental Assessment Method (BREEAM) for new building sustainable design (Team, n.d.) in the United Kingdom. This was followed by France's Haute Qualite Environnementale (HQE) in 1996. In 2000, the United States Leadership in Energy and Environmental Design (LEED) was launched, over the past few decades, these and other SBRSs have matured and developed into highly sophisticated blueprints on how to build sustainable high-performance buildings that protect human health and the natural environment. In 2001, the Japanese Comprehensive Assessment System for Building Environmental Efficiency

(CASBEE) was introduced. The Australian Green Star made its appearance in 2002. It is important to note that BREEAM, LEED, and Green Star NZ share the same patterns in the characteristics of categories. This is due to the strong influence of BREEAM on LEED and Green Star development, as demonstrated in Figure 2.3 (Ghaffarianhoseini & Tookey, 2017).

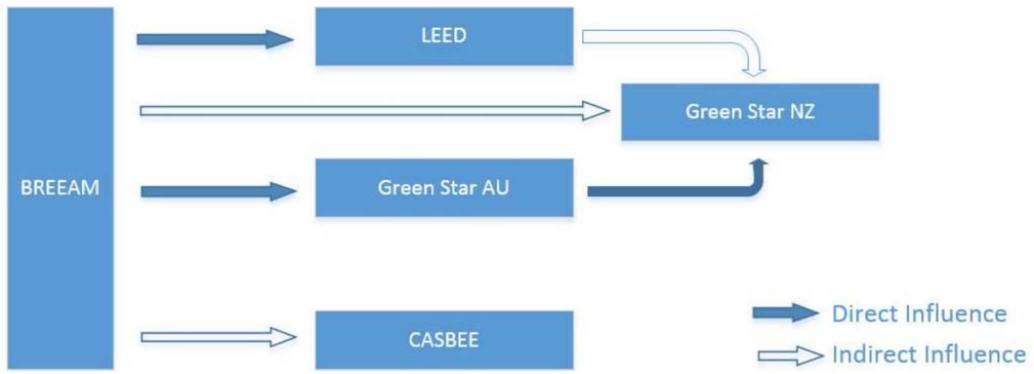

Figure 2. 3 The Relationship among Green Ratings

Source: adapted from Mao (2017)

DGNB – NSQ is one of the newest rating systems and the first one from Germany developed in 2009 (Hamedani & Huber, 2012).

Korea has developed and applied the G-SEED (Green Standard for Energy and Environmental Design) rating system, which was designed specifically for its own building environmental issues and needs (Lee & Shepley, 2019).

However, compared to other continents, Africa has a comparatively. The certification system of Excellence in Design for Greater Efficiencies (EDGE) established in 2014 focuses on the major problems not only in developed countries but also developing countries, especially Africa, where it helps to build resource-efficient buildings (Isimbi & Park, 2022).

2.5.3 Objective of Sustainable Building Rating Systems

The main objective of SBRSs is to motivate all stakeholders in the construction industry to strive toward a more liveable, healthy, and just living environment. This objective attempts to raise aspirations of governments, corporations, owners, and practitioners (Marchi, et al., 2021). Green building certification is sought after by building owners, designers, clients, and occupants because it offers a variety of economic and environmental benefits including energy and water savings, reduced waste and CO2 emissions, increased occupancy rate and market value, enhanced productivity, and improved health and user satisfaction (Stephanie, 2022).

SBRSs were created for assessment purposes, but they also act as design support tools (Marchi, 2020) and are effective project management tools because they provide a structured procedure for outlining significant synergies among the building's components and activities.

Since green building clients often do not clearly have an idea of what those entails, and at the same time architects are not always able to clearly motivate sustainable design strategies they envisage to their client, a further scope is to improve communication by making the building's performance noticeable to the market. Given that the rating processes are typically voluntary, this is a vital goal for them. Accordingly, it follows that the motivations for applying a rating tool are educational and marketing purposes, as a SBRS tool can provide owners and design teams with an efficient way of determining and communicating the ecological performance of the building; guidance effects in identifying the green standards to be followed and in choosing environmentally friendly products, materials, and strategies that the project can benefit from; and means of supporting stakeholders in becoming more aware of the value of green building and its long-term benefits (Marchi, et al., 2021).

2.5.4 Sustainable Building Rating Systems - Comparison in Approaches

SBRSs can vary in their approach to measuring a building's performance, some are prescriptive based and specify the minimum or maximum values for various elements in construction. In contrast, others are performance based where the desired outcome in modelled into a computer software and compared to a baseline. There is a push towards outcome-based verification that measures energy usage of the final occupied build project over a twelve-month period to validate whether the building meets the requirements of the rating systems.

There are however five fundamental areas that all SBRSs under green construction code use to help reduce the impact of the building on our planet. These are location and site, water, materials, energy, and air.

However, all SBRSs have certain traits and strategies that serve as the cornerstones of this type of tool, such as the use of a multi-criteria structure and the presentation of the outcome as an overall score. Many other differences can be found in each RS, which need to be thoroughly examined to describe particular features. However, comparing the four most used SBRSs globally (Say & Wood, 2008) can provide a good, though not full, picture of this diversity and provide an opportunity to discuss different approaches as indicated in figures 2.4 and 2.5.

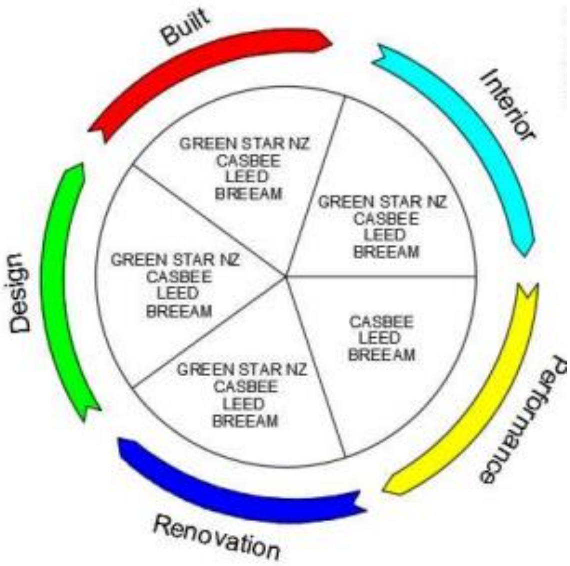

Figure 2. 4 Overview of Rating Systems- Building aspects

Source: adapted from Mao (2017)

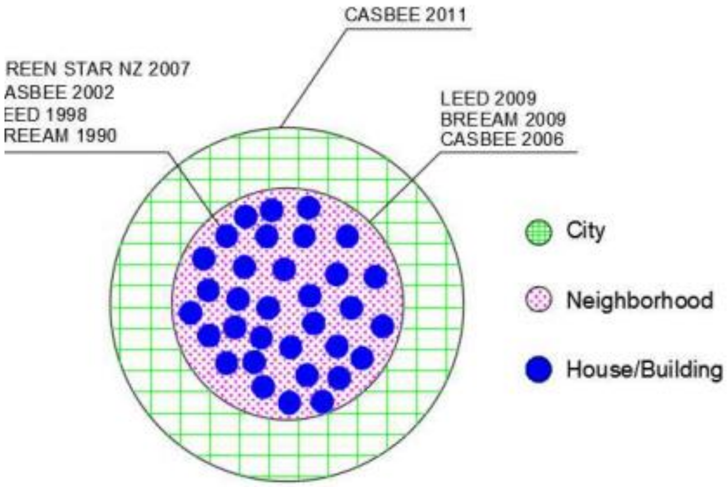

Figure 2. 5 Overview of Rating Systems- Building Context

Source: adapted from Mao (2017)

Table 2.2 compares BREEAM, LEED, Green Star, and CASBEE by emphasizing: i) the building adaption schemes that are accessible; ii) the basic evaluation categories; iii) the assessment processes; and iv) the certification levels. This made it possible to identify both important similarities - which are also fundamental elements of other GBRSs - and key differences.

Table 2.1-2 Comparison of most Diffused SBRSs worldwide

	BREEAM	LEED	CASBEE	Green Star
(i) Building adaptations	New Construction In-Use Refurbish. and Fit-Out Communities	New Construction Exist. Buildings Operations and Maintenance Comm. Interiors Core and Shell Schools Retail Healthcare Homes Neighbor. Develop.	Pre-design New Construction Existing Building and Renovation	Communities Buildings Design and As Built Interiors Performances
(ii) Categories	Management Health and Well-being Energy Transport Water Material Waste Land Use and Ecology Pollution Innovation	Integrative Process Location and Transportation Sustainable Site Water Efficiency Energy and Atmosphere Material and Resources Indoor Env. Quality Regional Priority Innovation	Indoor Environment Quality of Service On-site Environment Energy Resource and Materials Off-site Environment	Management Indoor Environment Quality Energy Transport Water Material Land Use and Ecology Emissions Innovation
(iii) Assessment method	Pre-weighted categories	Additive credits	BEE ranking chart	Pre-weighted categories
(iv) Certification levels	Pass $\geq$ 30 Good $\geq$ 45 Very Good $\geq$ 55 Excellent $\geq$ 70 Outstanding $\geq$ 85	Certified 40–49 Silver 50–59 Gold 60–79 Platinum $\geq$ 80	Poor: BEE < 0.5 Fairy Poor: BEE 0.5–1.0 Good: BEE 1–1.5 Very Good: BEE 1.5–3 or BEE $\geq$ 3 and Q < 50 Excellent: BEE $\geq$ 3 and Q $\geq$ 50	Min. Practice (1 star) Average Practice (2) Good Practice (3) Best Practice (4) Austr. Excellence (5) World Leader. (6)
Data source	[18]	[20]	[21]	[26]

2.5.5 Categories

Topics in different tools are known as Credit Category, Evaluation Area, Topic, Theme, etc., and they compile a set of criteria, credits, requirements, and core indicators that measure specific performances, by Indicators (Cordero, et al., 2019). Despite differences in names and details, nearly all SBRSs address the same core topics, demonstrating that the green building industry has similar concerns at a global level.

The primary BREEAM assessment categories focus on low impact design, lowering carbon emissions, resilience and durability, adaptation to climate change, ecological value, and biodiversity preservation. To combat climate change, improve occupant well-being, safeguard water resources, and promote biodiversity, regenerative material cycles, the green economy, community justice, and quality of life, LEED encompasses a broad range of sustainability goals. As a result, the other two SBRSs employ very similar categories (Marchi, et al., 2021).

2.5.6 Assessment Method

These tools' multiple-criteria structure enables each design team to choose the best strategy (i.e., credits) to achieve the intended result (i.e., certification level). However, several SBRSs have established a certain number of mandatory credits to prevent only certain topics being covered (i.e., prerequisites in LEED and BREEAM).

Each credit has in general a maximum number of points allocated over the entire assessment, and the findings are added to determine the overall score for sustainability assessment carried out. The weighting process adopted by BREEAM, and Green Star consist of pre-weighting categories before adding up selected credits, whilst the "additive credits" method of LEED allows a straightforward addition of all selected credits. CASBEE adopts a totally different and more complex approach: instead of calculating single credits and summing up, all the measurements are divided in internal and external loads and displayed on a graph (Marchi, et al., 2021).

2.5.7 Certification Levels

Each rating system adopt its own levels of certification, which are hardly comparable to each other. However, what can be observed is that all associate a qualitative or symbolic description to the numerical score or index. This shows how crucial it is for SBRSs to communicate their findings to the general public and non-technical audiences.

A project receives a certification level or grade based on the assessment. BREEAM rates from Acceptable (existing buildings only) to Pass (>30), Good, Very Good, Excellent, up to Outstanding (>85), corresponding to an increasing number of stars reported on the certificate. LEED uses four levels: Certified (>40), Silver, Gold, and Platinum (>80). The number of stars awarded by Green Star increases from Minimum Practice (1 star) to World Leadership (6) (Lia Marchi, 2021).

2.5.8 Integration of Existing SBRSs

While several Green Building Councils and other organizations around the world are updating and improving their rating systems to close the gap and eliminate the detected flaws, additional crucial elements are being integrated to enhance and broaden their uses.

The first approach is to incorporate Life Cycle Assessment (LCA) methods and indicators within SBRSs. This means not only the design or construction stages are evaluated, but also some projections are made of previous and following phases.

Another attempt of integration is Level(s), the framework for assessing and reporting on the sustainability performance of buildings recently issued by the European Union. In line with the call to uniform SBRSs' languages, the EU proposes a common set of simple indicators that relates the various building energy performances to the EU priorities as set by the Circular Economy Action Plan (CEAP) in 2020 (Cordero, et al., 2019). As a result, many international sustainability certification tools are aligning to Level(s), ensuring common EU policy objectives are considered.

In addition to ongoing upgrading and refinements of existing schemes, the most recent developments in the field are giving birth to other families of instruments. They are similar in approach and structure but differ in scope.

A set of tools shifts from sustainability to resilience since it is thought to be a more appropriate framework for the shifting nature of global concerns. Among the most known are the Resilience-based Earthquake Design initiative (REDi) by Arups Advanced Technology and Research team (Almufti & Willford, 2013) and Resilience Action List (RELi) by the USGBC (Wholey, 2015). These combine resilience-based innovative design criteria with integrative design processes for assessing and guiding the design of neighbourhoods, buildings, homes and infrastructures according to acute events (such as earthquakes, flooding) or chronic critical status of the ecosystem.

2.6 Sustainable Building Rating Systems- Comparisons

During the latter half of the of the 20th century, individuals all over the world started to boost their efforts in decreasing the environmental effects of buildings due to the growing awareness that buildings play a significant role in global energy usage, depletion of green spaces and landfill waste. This led to the establishment of voluntary assessment methods with the sole purpose of objectively assessing environmental performance of both new and existing buildings (IFMA, 2014). "Green building rating systems are methods used to certify green buildings and serve as a means of reducing construction impacts along the entire life cycle". Green Building Rating Systems are performance credit systems that provide 'green' certifications and ratings to buildings. The systems allocate points to specific 'green' criterions. The addition of all those points provides the basis for the "green building" certification.

These systems measure performance of buildings based on a range of principles. These systems were primarily created to clearly define, implement, and measure green goals or sustainability (Florez, 2020). Over the years, numerous green rating systems have been formulated across the globe and have further evolved from being voluntary to mandatory in some countries. Hundreds of GBRSs are now available worldwide, varying in approaches, application processes, and evaluation metrics. Among the most widely used globally are BREEAM, LEED, Green Globes, Green Star and CASBEE. Other notable GBRS include German Sustainable Building Council (DGNB), Haute Qualite Environnementale (HQE), The Green Standard for Energy and Environmental Design (G-SEED) and EDGE (Excellence in Design for Greater Efficiencies). Despite some differences, they all adhere to the same general evaluation structure: project performances areas measured using a set of relevant indicators, grouped per topics such as water management, energy use, materials, site qualities. According to (Mtonga & Kaliba, 2021) sustainable buildings are assessed by: (1) reduced production of greenhouse gas emissions (particularly carbon dioxide); (2) reduced use of natural resources, in particular, water, gas and electricity; (3) reduced waste production and increased recycling; (4) enhanced building occupant health, comfort, and safety; (5) production of renewable resources; (6) collection of water for potable and non-potable uses; and (7) recycling and treatment of sewage and waste water. Each assessed requirement is assigned a score/judgment and the sum of those scores, or judgments determines the level of sustainability achieved. In addition to regular updates, a current trend is to improve the effectiveness of protocols, making them more comprehensive and accurate, while keeping them easy to use.

