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THE IMPACT OF THE OMISSION OF STRUCTURAL ANALYSIS IN REINFORCED CONCRETE ON SUSTAINABILITY IN CONSTRUCTION IN BURUNDI

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Master's Thesis

Supervisor

Prof. Dr. Sepanta NAİMİ

İstanbul, 2025

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The thesis titled THE IMPACT OF THE OMISSION OF STRUCTURAL ANALYSIS IN REINFORCED CONCRETE ON SUSTAINABILITY IN CONSTRUCTION IN BURUNDI prepared by Alain Teddy BIMENYIMANA and submitted on 10/12/2025 has been **accepted unanimously** for the degree of Master of Science in Civil Engineering.

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I hereby declare that all information/data presented in this graduation project has been obtained in full accordance with academic rules and ethical conduct. I also declare all unoriginal materials and conclusions have been cited in the text and all references mentioned in the Reference List have been cited in the text, and vice versa as required by the abovementioned rules and conduct.

Alain Teddy BIMENYIMANA

Signature

DEDICATION

I dedicate this thesis work to all those who have assisted me in one way or another throughout this process, those who stood by me in this process, especially to my family and dear friends for the efforts they have made to ensure my full support.

PREFACE

The idea of writing on a relevant topic of this kind came from the desire to expose existing problems and suggest solutions that would be followed to solve these problems. As the world develops, so do all industries, as well as the construction industry which is growing at a blazing speed. I had a sincere desire to contribute through this project to ensuring that the construction work in Burundi is carried out in accordance with the standards in force, particularly in terms of sustainability. I would not have been able to carry out this work alone without the efforts and contributions of my network of relationships, for which I would like to express my sincere gratitude, especially to my dear parents for the sacrifices they have made to ensure that we receive a quality education, as well as to all my brothers and sisters with whom we share the same blood and my friends for their affection and support. Second, I would like to thank my committee members for their support, their sound advice and their great benevolence, which was essential during the development and structuring of this work. Thank you very much for your self-sacrifice.

ABSTRACT

THE IMPACT OF THE OMISSION OF STRUCTURAL ANALYSIS IN REINFORCED CONCRETE ON SUSTAINABILITY IN CONSTRUCTION IN BURUNDI

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Sustainable construction is a backup concept that is of concern to the whole world to advocate against climate change by constructing using techniques that aim to minimize ecological nuisance given that construction works have a considerable impact on environmental degradation and people's lives. This article aims to assess the sustainability impacts specifically on the environment, resource depletion and reduced lifespan of structures that are due to the omission of structural analysis in Reinforced Concrete (RC). The study was conducted in Burundi, which is a developing country that has gone through various socio-political crisis, and which determines the current situation of its construction industry with several construction projects that many of them are carried out devoid the structural analysis stage. A survey was undertaken in the 3 major cities of the country with 258 respondents who make up the construction industry in Burundi the data analysis was implemented using SPSS v.30 and AMOS 26 software and to have the most accurate calculations, different approaches were used including the reliability test, the Kaiser–Meyer–Olkin (KMO) test, Bartlett's test, Exploratory Factor Analysis (EFA), Principal Component Analysis (PCA), Confirmatory Factor Analysis (CFA) by different fit indicators and the Relative Importance Index (RII) and the results were Exquisite. It concluded that reinforced concrete is the type of structure commonly used in Burundi and that the major challenges are financial constraint, poor quality of materials, quality assurance of the education system, non-compliance with the regulatory framework and lack of monitoring and evaluation all

being reasons for the ignorance of certain stages of the design including the structural analysis followed by harmful consequences already recorded. Government bodies together with construction agents can collaborate and promote community welfare plus respect for the laws so that the construction works can be carried out properly.

Keywords: Sustainable Construction, Environmental Impact, Material Durability, Safety, Construction in Burundi.