The Building Research Establishment Environment Assessment Method (BREEAM) which was developed by the United Kingdom, is the first rating system to have been developed in the world. It is widely used and recognized globally due to its longevity and influence on other rating systems (Florez, 2020). The Leadership in Energy and Environmental Design (LEED) is a widely recognized rating system for measuring sustainability, that was developed by the United States Green Building Council (USGBC). From inception, LEED focused on new construction, however, over the years it has been expanded to include several other rating systems that focus on the design and construction of both new construction and existing buildings. Green Globes is another rating system offered in Canada, United States and United Kingdom, and has rating systems for both new and existing buildings. Green star is a rating that originated in Australia and has been adapted in other countries including New Zealand and South Africa (Marchi, et al., 2021) (IFMA, 2014). CASBEE is exceptional in that it is based on the concept of closed systems. Further, the assessment is limited to two elements: building performance and environmental load. The rating is expressed as an eco-efficiency gauge (BEE) given on a graph with environmental loads (L) on one axis and quality (Q) on the other; more sustainable buildings have the lowest environmental loads and highest quality.

The certification system of Excellence in Design for Greater Efficiencies (EDGE) focuses on the major problems in not only developed countries but also developing countries, especially Africa, where it helps to build resource-efficient buildings. The EDGE building certification system was established in 2014 by the International Finance Corporation (IFC). For residences in South Africa, EDGE certification is exclusively provided by the Green Buildings Council of South Africa (GBCSA). EDGE assists with cost calculations, emphasizes resource (energy, water, embodied energy in materials) efficiency, saves time through a streamlined process and provides bioclimatic modelling (Isimbi & Park, 2022). Educational facilities, residential buildings, accommodation facilities, medical facilities, light industry, office buildings, and retail and warehouses are among the building types with EDGE certification.

Table 2.3 shows the certification criteria of different certification systems. Some certifications have common criteria, sometimes named differently. It is important to remember that each certification credit has its own subcomponent and requirements and is given different points based on its impacts and focus. Additionally, the same criteria may be covered under different categories or combined with other aspects. Some elements, such as CO2 reduction, are included in some criteria but are not considered criteria on their own.

Table 2.1-3 Overview of certification criteria of different certification systems

Item	EDGE	BREEAM	LEED	DGNB	HQE	CASBEE	G-SEED
Energy	✓	✓	✓	-	✓	✓	✓
Water	✓	✓	✓	✓	✓	-	✓
Materials	✓	✓	✓	-	-	✓	✓
Indoor Environment	-	-	✓	✓	✓	✓	✓
Resources	-	✓	✓	✓	-	✓	✓
Land use	-	✓	-	✓	✓	-	✓
Transport	-	✓	✓	✓	-	-	✓
Site	-	-	✓	✓	✓	✓	-
Waste	-	✓	-	✓	✓	-	-
Ecology	✓	✓	-	-	-	-	✓
Innovation	-	✓	✓	-	-	-	-
Management	-	✓	-	-	-	-	✓
Pollution	-	✓	-	-	-	-	✓
Atmosphere	-	-	✓	-	-	-	✓
Health and wellbeing	-	✓	-	-	-	-	-
Integrative process	-	-	✓	-	-	-	-
Location	-	-	✓	-	-	-	-
Regional priority	-	-	✓	-	-	-	-
Resilience	-	✓	-	-	-	-	-
Economic quality	-	-	-	✓	-	-	-
Biodiversity	-	-	-	✓	-	-	-
Functionality	-	-	-	✓	-	-	-
Safety and security	-	-	-	✓	-	-	-
Technical quality	-	-	-	✓	-	-	-
Process quality	-	-	-	✓	-	-	-
Olfactory comfort	-	-	-	-	✓	-	-
Maintenance	-	-	-	-	✓	-	-
Quality of service	-	-	-	-	-	✓	-
Life cycle Assessment	-	-	-	✓	-	-	-
Components	-	-	-	-	✓	-	-
Off-site environment	-	-	-	-	-	✓	-

2.7 Empirical Literature

The idea of green building has slowly gained traction throughout the world (Doan, et al., 2017). Regulations, norms, tactics, and techniques have been established over the past few decades to encourage a quick and efficient change in the design and construction processes, with an emphasis on energy efficiency. At a global scale, several goals of the 2030 United Nations (UN) Agenda for Sustainable Development address the issue (UN, 2015). According to the World Health Organisation, the Sustainable Development Goals (SDGs) aim to transform our world. They are a call to action to end poverty and inequality, protect the planet, and ensure that all people enjoy health, justice and prosperity. Sustainable Development Goals (SDGs) comprises 17 goals and 169 targets. The SDGs replaced the Millennium Development Goals (MDGs) by merging the agendas of development and environment (Bexell & Jönsson, 2017). Goals 6, 7, 12, 13, 14 and 15 are directly related to environmental sustainability. The targets in these goals are mainly linked to natural environment. The aforementioned goals address clean water and sanitation, affordable and clean energy, sustainable consumption of natural resources, climate change, life below water and on terrestrial ecosystems, halting biodiversity loss and combating land degradation and desertification (Arora & Mishra, 2019). However, goals 11 and 9 also discusses cities and their infrastructure respectively. In sustainable buildings, focus was drawn to SDGs 11, 9 and 7 which directly address components used in sustainable rating systems. SDGs n. 11 (Sustainable cities and communities), n. 9 (Industry, innovation and infrastructures), and n. 7 (Clean and affordable energy). The following is a basic explanation of the aforementioned Sustainable Development Goals:

2.7.1 SDGs n. 11 - Sustainable cities and communities

SDG n. 11 aims at making cities and human settlements inclusive, safe, resilient and sustainable (Franco B. sabel, 2020). SDG n. 11 also addresses rapid urbanisation. More than half of the world’s population live in urban areas and the amount is still rising. Rapid urbanization is often associated with extreme poverty as governments struggle to keep up with the increasing number of inhabitants. This leads to rising prices and the development of slums and unsafe areas with lack of functioning transportation or infrastructure. SDG n. 11 addresses problems cities are facing from a sustainable development perspective. Sustainability in cities is important because they have such a large impact in peoples' everyday life. Cities provide people with homes, workplaces and surroundings for fulfilling life. Sustainable cities are designed with consideration of their social and environmental impact. They require cities to be dedicated to waste reduction, reducing the excessive use of energy, minimizing air and water pollution and providing access to green spaces, such as parks and other public areas. Sustainable cities promote the use of public transport, use of renewable energy and production and consumption of local food sources. It is also vital that cities are safe, inclusive and accessible for all citizens. SDG n. 11 wants to ensure that everyone has access to safe and affordable housing, basic services and that everyone can utilise sustainable transport systems. Because cities have such a high concentration of people in one space, they are traditionally big polluters (Ministry of Local Government and Housing, 2015). This explains why they need to make a positive social and environmental contribution especially when it comes to reliable infrastructure and transportation.

2.7.2 SDG n. 9 - Industry, innovation and infrastructures

SDG n. 9 promotes building a resilient infrastructure and inclusive sustainable industrialization (Franco B. sabel, 2020). It aims to foster innovation globally. SDG n. 9 is most tangible to private sector since industry and innovation are usually associated with businesses. Creating new business models, services and products is essential for almost any company. SDG n. 9 promotes innovating in a sustainable way. It also strives to reduce the environmental impact of industries. To illustrate, through increased resource efficiency and sustainable infrastructure, innovations can stimulate growth and thus create new jobs and income. It also stresses the importance of domestic technology development and research and innovation in less developed countries and the need for access to internet all around the globe.

2.7.3 SDG n. 7- Clean and affordable energy

SDG n. 7 aims to ensure access to affordable, reliable, sustainable, and modern energy for all (Franco B. sabel, 2020). It targets problems of lack of electricity to a billion people in the world, overuse of electric power by the rest of the world every year, and generation of electric power from unsustainable, non-renewable sources such as coal, natural gas and petroleum (Arora & Mishra, 2019). These sources also release a huge amount of carbon dioxide and other harmful chemicals in the atmosphere. The problem of energy is two-fold: many have to live without it, while on the other hand, only a small part of the increasing amount of energy for the rest of the population comes from renewable sources. If the consumption of unsustainable energy continues at the current rate, it will be depleted. There are many steps to be taken to prevent the above. The world needs to invest in the development of new, safe energy sources, make renewable infrastructure more energy efficient and that requires more international cooperation to facilitate access to clean energy research and technology.

2.8 Summary of Findings

Table 2.2 provides a summary of the most widely used green rating systems and their respective components.

Table 2.1-4 Most Widely Used Rating Systems

System	Year	Country of Origin	Buildings Certified	Rating Schemes	Levels of Certification
BREEAM	1990	United Kingdom	594,011 (2021) in 89 countries	• Communities • Courts • Education • Health care • Homes • Industrial • International • Multi-residential • Offices • Prisons • Retail	• Pass • Good • Very Good • Excellent • Outstanding
HQE (High Quality Environmental Standard)	1996	France	1,170 (2014)	• energy, • environment, • health, • comfort	• Pass • Good • Very Good • Excellent
LEED	1998	United States	79,418 (2021) mainly in the United States of America	• Building Design • and Construction • Interior Design • and Construction • Building • Operations and • Maintenance • Locality development • Homes	• Certified • Silver • Gold • Platinum
Green Globes	2000	Canada	Over 3,300	• Existing buildings • New construction	• 1 Globe • 2 Globes • 3 Globes • 4 Globes

System	Year	Country of Origin	Buildings Certified	Rating Schemes	Levels of Certification
CASBEE	2001	Japan	500 (2016) mainly in Japan	• Indoor Environment • Quality of Service • Outdoor Environment on site • Energy • Resources and Materials • Offsite environment	• C (Poor) • B- (Fairy Poor) • B+ (Good) • A (Very Good) • S (Excellent)
Green Star (AU) Green Star (NZ) Green Star (SA)	2002 2008	Australia (New Zealand and South Africa)	2,827 (2020)	• Design and as built communities: performance, interiors • Legacy rating tools: education, health care, industrial, multiunit residential, office, office interiors, retail center and public • building	• 4 Star • 5 Star • 6 Star for design and as built. communities and interiors • 1-6 Star for • performance
Germany Sustainable Building Council (DGNB – NSQ)	2009	Germany	8,700 (2021)	• Ecology • Economic • Social cultural and functional • Technical • Process	• Certified • Bronze • Silver • Gold
Excellence in Design for Greater Efficiencies (EDGE)	2014	US/ Africa Green Building Council of South Africa (GBCSA)	1,500 (2022)	• Energy • Water • Embodied Energy in Materials • CO_2 •	• LEVEL 1: EDGE Certified • LEVEL 2: EDGE Advanced (Zero Carbon Ready) • LEVEL 3: Zero Carbon
G-SEED (Green Standard for Energy and Environmental Design)	2016	Korea	8,000 (2017)	• Land Use and Transport, • Energy and Pollution, • Materials and Resources, • Water Management, • Ecological Environment, • Indoor Environment	• Green1, • Green2, • Green3, • Green4

Source: Adapted from IFMA (2014)

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

The preceding chapters reviewed literature on sustainable building rating systems (SBRSs) and provided a detailed comparison of SBRSs. This chapter firstly provides a brief overview on research design and thereafter provides details of the methodology employed in conducting the research. It covers the research sampling technique, collection of primary and secondary data, and analysis of data collected.

3.2 Research Design

Research design is essentially the structure or plan that is set out to collect and analyze data for the research work. It can also be considered as the decisions made with regards to collecting, processing and analyzing data (Akhtar, 2016). Given the mixed character of this study, information on sustainable building rating systems was gathered from a sample of real estate developers, designers/architects, facility managers, and contractors through semi structured interviews and previously published data. Additionally, personal observations were carried out using a checklist to determine the actual state of the seven selected rated building developments across Africa with a view to adapting sustainable building rating system to Zambian context. The inductive approach to qualitative analysis was used to analyze the data collected for the purpose of this research.

3.3 Population

Seventeen (17) experts out of the target of (twenty-three) 23 in Africa region where interviewed. The following seven buildings were selected: The United Nations building located in Nairobi, Kenya, the Nedbank Building, and the Vodafone Building both in South Africa, the Citibank at Addis Ababa Roundabout, the American Embassy, the newly constructed Evexia Building along Church Road and the Standard Chartered Bank Head office, which are in Lusaka, Zambia were included. The study further reviewed the processes followed by the Green Rating Building Organization in South Africa (Green Star SA certification) in formulating their sustainable building rating system. The experts interviewed included:

1. Designers/Architects

2. Contractors

3. Facilities Manager, and

4. Staff members of Green Rating Building Organization in South Africa (Green Star SA certification)

3.4 Sampling Method

This research employed the purposive sampling method to determine the participants of this study. Purposive sampling is a non-probability sampling method in which the researcher uses their own judgement when selecting members to participate in the research (Black, 2011). Due to the nature of the research and objectives to be met, this method proved to be the most effective given the limited number of persons and buildings that could serve as primary sources of data. In addition, purposive sampling had the following advantages:

i. It was found to the most time and cost-effective approach available (Black, 2011);

ii. Purposive sampling made it possible to validate information almost immediately, as it provides useful information that can prove the assertations of the researcher while in its raw form (Alchemer, 2021);

iii. It allows for the selection of persons that were well-informed or conversant with the field of study, as such, the margin of error could be reduced significantly (Cresswell & Clarke, 2011).

3.4.1 Sample

The targeted population were buildings in Africa region and in Zambia that employed or are in the process of implementing the sustainable building rating system, and the rating or green certification institutions. Three buildings in Africa region and four from Zambia were selected to participate in the study based on the level of certification in sustainable buildings, performance of the building, availability of a team of experts overseeing the design, construction and operation of the building, and project progress. While most building developments were found to be associated with some sustainability aspects, the United Nations building located in Nairobi, Kenya, the

Nedbank Building, and the Vodafone Building both in South Africa, the Citibank at Addis Ababa Roundabout, the American Embassy, newly constructed Evexia Building along Church Road and Standard Chartered Bank Head office, which are in Zambia met the criteria.

3.5 Collection of Data

In this research, both primary and secondary qualitative data was collected and used to address knowledge gaps and objectives of the research. Data was collected through semi structured interviews with personnel form property development firms and green certification institutions. In addition, data was collected from policy and regulatory documentation, particularly from the Sustainable Building Rating Systems and from recently published articles and books.

3.5.1 Primary Data

Primary data was collected through in-depth semi-structured interviews with Architects, Engineers and Property Developers and other personnel from building developments. Semi-structured interviews are interviews that use an interview protocol to guide the researcher while incorporating conversational aspects that allow the interviewer to prob the respondent with leading questions (Kallio , et al., 2016). Thus, the interviews were based on reviewed literature and guiding principles on sustainable building rating systems obtained from the rating institutions. Semi-structured interviews were selected in this research due to their flexibility in allowing the interviewer to probe further into open-ended questions (Newcorner, et al., 2015).

Furthermore, the observation method of collecting primary data was used to collect data from the selected building development project sites. This is a method that allows the researcher to use their vision as a means of collecting data. This method is useful in collecting data that people are unable to provide (Owlgen, 2020). A few personal observation sessions were conducted on the physical environment of the building developments in order to obtain first-hand information on the actual state of the building development sites.

3.5.2 Secondary Data

Secondary data was obtained from an extensive review of literature relating to sustainable building rating systems and their adaptation to local context of a particular country or region. This helped in understanding the concept of SBRS and their adaptation procedure. In addition, data that formed part of the basis of the interviews carried out, was obtained from the rating components of the Green Star SA rating system, specifically the weighting categories such as management, indoor environment quality, energy, transport, water, materials, land use and ecology, emissions, and innovations. Information was further obtained from drawings and specifications for the selected building development projects.

3.6 Analysis of Data

No one method of analysis can be used for all types of interview data. The method described here was appropriate for semi-structured, open-ended interviews that were carried out. It was assumed that an adapted version of this method could also be used for data arising from more clearly structured interviews.

The researcher used qualitative – deductive content analysis for most published data. The advantage of content analysis is that this research method leads to valid and replicable findings from contextual data, which further help in generating new data and thereby enhance existing knowledge. Most importantly, it assists in developing practical action guides, which happens to be the principal objective of the study. The other benefits include its sensitivity to content–context, thereby facilitating flexible research design for dealing with meaning and intention, and identifying critical processes (Pandey, 2019). The focus was on identifying frequencies and recurring words and subjects to make connections between concepts.

Further, the researcher also used thematic analysis to identify, analyse, and interpret patterns and themes in qualitative data.

Data was analyzed using the inductive approach to qualitative analysis. This a structured approach that requires the building up of categories that point to key themes that are relevant to the research (Azungah, 2018). Qualitative data has the potential to get unwieldy, thus, the inductive approach to qualitative analysis assists in maintaining focus on the purpose of the research. Broad categories in line with the research questions and objectives can be created, and in so doing, data can be sorted effortlessly (Bingham, 2021). In light of the forgoing, the inductive approach to qualitative analysis proved to be advantageous in analyzing data collected for the purpose of this research.

3.7 Ethical Considerations

This research was mainly conducted using existing data that had already been published as part of a larger study and as a result, it only involved little direct contact with the few selected participants. Participants were informed of the purpose of the research and participation was on a voluntary basis as they were under no obligation to take part in the study. Furthermore, there were no advantages or disadvantages to individuals who participated versus those who decided not to participate. The participants were interviewed either in person or via video conferencing applications.

The research was planned to meet ethical appropriateness. Approval was obtained from the selected building developments to conduct research on their premises where necessary. Participants were under no circumstances coerced or induced into taking part in the research.

All respondents were invited to participate with a clear understanding that they were under no obligation to do so and that there would be no negative consequences for them if they did not assist in the research. The confidentiality and anonymity were ensured, and the wellbeing, dignity and confidentiality of participants were protected. Lastly, no information was falsified or fabricated. Results were not misrepresented, and plagiarism and academic fraud were not committed. It is worth mentioning that works of other Authors used in any part of the dissertation were acknowledged.

CHAPTER FOUR
RESEARCH FINDINGS AND DATA ANALYSIS

4.1 Introduction

This chapter presents detailed findings of the study, and analysis of data collected based on the objectives that were formulated at the beginning of the study. The chapter states how the experts of the selected buildings understand the Sustainable Building Rating System, describes the certification awarded and sustainability achievements of some notable sustainable buildings found within the Africa region and the four green compliant buildings in Zambia. The chapter further evaluates the motivation for developing a green building, selection criteria for Sustainable Building Rating System used for each building. It also discusses the resource efficient features of the seven buildings in the study, monitoring or verification of the buildings' performance, and the chosen rating system's usability. Finally, the study reviewed the processes followed by the Green Rating Building Organization in South Africa in adapting the Green Star certification to South African context.

4.2 Descriptive Analysis

The study was conducted in seven buildings: three green buildings in the African region and four in Zambia. These include, United Nations building in Nairobi, Kenya, Nedbank Building in Sandton, and Vodafone Building in Midrand both in South Africa. The newly constructed EVEXIA Building along Church Road, Citibank at Addis Ababa Roundabout, the American Embassy and Standard Chartered Bank Zambia Head office all located in Lusaka. It was observed that other building developments in Zambia such as Protea Bonanza Resort, Sample and First Capital Bank buildings had applied for certification but could not be incorporated in the study since their evaluation by the SBRS was yet to be completed. Interviews were conducted with Designers/Architects, Contractors, Facilities Managers/Real Estate Agents, and Property Developers from the aforementioned buildings and institutions.

4.2.1 United Nations Office at Nairobi

The three-storey energy-efficient United Nations office complex facility at Gigiri in Nairobi houses the UN Environment Programme and the UN Human Settlements Programme (UN-HABITAT). The building is regarded as the first solar-powered United Nations office building in the world and was created as a model of green architecture for Africa. It's comprised of four buildings with sufficient space to accommodate 1,200 staff.

Figure 4.1-1 The Zero-Energy UN-Habitat and UNEP office building

Source: UNEP 2011

4.2.1.1 Definition of the Sustainable Building Rating System

Sustainable Building Rating System is a tool which enables designers, developers and contractors to develop a building that is energy and water efficient, to reduce and recycle resources by users, and to maximize sustainability without compromising the quality of the working environment and reducing the running and maintenance costs of the building.

4.2.1.2 Building Certification

The building is not graded or certified by any SBRS because of the developer's business practices.

4.2.1.3 Motivation for developing a green building

During the official opening of the building, the then UN Secretary-General Ban Ki-moon said the offices had set a new benchmark for sustainable buildings in sub-Saharan Africa and similar ‘green’ initiatives were to be adopted in all UN offices worldwide. The office facility has become an international showcase for sustainable buildings, and a central pillar of the United Nations broader goal of reducing its greenhouse gas emissions.

4.2.1.4 Selection and implementation of SBRS

The design and construction of the building is based on a combination of ratings systems and additional unique client requirements.

4.2.1.5 Resource Efficient Features of the Building

The structure raises the bar for environmental sustainability. Four buildings connected by light-filled pathways, drenched in natural light, and featuring distinctively themed and manicured green spaces. The building and its ecologically friendly characteristics are regarded to be a significant improvement of the surroundings and comfort in which its new occupants work, far from degrading the working environment (UNEP, 2011). Wetlands are preserved, wastewater is recycled, and rainwater is collected. Natural airflow cools every building, and office waste is segregated and recycled. Standby generators are load-sensing and only turn on, when necessary, while transformers are made of cast resin to reduce oil drip contamination.

The dual flush toilet cisterns have reduced water use in bathrooms by up to 60%. The solar glass in the windows prevents solar penetration and insulates the building. The maintenance-free external wall covering also helps to keep the building cool in hot weather and warm in cold weather.

An automatic irrigation system watering each garden uses minimal water and can be set to provide the right quantity of moisture for each area. The building also makes use of light detection controllers and low-energy bulbs, which can save lighting expenses by up to 70%.

Figure 4.2 describes other salient features of the building.

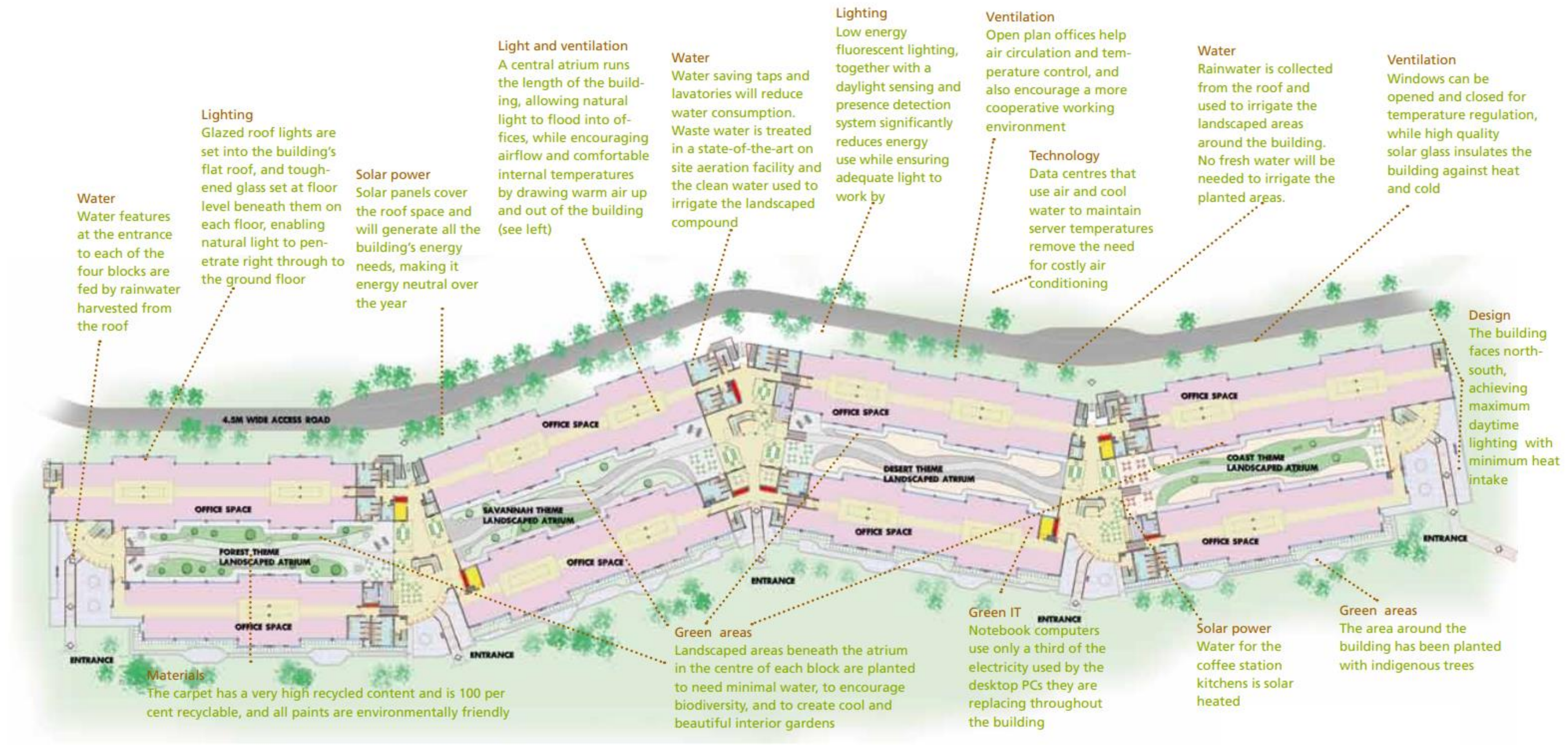

Figure 4.1-2 Environmental Features at a Glance

Source: UNEP 2011

4.2.1.6 Monitoring Building Performance

The United Nations office at Nairobi estimates that the money invested in the solar panels will be repaid through lower energy bills in around seven to ten years.

Since air conditioning and central heating are both huge consumers of energy and very expensive, running lengthways through the centre of the building is an atrium with a translucent vaulted roof. All office windows can be opened and closed so that cross ventilation can take place through the offices into the atrium garden. These beautiful and creative gardens are created and maintained using minimum amounts of water.

Figure 4.1-3 The Central Atrium with Unique Gardens

Source: UNEP 2011

This simple design feature enables the building to act as a chimney, where warm air is drawn up from ground level and through the office areas, and then escapes beneath the sides of the vaulted roof, maintaining comfortable temperatures in the offices and air circulation throughout the building as illustrated in figure 4.4.

4.2.1.7 Usability of the sustainable building rating system

The building has not employed any specific SBRS.

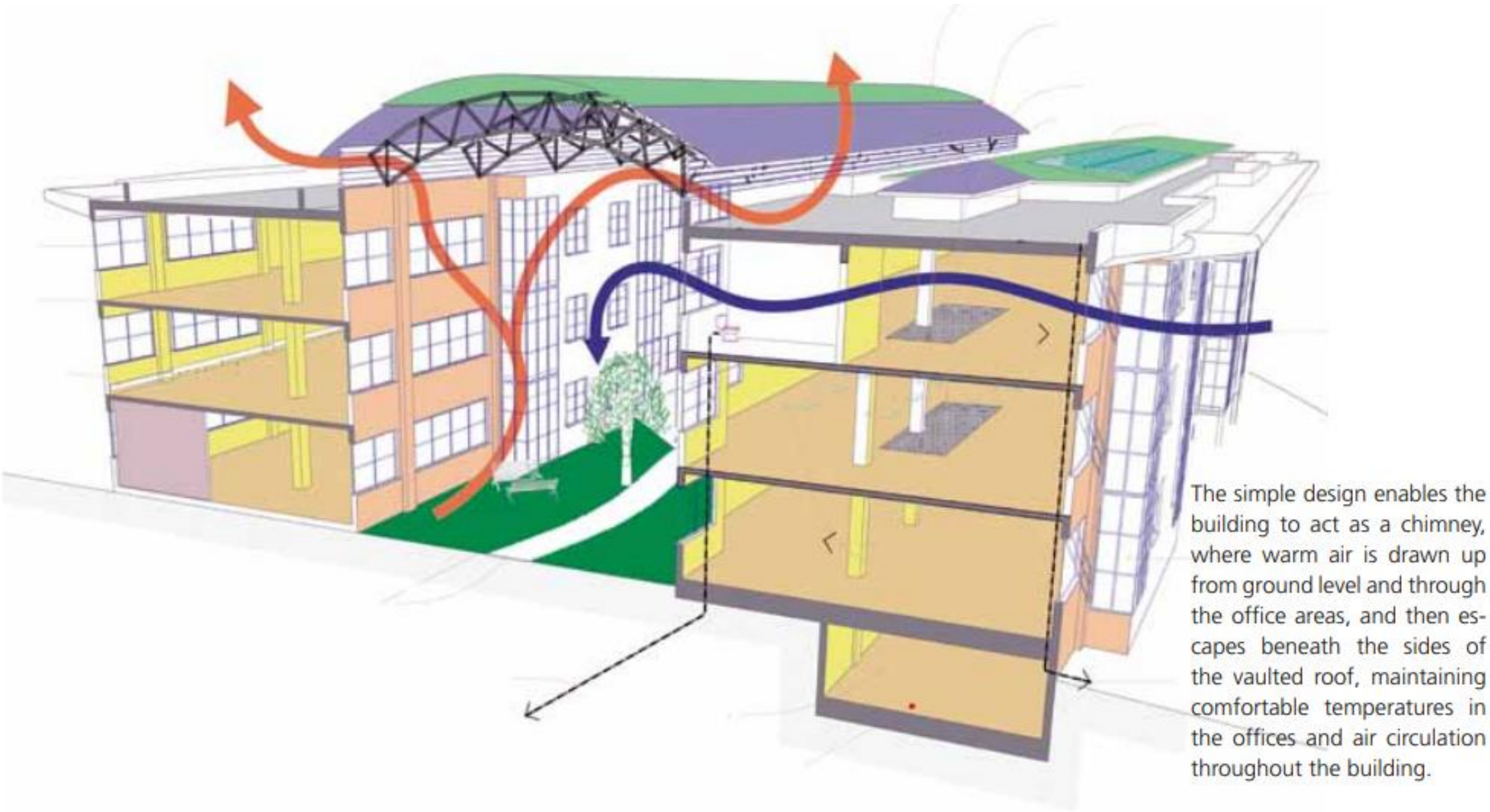

Figure 4.1-4 Air Circulation- Middle courtyard feature

Source: UNEP 2011

4.2.2 Vodafone (Site Solution Innovation Centre) Building in Midrand, South Africa

The SSIC is a sustainable living building envisaged as a functioning showcase for innovative techniques and design for construction, electrical, mechanical, and wet services. The building is the international hub for developing innovation, monitoring, and experimentation within the Vodafone Group worldwide.