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ABBREVIATIONS

AMOS	:	Analysis of Moment Structures
BC	:	Before Christ
BREEAM	:	Building Research Establishment Environmental Assessment Method
CAD	:	Computer-Aided Design
CFA	:	Confirmatory Factor Analysis
CFI	:	Comparative Fit Index
CO2	:	Carbon Dioxide
CT	:	Compliance And Technology
EFA	:	Exploratory Factor Analysis
EME	:	Environment And Material Efficiency
EMW	:	Economic And Material Waste
ETABS	:	Extended Three-Dimensional Analysis of Building Systems
GDP	:	Gross Domestic Product
GFI	:	Goodness of Fit Index
HQE	:	High Environmental Quality
KMO	:	Kaiser- Meyer- Olkin
LEED	:	Leadership in Energy and Environmental Design
MLE	:	Maximum Likelihood Estimation
NFI	:	Normed Fit Index
PCA	:	Principal Component Analysis
RC	:	Reinforced Concrete
RII	:	Relative Importance Index

RMSEA	:	Root Mean Square Error of Approximation
RS	:	Resilience And Sustainability
SANS	:	South African National Standard
SAP2000	:	Structural Analysis Program 2000
SDG	:	Sustainable Development Goals
SIR	:	Structural Integrity Risks
SPPS	:	Statistical Package for the Social Sciences
SRMR	:	Standardized Root Mean Square Residual
TLI	:	Tucker–Lewis Index
TVET	:	Technical and Vocational Education and Training
ZNEB	:	Zero Net Energy Building
αC	:	Alpha Cronbach's

1. INTRODUCTION

1.1 PROBLEM STATEMENTS

For several years, man has always sought shelter by leaving the nomadic life. Construction served to satisfy this need using the materials they had available including wood, earth, and stone [1, 2]. Following years, with the discovery of new technologies, the construction industry developed with the use of mathematical and physical sciences, and this allowed the introduction of reinforced concrete that goes hand in hand with structural analysis [3, 4]. This development spread throughout the world including Burundi with the arrival of European settlers (Germans and Belgians) at the end of the nineteenth century who introduced scientific construction techniques with a good structure of the city of Bujumbura. infrastructures such as industry in the west, administrative and commercial buildings in the south replacing those that existed built with the available natural materials [5-7].

Even though Burundi has experienced this introduction of development in the construction industry, this expansion in this field has experienced delays due to the various crisis that the country went through after its independence in 1962 among other ethnic and political conflicts that are dividing the population and slowing down the social and economic development from 1965 to 1993 which has had after-effects until today, the massive consumption of natural resources due to the high growth of the population which has led to the lack of land as well as deforestation and weakness plus the failure of good governance which leads to the lack of regard of established laws, corruption and even the abuse of power which weakens public governance [8, 9].

These various problems have directly affected the construction sector in Burundi so that the freedom of entrepreneurs, both local and international, who wish to work in the construction sector is very limited due to the business climate in the country. According to the World Bank's Doing Business report, on the ranking of how countries facilitate entrepreneurship, Burundi has fallen from 151st place to 166th place just in 5 years (from 2015 to 2020) [10]. Thus, according to a study conducted in 2005, due to these problems, it was revealed that local construction companies in Burundi have limited financial capacity and modern equipment, which makes the Burundian sector unable to meet the demands of the current market and the inadequacy of appropriate infrastructure due to the increase in market prices

which leads to the slowdown of deconstruction projects without forgetting construction in different ways. due to financial constraints [11, 12]. In 2018, the Government of Burundi in its National Development Plan identified institutional and regulatory challenges in the construction sector, highlighting the lack of construction control and harmony in the regulations governing the sector in Burundi [8].

Based on these challenges, research for this article was conducted in Burundi, which is an East African country with an area of 27,834 km² and a population of 14,227,502 habitats in 2024 at a high density of 560 habitats/km² to know the exact and current situation of the construction sector in Burundi and the challenges experienced by the construction sector.

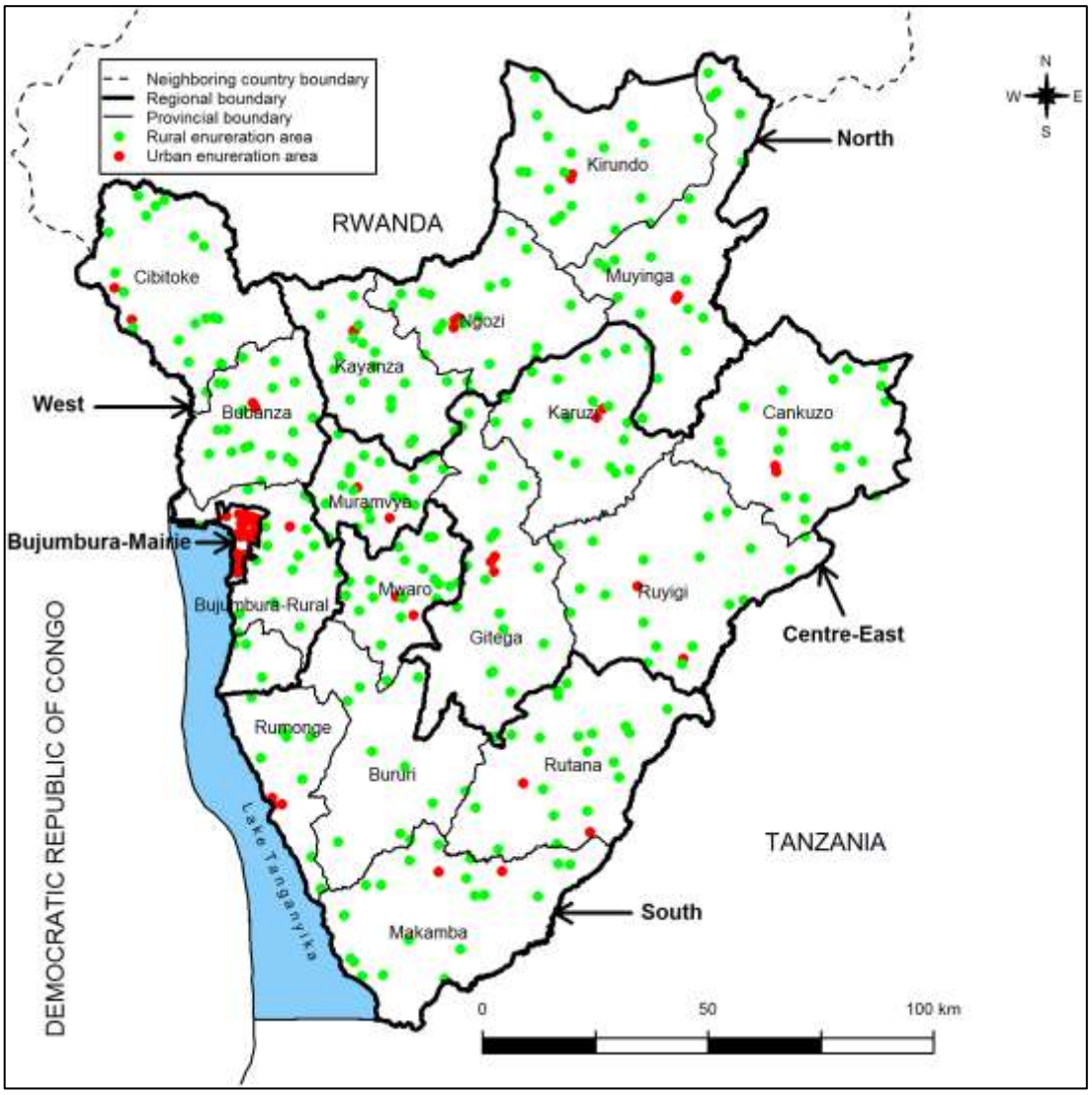

Figure 1.1: Map of Burundi[13].

Omission of structural analysis can have particularly disastrous effects in Burundi, where financial resources are scarce. Indeed, it could compound the already existing problems of building safe, affordable and sustainable infrastructure for a growing population. Here are some of the notable findings that the lack of structural analysis could lead to, and which we will examine throughout this work:

Sustainability issues: Poorly rated structures have a shorter lifespan and require more frequent maintenance, which increases the number of resources used. This undermines the sustainability of the building and challenges national, international and local campaigns to support environmentally friendly construction methods for sustainable construction.