Figure 4.1-5 Façade designed for Disassembly

Source: Archi DATUM- Architecture in Africa 2015

4.2.2.1 Definition of the Sustainable Building Rating System

A tool which enables a project to address sustainability in all respects such as water, energy and emissions in a manner that truly minimises the impact of the building on the environment.

4.2.2.2 Building Certification

Vodafone Site Solution Innovation Centre (SSIC) is the first 6 Star Green Star SA accredited building in South Africa and in the Southern Hemisphere, the equivalent of a LEED Platinum status. It is also the First 6 Star Green Star SA Office Design v1 Certified Building. It has won the following awards: Winner of the SAPOA Innovation Award 2012, Winner of the SAIA Award for Innovation 2012, Winner of the ESKOM ETA Award for Innovation 2012, Winner of the M&G Innovation in Renewables 2012.

4.2.2.3 Motivation for developing a green building

Vodafone Group's sustainability goal was to reduce global CO2 emissions by 50% by 2020 and to achieve a 20% carbon intensity reduction target for emerging markets by March 2015. Therefore, the construction of SSIC was to showcase innovative techniques and design for construction in line with the company's commitment to growing business in a sustainable way.

4.2.2.4 Selection and implementation of SBRS

The appropriate Sustainable Building Rating System for the area was used.

4.2.2.5 Resource Efficient Features of the Building

This carbon-neutral structure produces 215% of the energy it needs on site. The amount of solar energy produced is two times what the SSIC uses, with the excess being fed back into the Vodacom campus to create a zero-rated energy structure.

The goal of the aesthetic design was to achieve a seamless and aesthetically pleasing integration of the physical structure with the surrounding environment.

The design has a narrow floor plate surrounding a central open-air courtyard with a rainwater pond and wetland, and a fully glazed external facade allowing for excellent levels of interior daylight. More than 90% of the usable area has a daylight luminance of 250lux and 100% of the building has external views out onto the 3,300m2 landscaped site.

Material excavated from the site was reused in the earthworks and foundations, and the landscape shaping.

The excavated earth had been compacted to form the structural foundation, and the gabion walls used to pre-cool fresh air double as the supporting structure for the precast floor slabs, which are delivered sealed and don't require additional floor covering.

The structural columns are a combination of steel and eucalyptus gum poles, and the roof structure is an exposed timber beam system. The facades and structural elements are all designed for disassembly.

Through the use of performance glass, motorized blinds, and generous overhangs at the glass facades, the potential discomfort of glare is reduced to a minimum. LED luminaires are used throughout, with motion light detection sensors minimizing energy use. Fresh air is cooled in a gabion rock store below the building before it is released into the office space through perimeter floor level vents and is extracted at high levels into the courtyard for effective air change.

Figure 4.1-6 Solar Absorption Chiller

Source: Archi DATUM- Architecture in Africa 2015

A solar absorption chiller shown in figure 4.6 provides radiant cooling or warming through water pumped through a thermally activated slab. The chiller also provides cooled air to the office space, so no water-based heat rejection systems are used.

Efficient water fixtures and fittings allow significant savings in water consumption. During construction a recycling and waste management system was implemented to reduce the waste transported to dump sites, and a similar system is in place for the operation of the building.

Figure 4.1-7 Courtyard ponds

Source: Archi DATUM- Architecture in Africa 2015

Rainwater, harvested from the roof is stored in the pond (figure 4.7) in the courtyard and in tanks below the building, from where it is used for irrigation and toilet flushing.

Grey water from the basins and sink is treated (figure 4.8) through the constructed wetland and then reused for irrigation and toilet flushing.

The structure has reduced the use of concrete by over 20%, and the concrete used exceeds a cement replacement content of 60%. 90% of all the steel used has an average post-consumer recycled content of 60%, and 90% of all timber applications is derived from Forest Stewardship Council (FSC) accredited sources.

The landscape has been designed with xerophytic, indigenous and waterwise planting. All kerbs and bollards from the original parking area are reused with the bollards converted into seating along the meandering path.

Figure 4.1-8 Water Treatment

Source: Archi DATUM- Architecture in Africa 2015

4.2.2.6 Monitoring Building Performance

This tool is designed to improve any existing building's performance and functionality. The building must be continuously well-run and maintained for the rating to be valid for a three-year term. The Energy Water Performance (EWP) tool, a crucial part of the energy and water categories of the Green Star SA Tool accessible solely for offices, enables comparisons between a building's energy and water performance against industry benchmarks.

4.2.2.7 Usability of the sustainable building rating system

While the tool keeps improving, Green Star offers the following tools: The Existing Building Performance (EBP) Tool, Green Star New Building Tools, Green Lease Toolkit, Energy Water Performance (EWP) tool, and Existing Building Performance – Major Tenant.

4.2.3 Nedbank Head Office Phase II

The Nedbank is owned by Nedcor Investment Bank. Nedbank Phase II (figure 4.9) is located in the hub of Sandton on the corner of Rivonia Road and Maude Street, opposite the Village Walk. Officially the first Green Star SA rated office building in the country, Phase II of Nedbank's Head Office provides accommodation for 3,000 employees. The development includes retail spaces on the ground floor, presenting an active edge to the public realm, and seven levels of office space above.

Figure 4.1-9 Exterior View

Source: online 2022

4.2.3.1 Definition of the Sustainable Building Rating System

Sustainable Building Rating System is a tool that helps all to create better, healthier and more productive workplaces by improving indoor climate, maximising natural light and views, and adopting environmental building strategies.

4.2.3.2 Building Certification

The Nedbank Head office in Sandton was awarded 4-star Green Star SA Office V1 Design rating in 2009 for their new green office block.

4.2.3.3 Motivation for developing a green building

Nedcor's commitment to environmental sustainability is exemplified by the environmental sustainability standards that guide every aspect of Phase II's design.

4.2.3.4 Selection and implementation of SBRS

The Sustainable Building Rating System applicable in the region was employed.

4.2.3.5 Resource Efficient Features of the Building

The main elements that contributed to the four-star rating that Nedbank phase II was awarded include the full economy air conditioning system, the energy efficient light fittings, 60% of office areas with a visual connection to the outdoors or atrium (figure 4.10), the implementation of an efficient waste recycling system, both during construction and when the building is in use, and the fact that the building would achieve a 30% energy saving when compared with a conventional building.

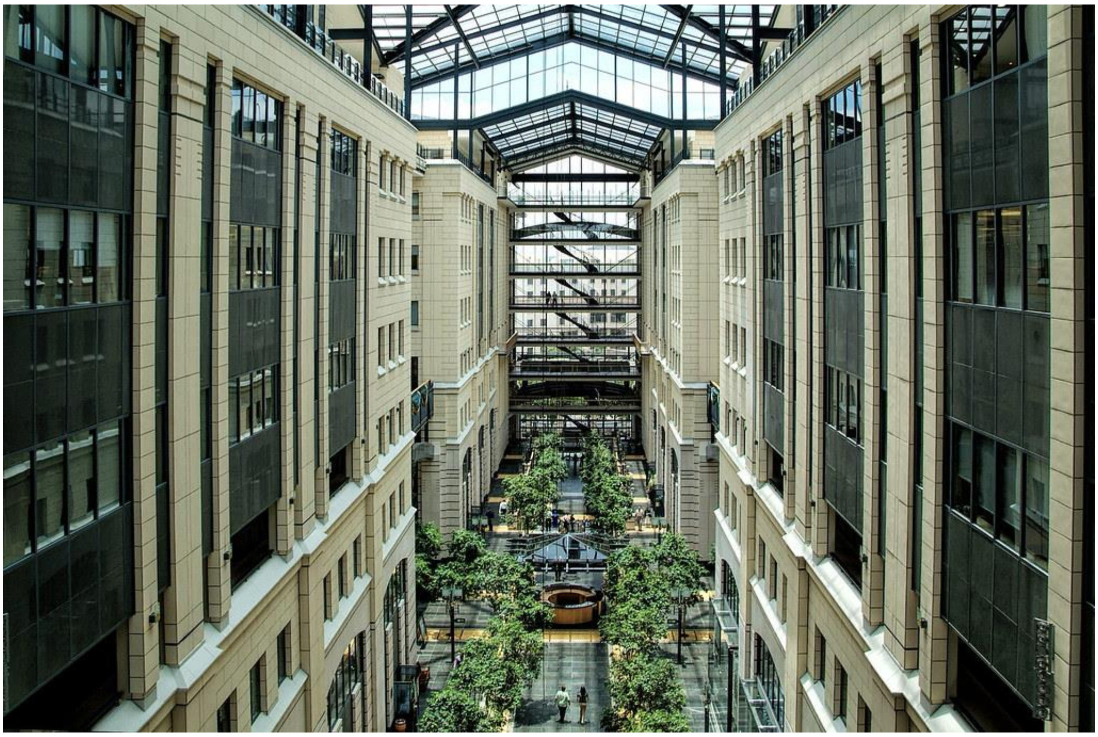

Figure 4.1-10 Atrium

Source: online 2022

Nedbank Phase II features a ventilation system with a rate of fresh air intake twice the national standard, a monitoring system for Carbon dioxide (CO2) levels connected to the ventilation system at the return points on each floor to ensure continuous monitoring and adjustments of fresh air into the building. Building is designated as non-smoking. Reduced-flicker lighting systems that are movement sensitive and interior paints and carpeting with reduced VOC levels.

Number of parking spaces does not exceed minimum local requirements, thus encouraging alternative modes of transportation. 5% of the parking bays dedicated to alternative fuel and hybrid vehicles and 5% are for motorbikes, mopeds, and scooters with preferred parking locations. Bicycle storage, showers and lockers are provided for 3% of the building staff; Visitors' bicycle parking is provided. Mass transport options for building occupants include minibus taxis, Metrobus, PUTCO buses, future Rea Vaya buses and the Gautrain Rapid Rail Link. Location in Sandton and across from the Village Walk shopping Centre offers numerous public amenities within a five-minute walking distance.

Building predominantly framed in reinforced concrete with a 95% recycled content for all reinforcing steel. Total cost of polyvinyl chloride (PVC) reduced by 30% through replacement with high density polyethylene (HDPE) plumbing and stormwater pipes.

Outflows to sewerage system reduced by 90% through the implementation of high efficient fixtures and fittings and the blackwater treatment system. Blackwater treatment system to provide recycled water for all non-portable water uses including irrigation, toilet flushing & cooling towers. Excavations during construction made space for the black water treatment plant and storage of rainwater and treated black water.

4.2.3.6 Monitoring Building Performance

Building User's Guide compiled for staff in close cooperation with design professionals. Contractor tracks all waste streams and completes quarterly reports on waste generation, recycling and reuse; Estimated 85% of all waste to be recycled or reused.

Dedicated storage area provided for the separation and collection of recyclables by all building occupants and for collection by recycling companies.

4.2.3.7 Usability of the sustainable building rating system

While the tool keeps improving, Green Star offers the following tools: The Existing Building Performance (EBP) Tool, Green Star New Building Tools, Green Lease Toolkit, Energy Water Performance (EWP) tool, and Existing Building Performance – Major Tenant.

4.2.4 Citibank Zambia Head Office

There are three LEED certified building in Zambia. In 2009, the Citibank head office building (figure 4.11) located at Addis Ababa Roundabout, Lusaka was the first building to be LEED certified in Zambia.

Figure 4.1-11 Exterior View of Citibank Head office

Source: Citibank online 2022

4.2.4.1 Definition of the Sustainable Building Rating System

A tool virtually used in all building, community, and home project types, to provide a framework to create healthy, highly efficient and cost-saving green buildings.

4.2.4.2 Building Certification

The Citibank Zambia head office is certified LEED compliant (Commercial Interiors category).

4.2.4.3 Motivation for developing a green building

Goal is to have all Citibank branches centred around the LEED certification. LEED certification is a globally recognized symbol of sustainability achievement.

4.2.4.4 Selection and implementation of SBRS

The Leadership in Energy and Environmental Design (LEED) is not only the most widely used sustainable building rating system in the world but also popular with Citibank shareholders because a significant number of buildings owned by US companies around the world follow the LEED certification procedure.

4.2.4.5 Resource Efficient Features of the Building

There are about 50 lots for cars underground parking which reduces the emission coming from the cars to be up in the air in the end releasing the ground to have grass compared to have so many cars parked.

There is adequate lighting inside coming from the outside, the paint used were Eco friendly paints and only green rated suppliers where allowed. All light fittings are green rated; the bulbs have the daylight sensors to take advantage of daylight harvesting. The outside finishes of the building used Mamoran, a paint which is low maintenance on the outer walls.

Everything from tap fitting, light fitting and paint had to be green rated from a green rated supplier. In the bathrooms the taps release enough water to wash hands, while saving at least 40 per cent of water usage.

4.2.4.6 Monitoring Building Performance

The developer uses LEED Dynamic Plaque, a “building performance monitoring and scoring platform and it may be applied to any structure, regardless of whether it is efficient or in need of renovation”. This platform provides a real-time LEED performance score for five major categories: energy, water, waste, transportation and human experience. It makes it possible for a building to get a starting point score and then track its development over time. This score is generated by comparing a particular building's values to other buildings all over the world with similar characteristics.