Safety Risks: If proper structural analysis is not performed, the design may miss significant load requirements for the structure. The safety of the occupants is put at risk due to an increased likelihood of failures such as cracks, severe deformation or even fatal collapses.

Increased costs: Overuse and underuse of materials can result from inadequate structural analysis. The integrity of a building is compromised by excessive use, which can lead to unnecessary expense, while insufficient use exposes it to major repairs, reinforcements, or even complete reconstruction.

A significant problem in the construction industry is the failure to comply with structural analysis in the planning and construction phases. This analysis is necessary to ensure the stability, longevity and safety of a building by assessing how it reacts to different loads and forces. Without it, structures are often built without a full assessment of their ability to support loads, including wind, seismic forces, and the weight of the building itself.

1.2 BACKGROUND AND CONTEXT

Structural analysis is considered a crucial procedure in the construction of reinforced concrete buildings, both in design and construction. Its main function is to evaluate the resistance of a structure to the loads and forces it will undergo throughout its life. Ensuring the safety, sustainability and profitability of buildings depends on this process. Structural analysis allows engineers to confirm the building's ability to support loads already in the design phase. This involves determining the strength of the steel reinforcement and concrete to ensure that the structure can safely support both the additional weight and its own weight.

Structural engineers can design stable structures in a variety of situations by looking at the distribution of forces and moments. To avoid structural failures that could jeopardize the safety of occupants, such as collapses or extreme deformations, this study is crucial. The optimal use of materials is ensured by appropriate structural analysis. With accurate evaluation of strength and reinforcement requirements, engineers can avoid over- or under-design of their designs. This strategy promotes sustainability by reducing waste and improving prices at the same time.

1.2.1 Review of the History of Structural Engineering

Although the beginnings of the history of civil engineering are difficult to define more precisely, its history is of great importance in the history of humanity, for a very long time, individuals have been building shelters to protect themselves from the elements and other needs related to the use of these shelters. All they did was old civil engineering. From 4000 to 2000 BC, in ancient Egypt and Mesopotamia (present-day Iraq), civil engineering emerged and gave meaning to an increasingly nomadic humanity. It also served as a starting point for the construction of shelters, which led to the emergence of roads and shipping. It was between 2700 and 2500 B.C. that the first pyramids were built in ancient Egypt. However, the practice of civil engineering has not always been taught in schools. The term "civil engineering" was introduced to France in the 18th century in 1747, and John Smeaton was the first civil engineer to proclaim himself as such [14].

The pyramids also marked the beginning of structural engineering, at least in 2700 BC, as they imposed structures built by ancient civilizations, and given their shapes and sizes, it was likely that these structures were stable. The qanat water management system is another ancient discovery that can also be used in modern structural engineering. Its technology was developed during the Mendes. (Modern Iran). During this period of ancient history, there were no theories regarding structural engineering, implying that all structural construction activities were conducted based on skill and a sense of how to proceed. Craftsmen, carpenters and stonemasons were among them [15].

Over time, as the world is constantly changing, the history of structural engineering has undergone a transformation thanks to the renaissance of technology. Although the first calculations are not documented, with the revolution in industry and concrete, structural

engineering began to develop thanks to the knowledge and vision of physics. The evolution of structural engineering has also been influenced by various researchers who have created and developed various principles that are still used in the field of construction. In the late 19th and 20th centuries, the history of structural analysis and strength of materials underwent a significant evolution. In 1821, Claude Louis Navier developed the theory of elasticity, which is one of the characteristics of the materials used in construction. A few years later, he introduced the modulus of elasticity, which allowed engineers to better understand the behavior of structural materials. As for concrete, one of its main components, cement, a hydraulic binder, was used by the Romans as well as by the Greek and Chinese civilizations in the last century in the form of pozzolanic cement. Portland cement was patented by Joseph Aspdin in 1824. Over time, advances in structural engineering have continued to expand thanks to many inventions such as finite element analysis, which revolutionized structural analysis and design by also using computers. New technology has continued to advance in understanding the behavior of materials in response to various topics, such as failure mechanisms, seismic activity, temperature effects on materials, dynamic-related vibrations, and structural fatigue. Now, knowledge related to structural analysis is accessible to the whole world, which leads to the specialization of structural engineers [16].