4.2.4.7 Usability of the sustainable building rating system

In addition to LEED certification, a new initiative called LEED Zero was introduced in 2018 to address issues with energy usage and track building performance. To receive certificates, monitoring data from a full year is needed. The most recent version of LEED, 4.1, which among other things provides assessment tools for all types of buildings, was introduced in 2019 with the aim of enhancing usability.

4.2.5 United States of America Embassy in Zambia

It was the second in Zambia to be awarded LEED certification in 2012. The American Embassy in Zambia campus (figure 4.12) consists of a three-story Chancery Building, two-story Marine Security Guard Quarters, Utility Building, and Warehouse / General Service Offices.

Figure 4.1-12 **Exterior View**

Source: Embassy website 2022

4.2.5.1 Definition of the Sustainable Building Rating System

Sustainable building rating system assists developers and building experts to design, construct and to monitor the building’s performance in an effort to work towards a more efficient and sustainable building.

4.2.5.2 Building Certification

The American embassy in Zambia received the Silver Level in LEED certification.

4.2.5.3 Motivation for developing a green building

In line with the Government policy, the goal was to work towards a more efficient and sustainable building.

4.2.5.4 Selection and implementation of SBRS

It is a preference that a good number of buildings owned by US Government around the world follow the LEED certification procedure.

4.2.5.5 Resource Efficient Features of the Building

Campus signage has been installed to identify the LEED applications that were designed into the site. LEED was fully implemented during the design and construction of the site. The building was designed to reduce energy costs through the installation of a white roof, light colour facade and sunshades around the windows to reduce solar heat gain as shown in figure 4.13. Apparently, all the water consumed is cleansed at an onsite treatment plan, reused for irrigation and ultimately infiltrated on site, keeping the ground water replenished.

Site Improvements include paved pedestrian walkways, paved roads, full automated irrigation system (Water from the wastewater treatment plant-WWTP is used), staff garden, parking areas, representational plaza, covered parking structures, fuel dispensing stations, compound lighting, and storm water management system.

The building conserves water through the installation of low flow and low flush plumbing fixtures.

Site open space is equal to 60% of the site area, and most of the construction waste from the site was recycled locally.

Figure 4.1-13 Natural lit hall and shading devices on exterior

Source: Embassy website 2022

4.2.5.6 Monitoring Building Performance

The LEED Dynamic Plaque is used to monitor building performance. Arrangements are under way to use a new program called LEED Zero. Energy and water consumption and reuse are periodically monitored.

4.2.5.7 Usability of the sustainable building rating system

To keep up with the constantly changing demands of the modern world, LEED continues to develop. The most recent LEED version, 4.1, was launched in 2019 and features, among other things, assessment tools for all kinds of buildings.

4.2.6 EVEXIA Building, Church Road- Lusaka

Evexia is a high quality, functional office workplace building located on Church Road, Lusaka, Zambia.

Figure 4.1-14 Exterior View

Source: Estim Construction 2022

4.2.6.1 Definition of the Sustainable Building Rating System

During the development of the project, Sustainable Building Rating System assists in the best use of renewable sources of energy, sustainable use of local materials, conserving natural trees, minimal generation of waste, reduce, reuse, recover and recycle water.

4.2.6.2 Building Certification

Evexia is the first LEED v4 Certified project in Zambia, the second LEED v4 project in Africa, the first LEED v4 Gold certified project in Africa, the first LEED v4 Core and Shell certified project in Africa.

4.2.6.3 Motivation for developing a green building

Evexia is a benchmark for sustainable buildings in the Zambian region. It reflects inspiration and innovation driven from the local environment. The building was set to mark a new threshold of modern international "A-Grade" standard in office spaces in Zambia.

4.2.6.4 Selection and implementation of SBRS

LEED was popular with investors.

4.2.6.5 Resource Efficient Features of the Building

As indicated in figure 4.15, the building is orientated exactly on the North South facing direction to ensure that it is well lit with natural light from sunrise to sunset (further reducing the use of electrical lighting). All tenants have natural light with views to connect occupants with the outdoors.

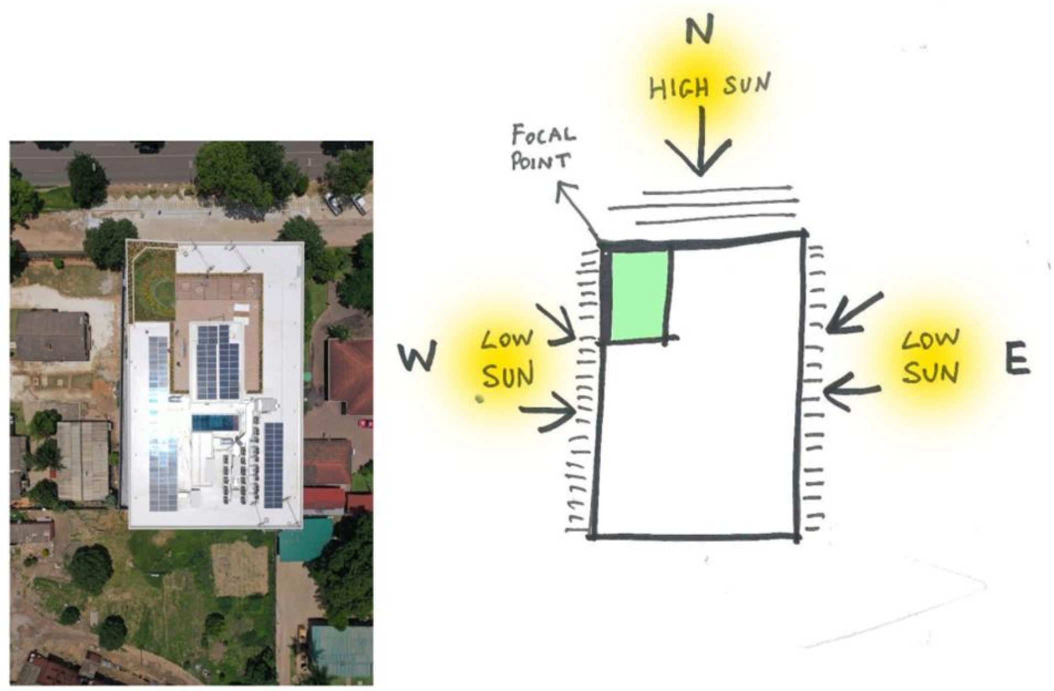

Figure 4.1-15 Roof solar panels and building orientation illustration.

Source: Architect Rusell 2022

All the electrical and sanitary fittings have sustainability features with low energy consumption. Solar panels supply 10% of the building's electricity. There is a Hybrid

Solar inverter and generator set backup power onsite with an estimated power savings of 30 to 40% for occupants. All office levels have suspended floors, brand-new energy-efficient central air conditioning, and fiber cables to enable easy access to power outlets throughout the space.

The roofing has a Solar Reflectance Index (SRI) of more than 39 which reduces the heat island effects on the roof, keeping the building cool. The shading devices have been designed to block different angles of the sun at different times of the day. This helps cool the building while maximizing lighting. The natural sunlight is made use of by the featured atrium with roof light above.

All local materials have been used and all doors are made of solid timber from sustainable sources. All paints, coatings, adhesives and seaplanes applied on the project are non-emitting sources of Volatile Organic Compounds (VOC). This reduces the concentration of chemical contaminants that can damage air quality, humans, health, productivity, and the environment.

A system of air purification was installed to lessen odor, mold, and germs. It was also made to relieve allergy symptoms and prevent the spread of colds and the flu.

Special attention and care were put into landscaping the indoor and outdoor area. Existing trees have been conserved and added into the design blending with the special water features.

Rainwater is collected from the roof and is used for landscape irrigation throughout the year.

4.2.6.6 Monitoring Building Performance

LEED Dynamic Plaque is used to monitor building performance. LEED Dynamic Plaque monitors the amount of water and energy a building uses. Real-time data provided by the LEED Dynamic Plaque aids in maintaining green buildings.

4.2.6.7 Usability of the sustainable building rating system

Just like any tool, LEED gets regular updates. The building must achieve a high level of energy efficiency in order to be certified, and the documentation process can be quite time-consuming for all members of the design and construction team.

4.2.7 Standard Chartered Bank Zambia Head Office

Standard Chartered Bank's head office (figure 4.16) in Lusaka is the first office building in Zambia to receive an EDGE (Excellence in Design for Greater Efficiencies) certification.

Figure 4.1-16 Standard Chartered Bank Zambia Head Office, Lusaka

Source: Author 2022

4.2.7.1 Definition of the Sustainable Building Rating System

A tool designed to assist estimate the resource utilization of buildings during the planning phase and development stage and awards projects that conserve resources.

4.2.7.2 Building Certification

Standard Chartered Bank's head office has EDGE advanced preliminary certification. Standard Chartered House not only successfully achieved an EDGE certification, but it also exceeded the criteria by achieving over 53% reduction in energy usage, a 57% reduction in water usage and 24% less energy embodied in materials against a target of 20% for last the two categories.

4.2.7.3 Motivation for developing a green building

The construction of the green building was in line with the institution's vision to become the world's most sustainable and responsible bank. The Standard Chartered Bank submitted the building for EDGE assessment, and after being examined, it received "Edge Advanced preliminary Certification." Data for the building assessment was compiled by the architects, the client, the mechanical engineer, and the electrical engineer.

4.2.7.4 Selection and implementation of SBRS

EDGE was preferred by the developer because EDGE is a green building rating system for new residential and commercial buildings in emerging markets created by the International Finance Corporation (IFC) of the World Bank Group. The cloud-based platform has a sophisticated set of city-based climate and cost data, consumption trends and algorithms for predicting the most accurate performance results. On this basis, the tool calculates additional costs associated with building sustainably and how long it takes to offset those expenditures through operational savings.

4.2.7.5 Resource Efficient Features of the Building

The most energy efficient window to wall ratio was considered in the design of the building and the materials used. Greater thermal efficiency was achieved through the application of an insulating screed to the roof slab, use of higher thermal performance glass (high-spec double glazing or 'low E'), the strategic implementation of shading systems and the application of a reflective roof colour.

Standard Chartered Bank Zambia has saved 70 percent of electricity and water bills due to use of solar panels to power all the major energy requirements in the building and water recycling and purification facilities.

A variable refrigerant flow (VRF) cooling system was designed for the building to ensure a varied flow of refrigerant to cool down any indoor units on demand.

LED energy saving light bulbs were used throughout the building, supplemented by occupancy sensors in select areas such as the bathrooms and conference rooms.

All bathrooms have been fitted with low-flow faucets, dual flush water closets, and waterless urinals. Low flow aerators were fitted on the taps to restrict the water flow to 2.9 litres per minute. All kitchen sinks were also fitted with water-efficient faucets.

The internal environmental quality (IEQ) is managed through use of materials with low volatile organic compound (VOC) emissions. The reinforced concrete frame structure used medium-weight hollow concrete blocks for the walls and areas of insulated dry-walling for internal partitioning.

4.2.7.6 Monitoring Building Performance

The certification system includes the EDGE app, innovative software designed to help home builders track and regulate the financial viability of their projects. This free app allows officials and developers to assess the costs and advantages of strategies related to carbon reduction. Building management system (BMS): A world-class BMS links high-level digital ICT infrastructure, efficient heating, ventilation, and air conditioning (HVAC) systems, and LED lights with occupancy sensors.

4.2.7.7 Usability of the sustainable building rating system

When Compared to BREEAM and LEED, EDGE is designed based on scalability and can easily be used to evaluate multiple homes and businesses at a cheaper rate.

4.3 Summary of Findings

Table 4.1 provides a summary of the research findings on the sustainable building rating systems' application regional and local buildings.

Table 4.1-1 Application of SBRS on regional and local buildings

GUIDING PRINCIPLES	United Nations office at Nairobi	Vodafone SSIC Building	Nedbank Head Office Phase II	Citibank Zambia Head Office	US Embassy in Zambia	EVEXIA Building in Lusaka	Standard Chartered Bank Zambia Head Office
Motivation for Sustainable Building	Set new benchmark for sustainable buildings	Showcase innovative techniques and design for construction	Nedbank's commitment to environmental sustainability	Goal is to have all branches centered on LEED certification	Goal is to work towards a more efficient and sustainable building	Reflect inspiration and innovation for local environment	Vision to become world's most sustainable and responsible bank
Selection of Sustainable Building Rating System (SBRS)	Unique client requirements	Applicable in the region	Applicable in the region	Popular with shareholders	Popular with the country of Origin	Popular with investors	Client preference
SBRS	Own Standards	Green Star SA	Green Star SA	LEED	LEED	LEED	EDGE
Level of Certification	Not Rated	6- Star or LEED Platinum equivalent	4- Star	Compliant-Commercial Interior	Silver	Gold	Advanced Preliminary Certification

Source: Author

CHAPTER FIVE
DISCUSSION OF RESEARCH FINDINGS

5.1 Introduction

This chapter discusses the research findings highlighted in chapter 4, in relation to the sustainable building rating systems' certifications obtained by selected buildings across Africa. It also indicates how the author selected the sustainable building rating system appropriate for the Zambian setting. It further discusses the results in relation to the rating components of the Green Star SA rating system specifically the weighting categories such as management, indoor environment quality, energy, transport, water, materials, land use and ecology, emissions, and innovations. It further discusses how to modify the chosen rating system to make it easy to use and adapt to the changing world.

5.2 Green Building Council South Africa (GBCSA)

As a stand-alone, non-profit organization, the Green Building Council of South Africa (GBCSA) was established in 2007. To give a standardized measurement of green buildings in the real estate business, the GBCSA created Green Star SA in 2008, its first building-rating tool which is based on the Green Star Rating System of the Green Building Council of Australia. The GBCSA is the official certifying agency for buildings under the Green Star SA Rating System and a full member of the World Green Building Council. The Green Star Rating system aims to promote integrated, whole-building design, increase public awareness of the benefits of green buildings, lessen the environmental impact of development, and reward environmental leadership. The rating system focuses on nine categories which are divided into credits (Alli, 2013). The Green Star SA rating system considers a number of design factors for minimizing the building's environmental impact, including energy, water, emissions, building materials, land usage, integration with transportation systems, and building management practices. The rating system allows for up to 100 points to be obtained in nine categories and uses a star rating system based on the number of total points achieved; that is, 45 to 59 points (four stars), 60 to 74 points (five stars), and 75 to 100 points (six stars).

5.3 Green Star Rating System

The Green Star system originated in Australia, however, after much investigation, South Africa decided to adopt this system and customise it to depict their own tool for 'green' rating. The Green Star guide sets out a list of measures that are considered as 'green'; if a building has any of these features, they are awarded points. Finally, these points are weighted and summed up to achieve a total, and this total determines the 'green' star rating a building has achieved. To be considered for a Green Star rating, owners have to submit documentation to an assessment committee within the Green Building Council, where the building will be categorised as either 4-star, 5-star or 6-star. The categories that are used to assess the green buildings and achieve points are that of management, indoor environment quality (IEQ), energy, transport, water, materials, land use and ecology, emissions, as well as innovation.

It must be noted that the categories that were previously stated are not as clean cut as they may be portrayed on the surface. For example, the design of a 'green' building incorporates many different aspects that can be rated, such as the use of natural lighting in offices; individual environmental control; techniques designed to recover heat and achieve low energy lighting; carefully thought-out landscaping minimising environmental impact; bicycle racks designed for employees to reduce CO2 emissions, as well as specially selected building materials allowing for the reduction in environmental degradation. Furthermore, the underlying objectives of the rating system need to be acknowledged. These include the promotion of a holistic building design; the promoting of green awareness within South Africa; to acknowledge environmental leadership, as well as- the ability to reduce the environmental impact of development. On the organisational level, the Green Star rating system affords the opportunity to create a working environment for employees that increases positive experiences and allows for better physical conditions that impact positively on their overall feelings.

5.4 Green Star Africa Adaptation

The GBCSA works in collaboration with emerging Green Building Councils (GBC) throughout Africa and allows the adaptation of the Green Star tools for certification in the respective countries. Each country develops and submits a Local Context Report for review by the GBCSA and once approved allows for projects within the specific countries to be certified using a Green Star tool, with the adaptions identified in the Local Context Report. Projects in Africa can register for Green Star certification where a Green Star Local Context Report has been prepared for that tool in that country and where the approved report is available on the GBCSA website.

5.5 Identification of SBRS Suitable for Zambia

From the foregoing, Green Star SA was chosen to be suitable for Zambian context due to the following reasons:

1. It was influenced by the most popular SBRSs i.e. BREEAM & LEED
2. It is provided by GBCSA who already have structures for adaptation in African countries.
3. It will be easy to incorporate improvements observed in EDGE since EDGE is also linked to GBCSA.

According to the GBCSA website, below are the steps in summary of how any African country can adapt Green Star Rating Tool to its context.

First, create a Green Building Council (GBC) whose focus will be the implementation of the priority areas detailed in the *Africa Manifesto for Sustainable Cities and the Built Environment.* Zambia already has a Zambia Green Building Association (ZGBA) established in 2015.

Second, ZGBA to collaborate with GBCSA.

Third, ZGBA to submit a local context report for Zambia for review by GBCSA.

Fourth, once approved, adapt a green star tool to local context.

5.6 Green Star SA Weighting Categories

The Green Building Council developed the Green Star SA rating tools to provide an objective measurement for green buildings in South Africa and Africa. These tools recognise and reward environmental leadership in the property industry. The tools are based on nine (9) different categories, each with a range of credits that address environmental and sustainability aspects of designing, constructing, and operating a building. Each category has a number of credits within it that address specific green building aspects and actions. The Green Star SA environmental weightings are as given in table 5.1.

Table 5.1-1 Green Star SA environmental weightings

Item	Symbol	Impact Categories	GBCSA Credit
1		Management	9
2		Indoor Environment Quality	15
3		Energy	25
4		Transport	9
5		Water	14
6		Materials	13
7		Land Use and Ecology	7
8		Emissions	8
9		Innovation	0
		Total	**100**

Source: GBCSA, 2020: online

Based on the GBCSA website, the following weighting categories were applied to the case study buildings and the results are outlined below:

i. **Management:** The credits within the management category promote the adoption of environmental principles from project inception, design, and construction phases, to commissioning and operation of the building and its systems. This is achieved in part by encouraging and recognising the engagement of professionals who can assist the project team with the integration of Green Star aims and processes throughout design and construction phases. Also, by the provision of user guides to assist with information management that enables building users to optimise the building's environmental performance, and further through management practices that minimise the amount of construction waste going to disposal.

All the buildings studied did not have a combined document for use as user manual, but all specialist contractors had submitted their commissioning report and the manuals. Training was provided mainly to maintenance staff to explain the operation of the building. However, the UN building in Nairobi, Nedbank, Vodafone, Standard Chartered bank and Citibank buildings had a few guidelines for users of the building. The UN building, Vodafone, Evexia and Citibank had utilised some excavated materials in the building site landscaping to reduce construction waste going to disposal. It was further observed that Standard Chartered bank subscribed for sustainable certification after the building was built.

The lack of user manual in energy efficient buildings was also observed by (Sarah Noye, 2016). The challenge was attributed to the lack of time available for data collection towards the end of the project. To resolve the challenge, GhaffarianHoseini proposed the utilization of Building Information Modelling (BIM) during building maintenance for the consequential post-construction energy efficiency (GhaffarianHoseini, 2014).

ii. **Indoor Environment Quality (IEQ):** Each of the credits in the IEQ category target the wellbeing of the occupants. The credits address how the heating, cooling, lighting, and indoor air pollutants contribute to a healthier indoor environmental quality. The aim is to encourage and recognise designs that provide ample amounts of outside air to counteract build-up of indoor pollutants, systems that effectively delivers optimum air quality to any occupant throughout the occupied area, monitor carbon dioxide levels, and designs that provides good levels of daylight for building users and reduce the discomfort of glare from natural light. It further provides occupants with a visual connection to the external environment, efficient electric lighting, reduce health risks to occupants from the presence of hazardous materials, maintain internal noise levels at an appropriate level, eliminates the risk of mould growth, prohibiting smoking inside the building, and high level of and individual control thermal comfort.

The orientation of all the building ensured good air flow and adequate sunlight. On local buildings, Evexia and US Embassy stood out. All the local buildings except Citibank had shading devices to prevent excess sun glare from entering the building interiors. The UN building and Nedbank have central atrium to ensure that all office areas have a visual connection to the outdoors. Nedbank has a carbon dioxide monitor integrated at the return point of each floor. All buildings have efficient electric lighting which responds to the amount of natural light available and the presence of occupants. UN Building and Vodafone do not require air conditioning. To reduce odour, mould, bacteria and improve allergy relief from cold and flu, Evexia has specifically installed air purification system. The Standard Chartered House open plan offices and meeting rooms all received a high level of acoustic treatment to absorb sound, eliminate noise and enhance privacy.

In his study, Y Al Horr identifies eight physical factors which affect occupant satisfaction and productivity in an office environment such as Indoor Air Quality and Ventilation, Thermal Comfort, Lighting and Daylighting, Noise and Acoustics, Office Layout, Biophilia and Views, Look and Feel, and Location and Amenities (Y Al Horr, 2016). All the buildings in the study performed fairly well in Indoor Environment Quality.

iii. **Energy:** The credits within the energy category target an overall reduction in energy consumption and a reduction of greenhouse gas emissions associated with energy generation. This is achieved by encouraging and recognising designs that minimise the greenhouse gas emissions associated with operational energy consumption, and maximise potential operational energy efficiency of the base building, installation of energy sub-metering to facilitate on-going management of energy consumption, provide artificial lighting with minimal energy consumption, offer greater flexibility for light switching, making it easier to light only occupied areas, and reduces peak demand on energy supply infrastructure.

All the buildings in the study have alternative power, however only the UN Building and Vodafone generate more power than needed. The solar panels on the roofs have also assisted in reducing the heat gain via the roof covering. Evexia has wind turbines on the roof in addition to solar panels. The generators have been set to produce only the optimum power requirements when needed. To reduce both costs and carbon footprint, the UNEP has maximised the use of Internet Protocol telephony, which enables international video conferencing as opposed to international travels.

(Shristi Khosla, 2014) equally highlighted a number of energy-saving ideas that can be incorporated to improve buildings' energy efficiency while also keeping costs in mind during the planning, designing, building, and execution stages.

iv. **Transport:** The credits within the transport category reward the reduction in automotive commuting while encouraging use of alternative transport. This is achieved by encouraging and recognising developments that facilitates the use of alternative modes of transportation for commuting to work, developments that facilitates the use of more fuel-efficient vehicles for work commuting, bicycles by occupants and visitors, and mass transport for work commuting. It further provides for office buildings that are integrated with or built adjacent to community amenities and/or dwellings in order to reduce the overall number of automobile trips taken by building users.

All three buildings in Zambia except the American embassy are located about a kilometer away from shopping malls. The Nedbank is located within a five-minute walking distance to the public amenities. Standard Chartered Bank encourages the use of shuttle buses for most employees, Nedbank and the US Embassy encourages cycling, Nedbank has provided showers for cyclists.

(Isimbi & Park, 2022) also affirms that the transport energy requirements for the building are because of the building’s location in relation to other amenities. Better sustainability ratings are given to structures in prime locations where residents can easily access employment opportunities, public transportation, educational institutions, and other amenities.

v. **Water:** All the water credits aim to reduce the use of potable water through the design of efficient systems, rainwater collection and water re-use. Achieved through encouraging and recognising designs that reduce potable water consumption by building occupants, systems that both monitors and manages water consumption, aim to reduce, or replace the consumption of potable water for landscape irrigation, reduces potable water consumption from heat rejection systems and for the building's fire protection and essential water storage systems.

The most efficient water system for recycling and reuse was seen at the UN Building and Vodafone. Rainwater is harvested and used for fountains and irrigations. Grey water from basins and sinks is treated and then reused for irrigation and toilet flushing. All three buildings selected in the Africa region treat sewer and grey water on site before using it for irrigation. The four buildings in Zambia discharge into the municipal sewerage system. They have sunk boreholes to provide alternative water source. All buildings except Citibank have water efficient faucets and waterless urinals. However, Citibank has dual flush water closets.

It was observed that all buildings had many water saving measures despite the nature of sustainable certification obtained. These findings are contrary to previous arguments in the literature that LEED-certified green buildings have considerable environmental, social, and economic benefits regarding water-saving measures (Alawneh Rami, 2018).

vi. **Materials**: All the credits in the materials category target the consumption of resources through the selection and reuse of materials. The concept is to reduce the amount of natural resources used and reuse materials that can be reused or recycled. This is achieved by encouraging and recognising the inclusion of storage space that facilitates the recycling of resources used within buildings to reduce waste going to disposal, prolongs the useful life of existing products and materials, and base building delivery mechanisms that eliminate the need for immediate tenant refits. It further provides for the reduction of embodied energy and resource depletion occurring through use of concrete, specification of reused timber products or timber that has certified environmentally responsible forest management practices, a net reduction in the total amount of material used, using materials and products that are sourced within close proximity to the site to reduce transportation emissions.

UN Building and Vodafone buildings boast of the most environmentally friendly materials used for slabs and reinforced columns. Nedbank saw a 30% reduction in the use of Portland cement across all concrete mixes and reinforced concrete with a 95% recycled content for all reinforcing steel. Evexia used all local materials and products that are sourced within proximity to the site to reduce transportation emissions. All materials that could not be found locally were obtained from sustainable sources. Paints, coatings, adhesives and sealants applied on the project are non-emitting sources of VOCs.

The findings agree with (Hart, 2014) who highlighted that specially selected building materials allow for the reduction in environmental degradation.

vii. **Land Use and Ecology:** All the credits in the land use and ecology section promote initiatives that improve or reduce the buildings impact on ecological systems and biodiversity. Achieved through encouraging and recognising development on land that has limited ecological value and to discourage development on ecologically valuable sites, construction practices that preserves the ecological integrity of topsoil, reuse of land that has previously been developed and where the site is within an existing municipally approved urban edge, and developments that reclaim contaminated land that otherwise would not have been developed.

Except the UN Building, Vodafone and the US Embassy, all buildings in the study have been built on previously built on sites which are municipally zoned for the nature of building development. Evexia and Citibank have underground parking that had replaced the open car parks to increase landscaped areas. To further soften the landscape, Evexia has conserved the existing trees, and integrated them into the landscape design blended with water features. A roof top garden is also natured on one end of the building while some draping plantings embrace some balconies. Similar draping plants were also visible at the Citibank building.

The above confirms the observation made by (Nolon, 2012) that Techniques and tools for land use offer tremendous potential to lower energy use, improve the economy, and mitigate climate change.

viii. **Emissions:** All the emissions credits target the environmental impacts of a developments emissions or substances emitted from the site. This is achieved by encouraging and recognising the selection of refrigerants and other gases that does not contribute to long-term damage to the Earth’s stratospheric ozone layer, selection of refrigerants that reduces the potential for increased global warming from the emission of refrigerants to the atmosphere and insulants that does not contribute to long-term damage to the Earth’s stratospheric ozone layer, minimise discharge to the municipal sewerage system, minimise light pollution into the night sky, use of boilers and generators that minimise harmful emissions, and minimise stormwater run-off to, and the pollution of, the natural watercourses.

All the buildings in the study consume energy efficiently. The refrigerants used in all the buildings under the study do not contribute to long term damage to the Earth’s stratospheric ozone layer.

(Alawneh Rami, 2018) also confirms that when buildings consume energy efficiently, the amount of greenhouse gas emissions from energy production is reduced.

ix. **Innovations:** The innovation category encourages, recognises and rewards the spread of innovative technologies, designs and processes that impact on the overall environmental performance of the building.

All office wings of the UN Building in Nairobi benefit from a centrally monitored access control system, which identifies everyone who has entered or left the building.

Standard Chartered Bank has a free application provided by the rating tool which is incorporates all systems in the building and assists in monitoring the performance of buildings. All information memorandum and guidelines for building usage are shared on electronic platforms to reduce the use of paper. All building users are not allowed to bring in any plastics and there is a monitoring system in place to ensure that only glass and metal drinking bottles are allowed in the building for drawing water from the dispensary.

(Ayojedi Oke, 2019) observed that sustainable buildings have already adopted innovations, but they are continually being improved upon through further research to bring about energy saving.

Based on the findings, the Author used Table 5.1 credits to rank the seven buildings in the study based on Green Star SA as indicated Table 5.2.

Table 5.1-2 Critical comparisons of regional and local buildings based on Green Star

Guiding Principles	United Nations office at Nairobi	Vodafone SSIC Building	Nedbank Head Office Phase II	Citibank Zambia Head Office	US Embassy in Zambia	Evexia Building in Lusaka	Standard Chartered Bank Zambia Head Office
Management	✓	✓	✓	✓	✓	✓	✓
Indoor Environment Quality	✓	✓	✓	✓	✓	✓	✓
Energy	✓	✓	✓		✓	✓	✓
Transport	✓	✓	✓	✓	✓	✓	✓
Water	✓	✓	✓	✓	✓	✓	✓
Materials	✓	✓	✓		✓	✓	✓
Land use and ecology	✓	✓		✓		✓	
Emissions	✓	✓	✓				
Innovations	✓	✓	✓	✓	✓	✓	✓
Position in Relation to the Seven Buildings in the Study	**1**	**2**	**3**	**7**	**5**	**4**	**6**

Source: Author

5.7 Modification and upgrading of SBRS

The section discusses how the selected sustainable building rating system can be modified to make it easy to use and adapt to the changing world.

EDGE has developed a computerised system to help building designers as they work through the design of sustainable buildings and an application to be incorporated in the building to monitor the performance of the building over time. The application is useful to the clients as it provides information in a way that is easy to interpret and relate.

Incorporating a rating system in the computerised system for building design will enable designers to have an idea of the rating for the building at design stage and therefore assist them to look for alternative ways of improving the thermal comfort of the building as well as reducing the environmental impact.

The World Green Building Council should consider standardizing the rating categories since some certifications have common criteria, sometimes named differently and further, the same criteria may be covered under different categories or combined with other aspects. The standardization may make it possible to compare rating systems using similar categories and hence create a common platform for assessment of buildings all over the globe.

CHAPTER SIX
CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents the conclusions and recommendations from the research findings and discussion given in Chapter 5 and 6. The main objective of this research was to examine all prominent sustainable rating systems in order to select one that would be appropriate and could be adapted to Zambian context. The research sought to answer three questions, which are as follows:

1. What are the available sustainable building rating systems in the world and how do they compare with each other?
2. How do developers, designers and authorities choose what sustainable building rating systems to use on various developments?
3. Are the current sustainable building rating systems easy to use and adapting to the changing world?

This chapter is therefore divided into three sections. The first section provides a conclusion on the adaptation of sustainable building rating systems to Zambian context. The second section provides the recommendations, while the third section makes suggestions on areas for future research.

6.2 Conclusion

The study made conclusions on three research objectives as follows:

a) **Identification all prominent sustainable rating systems in the world.**

   The study identified numerous sustainable building rating systems that have been formulated across the globe and have further evolved from being voluntary to mandatory in some countries. Hundreds of SBRSs are now available worldwide, varying in approaches, application processes, and evaluation metrics. Among the most widely used globally are the Building Research Establishment Environment Assessment (BREEAM) which was developed by the United Kingdom in 1993 as the first rating system to have been developed in the world. It is widely used and recognized globally due to its longevity and influence on other rating systems. This was followed by

France's Haute Qualite Environnementale (HQE) in 1996. In 2000, the United States Leadership in Energy and Environmental Design (LEED) was launched. In 2001, the Japanese Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) was introduced. The Australian Green Star made its appearance in 2002.

Africa has a comparatively low number of green building certifications compared to other continents. As a result, the Green Building Council of South Africa (GBCSA) was established in 2007. To give a standardized measurement of green buildings in the real estate business, the GBCSA created Green Star SA in 2008, its first building-rating tool which is based on the Green Star Rating System of the Green Building Council of Australia.

DGNB – NSQ is one of the newest rating systems and the first one from Germany developed in 2009. Korea has developed and applied the G-SEED (Green Standard for Energy and Environmental Design) rating system, which was designed specifically for its own building environmental issues and needs.

The Excellence in Design for Greater Efficiencies (EDGE) was established in 2014 by the International Finance Corporation (IFC). It focuses on the major problems in not only developed countries but also developing countries, especially Africa. EDGE certification is exclusively provided by the Green Buildings Council of South Africa (GBCSA) for buildings in Africa.

Despite some differences, the overall aim of all SBRS is not only to consider the building's impact on its inhabitants and the natural environment, but also building's ongoing ecological footprints. Some SBRSs even look into the social and equitable implications of the building. They all also adhere to the same general evaluation structure: project performances areas measured using a set of relevant indicators which are grouped per topic such as water management, energy use, materials, site qualities, etc.

b) The selection of appropriate sustainable rating systems used on various developments.

The study revealed that the SBRS are largely voluntary and not mandatory and therefore, the motivations for applying rating tool are educational and marketing purposes. The attraction of green rating systems depends on their marketing as well as their transparency. The selection was based on the more commonly used rating tool in the region or those popular with the client and investors. In Africa, the GBCSA works in collaboration with emerging Green Building Councils (GBC) throughout the continent and allows the adaptation of the Green Star tools for certification in the respective countries. The GBCSA also provides EDGE certification for buildings in Africa. The above justifies the selection of GBCSA tools by most developers in African countries.

c) Proposed modifications to the selected rating system to make it easy to use and adapt to the changing world.

SBRSs' certification is sought after by building owners, designers, clients, and occupants because it offers a variety of economic and environmental benefits including energy and water savings, reduced waste and CO2 emissions, increased occupancy rate and market value, enhanced productivity, and improved health and user satisfaction.

The main objectives of SBRSs are:

i) to motivate all stakeholders in the construction industry to strive toward a more liveable, healthy, and just living environment. This objective attempt to raise aspirations of governments, corporations, owners, and practitioners.

ii) SBRSs were created for assessment purposes, but they also act as design support tools and are effective project management tools because they provide a structured procedure for outlining significant synergies among the building's components and activities.

iii) to monitor the performance of the building over time making the building's performance noticeable to the market.

The research findings indicate that SBRS are usable as evidenced by the growing numbers of building certifications in both developed and developing countries, as well as the move by certain developed countries from voluntary to mandatory SBRSs. Further, the formulation of new SBRSs indicates that there will always be room for evolution and growth. More innovations are required in incorporating a rating system in the computerised system for building design and construction, and for the creation of SBRSs' interactive application for the clients to provide information in a way that is easy to interpret and relate.

6.3 Recommendations

In view of the findings of the research, the following were recommended:

i. Green Star South Africa (Green Star SA) rating system would best respond to the Zambian environment.
ii. To successfully adapt Green Star SA to Zambian context, Zambia Green Building Association (ZGBA) must collaborate with GBCSA and submit a local context report for review and approval by GBCSA as a prerequisite for the establishment of Green Star Zambia.
iii. For further evolution and growth of the sustainable rating system in Zambia, the rating tool should be incorporated in the computerised system for building design and construction, and an interactive application for the clients should be created borrowing the concept from EDGE.

6.4 Study Limitations and Proposed Future Research

Despite having obtained necessary approval and ethical clearance, several building developments were reluctant in granting access to conduct the study on their premises due to security concerns. Furthermore, the collection of physical data was constrained by the COVID 19 restrictions.

The study variables of SBRSs were obtained from published information and specialised personnel from the selected building development projects, and not from the buildings' end users or individual occupants/tenants. Future research can be extended to cover perspectives from buildings' end users regarding the environmental performance of sustainable building.

The study was confined to the four local buildings which already have rating certifications. However, there were two other buildings (Bonanza and Sample) under evaluation and a third one (First Capital Bank) under construction. Therefore, other researchers could explore the SBRSs employed and compare the buildings' performance using the selected Green Star SA rating tool.

Furthermore, the popular sustainable building rating systems are limited to building structures, future research should include the environmental impact of extracting critical building materials such as cement, timber, blocks, and glass.

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APPENDICES

Appendix 1: Interview Schedule

November 2022

Dear Sir / Madam,

INTERVIEW SCHEDULE ON THE ADAPTATION OF THE SUSTAINABLE BUILDING RATING SYSTEM TO ZAMBIAN CONTEXT

I am a student at the University of Zambia, pursuing a Master of Engineering degree in Construction Management. The topic of my research is **"Adaptation of the Sustainable Building Rating System to Zambian Context."**

The study seeks to identify and then modify a sustainable building rating system (SBRS) that provide a realistic, consistent foundation for comparison, evaluate key technical aspects of sustainable design, and that won't be overly burdensome to implement and communicate in the Zambian setting.

Despite playing a key role in most economies, building construction contributes significantly to climate change. This has prompted the creation of green building standards, certifications, and sustainable building rating systems aimed at reducing the direct and indirect social and environmental impacts of buildings through sustainable design. While some developed countries have embraced and promoted these rating systems, developing countries such as Zambia have yet to do so. Therefore, the data collected, and findings of this research can be used to identify SBRS that is well suited and can be adapted to Zambian Context, and the deeper knowledge about the rating system selected might form a basis for further evolution and growth SBRS in Zambia.

Attached herewith, are interview questions and based on your experience in this sector, answer all the questions. Please note that information that will be collected will only be used for the purpose of this research and will be strictly confidential. For any queries, contact the undersigned using the address provided above.

Thank you so much for your time and cooperation.

Yours Faithfully,

Anderson Zulu

Master of Engineering Student

INTERVIEW QUESTIONS

Please note: All information provided will be strictly confidential. Please tick your choice in the boxes provided. Tick your answer(s) where there are several choices too.

Section 1. Background information

1. Name of employer…………………………………………….............................
2. What is your profession?...
3. Years of experience? ……………………………………………………………
4. Kindly provide a brief background of this building development as outlined below:
   Name of Building: ……………………………………………………….…………
   Developer/owner: ……………………...……………………………………….
   Designer: ……………..…………………..…………………….…………………
   Contactor: ……………………………………...………………………………
   Year of commissioning/handover: ………………….……………………………
   Location: …………………………………………………………………………
   Area coverage: ……………………………………………………………………

Section 2: Sustainable Building Rating System

1. What do you understand by the term sustainable building rating system?
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2. Does the building have any sustainable rating (green certification), if so which one and what category? State the year.

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3. What was the motivation to develop or construct a green building?

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4. What was the basis of the selection of the sustainable building rating system in 2. above?

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5. When was the sustainable building rating system employed in the building development, was it at design stage, during construction or after completion?

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6. Please list some design, construction and operation aspects of the building which demonstrates how resource efficient your building is?

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7. How do you monitor or verify the resource consumption of your building?

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8. How easy to work with is the sustainable building rating (green building certification) system you have employed?

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9. Kindly share the link or website for any published material about the sustainability of the building or contact of the resource person?

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Section 3 Sustainable Building Rating System Checklist

1. **Management:** This category promotes the adoption of environmental principles from project inception, design, and construction phases, to commissioning and operation of the building and its systems.

   a) Where any professionals engaged to assist the project team with the integration of sustainable environment aims and processes throughout design and construction phases.

   Yes ☐ No ☐

   If yes, please name them.

   ……………………………………………………………………………………

   …...

   b) Where any user guides or building manuals provided to assist building users to optimise the building's environmental performance.

   Yes ☐ No ☐

   If yes, please provide a copy.

   ……………………………………………………………………………………

   ……………………………………………………………………………………

2. **Indoor Environment Quality (IEQ):** The category targets the wellbeing of the occupants. It addresses how the heating, cooling, lighting, and indoor air pollutants contribute to a healthier indoor environmental quality.

   a) Is the building fitted with any carbon dioxide levels monitor?

   Yes ☐ No ☐

   b) Do all building occupants have a visual connection to the external environment?

   Yes ☐ No ☐

   c) How efficient are the building’s electric lighting?

   ……………………………………………………………………………………

   ……………………………………………………………………………………

3. **Energy:** The category targets an overall reduction in energy consumption and a reduction of greenhouse gas emissions associated with energy generation.

a) What provisions are there in the building to facilitate on-going management of energy consumption?

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b) What alternative power sources does the building have and how much is generated in relation to the entire energy requirements of the building?

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4. **Transport:** The category rewards the reduction in automotive commuting while encouraging use of alternative transport.

   a) What are the available alternative modes of transportation for commuting to building premises?

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   …………………………………………………………………………………

   b) How far are the nearest public amenities such as shopping malls?

   …………………………………………………………………………………

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5. **Water:** Aims to reduce the use of potable water through design of efficient systems, rainwater collection and water re-use.

   a) What has been done to reduce potable water consumption by building occupants?

   …………………………………………………………………………………

   …………………………………………………………………………………

   b) Is there any water system for harvesting, recycling and reuse?

   …………………………………………………………………………………

   …………………………………………………………………………………

6. **Materials**: The category targets the consumption of resources through the selection and reuse of materials.

   a) Name some natural resources used and reused materials that can be reused or recycled?

   ……………………………………………………………………………………
   ……………………………………………………………………………………

   b) What are some local materials used and those that could not be found locally?

   ……………………………………………………………………………………
   ……………………………………………………………………………………

7. **Land Use and Ecology:** This section promotes initiatives that improve or reduce the buildings impact on ecological systems and biodiversity.

   a) Was the building built on the brown, grey or green fields?

   ……………………………………………………………………………………
   ……………………………………………………………………………………

   b) Have any of the existing trees and unique landmarks been conserved?

   Yes ☐ No ☐

   Please explain any initiative applied.

   ……………………………………………………………………………………
   ……………………………………………………………………………………

8. **Emissions:** This targets the environmental impacts of a development's emissions or substances emitted from the site.

   a) Name any refrigerants and other gases used in the building's cooling system.

   ……………………………………………………………………………………
   ……………………………………………………………………………………

9. **Innovations:** The category encourages, recognises and rewards the spread of innovative technologies, designs and processes that impact on the overall environmental performance of the building**.**

   a) Are you using any application or computerised system to monitor building performance?

      Yes ☐ No ☐

      Please explain any initiative applied.

      ……………………………………………………………………………………

      ……………………………………………………………………………………

Thank you for your time and cooperation

Appendix 2: Observation Schedule

Sites of the various building developments was observed to obtain information as listed in the following sections.

Section 1. Site Selection and Planning

1. The building and all windows orientation according to the position of the sun and the direction of the wind………………………………………………
2. How passive architecture techniques have been integrated within the design of the building…………………………………………………………….
3. Are all the trees and natural vegetation preserved at the site………………….

Section 2. Water Management

1. Use of water efficient plumbing fixtures in the bathrooms and kitchens……
2. Rainwater harvesting system……………………………………………….
3. Does the building have its own source of groundwater e.g., borehole?...............
4. Is there a sewer treatment plant/ wastewater recycling plant or is the building connected to sewer main line?...
5. Are recharge trenches or recharge pits that can divert the rainwater into the ground water table available?...

Section 3. Energy Efficiency of the Building

1. Does the building have a reflective roof coating or roof garden?....................
2. Is the area serviced by ZESCO?...
3. Are water bodies integrated within the indoors and outdoors? ……………
4. What are the other available sources of energy? E.g., solar or wind…………
5. Are there adequate numbers of plants within the indoors and outdoors? …….

Section 4. Creating a Health Indoor Environment

1. Are only low volatile organic compound (VOC) sealants paints and adhesives used? ………………………………………………………………………

2. Are the indoor and outdoor noise levels within acceptable limits? ……………………………………………………………………………………
3. Is there good accessibility for people with disabilities? ……………………………...………………………………………………….

<u>Section 5. Building Materials and Resources</u>

1. What locally sourced materials were used?..
2. Was the building constructed with recycled materials? ....

<u>Section 6. Innovation</u>

1. Were low emissivity coated glass used?..
2. Does the building have energy efficient air conditioners?...............................

Appendix 3: Rating Certificates

VODAFONE SITE SOLUTION INNOVATION CENTRE

Vodacom Campus, Midrand, Gauteng, SA

GREEN BUILDING COUNCIL SOUTH AFRICA

greenstar

6 Star Green Star SA – Office v1 Design Rating

Achieved in October 2011

Vodafone identified the Vodacom Campus in Midrand, South Africa as the ideal location to host their Innovation Centre. The building is the centre of tower and telecom experimentation, developing technologies that are appropriate for environments which are poorly served by conventional infrastructure and future proofing technology for a resource constrained future. The brief required that the building be a reflection of the activities that will take place in the Innovation Centre and embrace passive design, renewable energy, water sustainability and locally appropriate materials and technology. The building is designed to serve as a "concept building", exploring the feasibility of the various design initiatives employed in the building and assessing their applicability for future developments within both the Vodafone and Vodacom fold. The building is available for visitors to view the low energy, sustainable design and construction solutions.

Sustainable building features include:

- Solar absorption chiller, Rock store and tass for thermal comfort and ventilation. All energy provided by photovoltaic panels.
- Thermal comfort levels are achieved through a combination of thermally activated slab, radiant space panels for cooling as well as rapid response heating, as well as displacement ventilation.
- Excess power fed back into Vodacom grid which is used as back up for non-daylight hours.
- Dual flush concealed cisterns are specified for the public toilets as well as the paraplegic toilet, electronic sensor taps are specified for all the wash hand basins and all taps are specified to have aerator.

PROJECT TEAM:

DEVELOPER
Vodafone

ARCHITECTS
GLH

ELECTRICAL ENGINEER
OneZero

MECHANICAL ENGINEER
WSP Consulting

WET SERVICES ENGINEER
WSP Consulting

PROJECT MANAGER
Jenmeg PM

QUANTITY SURVEYORS
BHA

STRUCTURAL ENGINEERS
WSP Structures

SUSTAINABLE DESIGN CONSULTANT
WSP GREEN by DESIGN.

TOTAL POINTS: 86

POINTS ALLOCATION:

PROJECT FLOOR AREAS:

TOTAL GROSS FLOOR AREA (GFA): 458 m^2

TOTAL COMMERCIAL OFFICE AREA: 348 m^2

CAR PARKING AREA: - m^2

NEDBANK HEAD OFFICE PHASE II

135 Rivonia Road, Sandton, Johannesburg, SA

GREEN BUILDING COUNCIL SOUTH AFRICA

greenstar

4 Star Green Star SA – Office v1 Design Rating

Achieved in October 2009

Nedbank Phase II is located in the hub of Sandton on the corner of Rivonia Road and Maude Street, opposite the Village Walk. The architectural style of the building mirrors the first phase building. However, the detail of the design of Phase II is governed by environmentally sustainable principles epitomising Nedcor's commitment to environmental sustainability. Officially the first Green Star SA rated office building in the country, Phase II of Nedbank's Head Office will provide new accommodation for 3,000 employees. The development will include retail spaces on the ground floor, presenting an active edge to the public realm, and seven levels of office space above. Excavations make space for the black water treatment plant and storage of rainwater and treated black water.

Sustainable building features include:

- 60% of office areas with a visual connection to the outdoors or atrium.
- Mass transport options for building occupants include minibus taxis, Metrobus, PUTCO buses, future Rea Vaya buses and the Gautrain Rapid Rail Link.
- Building predominantly framed in reinforced concrete with a 95% recycled content for all reinforcing steel.
- Outflows to sewerage system reduced by 90% through the implementation of high efficient fixtures and fittings and the blackwater treatment system
- Blackwater treatment system to provide recycled water for all non-portable water uses including irrigation, toilet flushing & cooling towers.

PROJECT TEAM:

OWNER
Nedbank Limited

ARCHITECTS
GLH Architects
Terra Ether Architects

DISABILITY SPECIALIST
Disability Solutions (Pty)

ELECTRICAL ENGINEER
Claasen Auret Inc.

FIRE ENGINEER
TWCE

LIFT SPECIALIST
Building Transportation Consultants

MECHANICAL ENGINEER
Aurecon

PROJECT MANAGER
Coffey Projects

MAIN CONTRACTOR
Group 5 Building

QUANTITY SURVEYORS
SBDS LDM JHM Inc.

STRUCTURAL ENGINEERS
WSP Structures Asakheni

SUSTAINABLE DESIGN REVIEW CONSULTANTS
GREEN by DESIGN PJCarew Consulting CSIR

SUSTAINABLE BUILDING CONSULTANT
WSP GREEN by DESIGN

WET SERVICES
WSP Group

TOTAL POINTS: 54

POINTS ALLOCATION:

PROJECT FLOOR AREAS:

TOTAL GROSS FLOOR AREA (GFA): **45 401 m^2**

TOTAL COMMERCIAL OFFICE AREA: **41 946 m^2**

CAR PARKING AREA: **59 253 m^2**

1000024303, Lusaka

Citibank Lusaka

LEED ID+C: Commercial Interiors (v2009)

CERTIFIED, AWARDED JUL 2013

SUSTAINABLE SITES — AWARDED: 8 / 21

SSc1	Site selection	2 / 5
SSc2	Development density and community connectivity	6 / 6
SSc3.1	Alternative transportation - public transportation access	0 / 6
SSc3.2	Alternative transportation - bicycle storage and changing rooms	0 / 2
SSc3.3	Alternative transportation - parking availability	0 / 2

WATER EFFICIENCY — AWARDED: 6 / 11

WEp1	Water use reduction	REQUIRED
WEc1	Water use reduction	6 / 11

ENERGY & ATMOSPHERE — AWARDED: 12 / 37

EAp1	Fundamental commissioning of building energy systems	REQUIRED
EAp2	Minimum energy performance	REQUIRED
EAp3	Fundamental refrigerant Mgmt	REQUIRED
EAc1.1	Optimize energy performance - lighting power	1 / 5
EAc1.2	Optimize energy performance - lighting controls	2 / 3
EAc1.3	Optimize energy performance - HVAC	5 / 10
EAc1.4	Optimize energy performance - equipment and appliances	4 / 4
EAc2	Enhanced commissioning	0 / 5
EAc3	Measurement and verification	0 / 5
EAc4	Green power	0 / 5

MATERIAL & RESOURCES — AWARDED: 1 / 14

MRp1	Storage and collection of recyclables	REQUIRED
MRc1.1	Tenant space - long-term commitment	0 / 1
MRc1.2	Building reuse - maintain interior nonstructural elements	0 / 2
MRc2	Construction waste Mgmt	0 / 2
MRc3.1	Materials reuse	0 / 2
MRc3.2	Materials reuse - furniture and furnishings	0 / 1
MRc4	Recycled content	1 / 2
MRc5	Regional materials	0 / 2
MRc6	Rapidly renewable materials	0 / 1
MRc7	Certified wood	0 / 1

INDOOR ENVIRONMENTAL QUALITY — AWARDED: 6 / 17

EQp1	Minimum IAQ performance	REQUIRED
EQp2	Environmental Tobacco Smoke (ETS) control	REQUIRED
EQc1	Outdoor air delivery monitoring	0 / 1
EQc2	Increased ventilation	1 / 1
EQc3.1	Construction IAQ Mgmt plan - during construction	1 / 1
EQc3.2	Construction IAQ Mgmt plan - before occupancy	0 / 1
EQc4.1	Low-emitting materials - adhesives and sealants	0 / 1
EQc4.2	Low-emitting materials - paints and coatings	1 / 1
EQc4.3	Low-emitting materials - flooring systems	1 / 1
EQc4.4	Low-emitting materials - composite wood and agrifiber products	0 / 1
EQc4.5	Low-emitting materials - systems furniture and seating	1 / 1
EQc5	Indoor chemical and pollutant source control	0 / 1
EQc6.1	Controllability of systems - lighting	0 / 1
EQc6.2	Controllability of systems - thermal comfort	0 / 1
EQc7.1	Thermal comfort - design	0 / 1
EQc7.2	Thermal comfort - verification	0 / 1
EQc8.1	Daylight and views - daylight	0 / 2
EQc8.2	Daylight and views - views	1 / 1

INNOVATION — AWARDED: 6 / 6

IDc1	Innovation in design	1 / 1
IDc2	LEED Accredited Professional	1 / 1

REGIONAL PRIORITY CREDITS — AWARDED: 4 / 4

EAc1.1	Optimize energy performance - lighting power	1 / 1
EAc1.2	Optimize energy performance - lighting controls	1 / 1
EAc1.3	Optimize energy performance - HVAC	1 / 1
WEc1	Water use reduction	1 / 1

TOTAL 43 / 110

40-49 Points	50-59 Points	60-79 Points	80+ Points
CERTIFIED	SILVER	GOLD	PLATINUM

1000102462, Lusaka

Evexia

LEED BD+C: Core and Shell (v4)

GOLD, AWARDED AUG 2020

SUSTAINABLE SITES — AWARDED: 5 / 11

Prereq	Construction activity pollution prevention	0 / 0
Credit	Site assessment	1 / 1
Credit	Site development - protect or restore habitat	0 / 2
Credit	Open space	1 / 1
Credit	Rainwater Mgmt	0 / 3
Credit	Heat island reduction	2 / 2
Credit	Light pollution reduction	0 / 1
Credit	Tenant design and construction guidelines	1 / 1

WATER EFFICIENCY — AWARDED: 8 / 11

Prereq	Outdoor water use reduction	0 / 0
Prereq	Indoor water use reduction	0 / 0
Prereq	Building-level water metering	0 / 0
Credit	Cooling tower water use	0 / 2
Credit	Water metering	1 / 1
Credit	Outdoor water use reduction	2 / 2
Credit	Indoor water use reduction	5 / 6

ENERGY & ATMOSPHERE — AWARDED: 22 / 33

Prereq	Fundamental commissioning and verification	0 / 0
Prereq	Minimum energy performance	0 / 0
Prereq	Building-level energy metering	0 / 0
Prereq	Fundamental refrigerant Mgmt	0 / 0
Credit	Enhanced commissioning	6 / 6
Credit	Advanced energy metering	1 / 1
Credit	Demand response	0 / 2
Credit	Renewable energy production	3 / 3
Credit	Enhanced refrigerant Mgmt	1 / 1
Credit	Green power and carbon offsets	0 / 2
Credit	Optimize energy performance	11 / 18

MATERIAL & RESOURCES — AWARDED: 5 / 14

Prereq	Storage and collection of recyclables	0 / 0
Prereq	Construction and demolition waste Mgmt planning	0 / 0
Credit	Building life-cycle impact reduction	3 / 6
Credit	Building product disclosure and optimization - environmental product d...	0 / 2
Credit	Building product disclosure and optimization - sourcing of raw materia...	0 / 2
Credit	Building product disclosure and optimization - material ingredients	0 / 2
Credit	Construction and demolition waste Mgmt	2 / 2

INDOOR ENVIRONMENTAL QUALITY — AWARDED: 5 / 10

Prereq	Minimum IAQ performance	0 / 0
Prereq	Environmental tobacco smoke control	0 / 0
Credit	Enhanced IAQ strategies	2 / 2
Credit	Low-emitting materials	0 / 3
Credit	Construction IAQ Mgmt plan	1 / 1
Credit	Daylight	1 / 3
Credit	Quality views	1 / 1

INNOVATION — AWARDED: 5 / 6

Credit	Innovation	4 / 5
Credit	LEED Accredited Professional	1 / 1

REGIONAL PRIORITY CREDITS — AWARDED: 4 / 4

Credit	Renewable energy production	1 / 1
Credit	Building product disclosure and optimization - material ingredients	0 / 1
Credit	Site development - protect or restore habitat	0 / 1
Credit	Open space	1 / 1
Credit	Outdoor water use reduction	1 / 1
Credit	Indoor water use reduction	1 / 1

LOCATION & TRANSPORTATION — AWARDED: 19 / 20

Credit	LEED for Neighborhood Development location	0 / 20
Credit	Sensitive land protection	2 / 2
Credit	High priority site	2 / 3
Credit	Surrounding density and diverse uses	6 / 6
Credit	Access to quality transit	6 / 6
Credit	Bicycle facilities	1 / 1
Credit	Reduced parking footprint	1 / 1
Credit	Green vehicles	1 / 1

INTEGRATIVE PROCESS CREDITS — AWARDED: 1 / 1

Credit	Integrative process	1 / 1

TOTAL 74 / 110

40-49 Points	50-59 Points	60-79 Points	80+ Points
CERTIFIED	SILVER	GOLD	PLATINUM

THIS CERTIFIES THAT

SCB Head Office Zambia

HAS ACHIEVED AN

EDGE ADVANCED PRELIMINARY CERTIFICATE

CERTIFICATE NUMBER

GP1-ZMB-19032510063133-P

EDGE ADVANCED

Exemplifying achievement in the following areas:

53%
Energy Savings

57%
Water Savings

24%
Less Embodied Energy in Materials

102.40 tCO_2/year
Operational CO_2 Emissions

112.91 tCO_2/year
Operational CO_2 Savings

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Novare Equity Partners

CERTIFIED BY

Sintali-SGS

Thomas Saunders, Managing Director

DATE OF ISSUE: 08-FEB-2021

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path to a sustainable future

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THIS CERTIFIES THAT

SCB Head Office Zambia
Corner Mwaimwena Road and Addis Ababa Drive
Maluba
Lusaka,
Zambia

DEVELOPED BY

Novare Equity Partners

HAS ACHIEVED AN

EDGE PRELIMINARY CERTIFICATE

CERTIFICATE NUMBER

GP1-ZMB-19032510063133-P

WAS AUDITED BY

Gladys Assan
EDGE Software Version: v2.1.5

CERTIFIED BY

Sintali-SGS

Thomas Saunders, Managing Director

path to a sustainable future

DATE OF ISSUE

08-FEB-2021

DATE OF EXPIRY

07-FEB-2024

ENERGY MEASURES

Reduced Window to Wall Ratio
Insulation of Roof
Higher Thermal Performance Glass
Variable Refrigerant Volume (VRV) Cooling System
Energy-Saving Light Bulbs - Internal Spaces
Energy-Saving Light Bulbs - External Spaces
Occupancy Sensors in Bathrooms, Conference Rooms, and Closed Cabins
Occupancy Sensors in Open Offices
Solar Photovoltaics

WATER MEASURES

Low-Flow Faucets in Bathrooms
Efficient Flush for Water Closets in All Bathrooms
Water-Efficient Urinals in all Bathrooms
Water-Efficient Faucets for Kitchen Sinks

MATERIALS

Floor Slabs - In-Situ Reinforced Concrete Slab
Roof Construction - In-Situ Reinforced Concrete Slab
External Walls - In-Situ Reinforced Wall
Internal Walls - Medium Weight Hollow Concrete Blocks
Internal Walls - Plasterboards on Metal Studs with Insulation

www.edgebuildings.com

The EDGE standard requires 20% efficiencies in energy, water and materials compared to a local benchmark. Predicted efficiencies are not a guarantee of future operational performance. Energy savings may be associated with virtual energy for comfort depending on the presence of heating and cooling systems. Virtual energy does not contribute savings to utility bills.

This certificate is issued by the Certifier based on information provided by the client and the audit by the Auditor, and is subject to the terms and conditions of the Certifier. Contact edge@ifc.org if the above measures are not consistent with your observation on the project.

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