1.2.1.1 History of Structural Engineering in Burundi

The history of construction in ancient Burundi is fictional, as there is very little written about it. In Burundi, as in other countries, some people have developed innovative housing solutions and decided to abandon the nomadic life. Construction in Burundi has a very rich and diverse history, dating back long before the arrival of the colonizers (Germans and Belgians) who then introduced modern construction techniques. The architecture was classical and mainly based on natural materials (straw, wood, rammed earth) for shelters built without any theory related to structural engineering. The central body was round and played an important role in protecting against the elements, although it was not effective against climatic and temperature factors (such as fire resistance) due to the materials used. When they arrived in Burundi (late 19th century 1916), the colonizers adopted modern construction methods that continued to be used in construction in Burundi. This introduction serves as recognition, because to this day, the construction industry in Burundi follows in the footsteps of this integration by the European colonizers. Their entry into the education

system was also welcomed, as it gave Burundians the opportunity to learn about various construction techniques and theories, leading to a revolution in the field of construction and structural engineering in Burundi. In 1962, Burundi gained independence, and, as a developing country, many projects have been completed and others are under way, both public and private. The materials used are no longer traditional, but comply with international standards, requirements and specifications. As in other countries [17].

1.2.2 Significance in Burundi

Burundi is experiencing accelerated urbanization, as are many other developing countries. Because people are moving from the countryside to the cities, the populations of places like Bujumbura, Gitega and Ngozi have increased dramatically. This growth in cities is creating an increased need for new public, commercial and residential buildings. Cities increasingly need strong infrastructure like roads, bridges, and tall buildings as they grow. Reinforced concrete is necessary to achieve these goals, as it can support huge buildings and solve the unique problems that arise in cities.

Burundi is in the region that is known to have many destructive natural phenomena. This location clearly shows how important it is for structures to be safe. Reinforced concrete construction gives buildings the strength and flexibility they need to survive earthquakes and other natural disasters, keeping people safe inside. International building rules and standards are under increasing pressure to be met because people want buildings to be safer. These standards are met by concrete reinforcement construction, which ensures that buildings are constructed to protect people and property in the event of a disaster [18].

The construction industry is very important for Burundi's economic growth. Projects that use reinforced concrete create jobs and help related businesses, such as those that manufacture cement and steel. In turn, this helps the local business and gives more people the opportunity to find work. While these construction methods may cost more upfront than standard methods, using reinforced concrete will save you money in the long run because it lasts longer and requires less maintenance [19]. This makes it a good choice for both public and private projects, especially when money is limited. As more people move to cities, the need for cheap housing increases. Reinforced concrete is perfect for the construction of multi-story apartment buildings, making the best use of limited urban space. As a result, it helps

growing cities get more housing while providing people with safe and sustainable places to live [20]. In addition to houses, there is a great need for social infrastructure such as schools, hospitals, and public buildings. Many people like to use reinforced concrete for these kinds of projects because it is strong and meets safety standards, which ensures the durability of public buildings.

Au Burundi, où les villes se développent et où les bâtiments doivent être solides et durer longtemps, le béton armé fonctionne bien. Cela est dû à la croissance économique et sociale du pays. À mesure que le pays continue de se moderniser, le béton armé sera un élément clé de la construction de l'infrastructure qui aidera les villes à se développer et à faire face à des problèmes tels que le changement climatique et la gestion de ressources limitées [21].

1.2.3 Concepts in Sustainable Construction and Reinforced Concrete

The structure is described by parts that are connected for a purpose to maintain or lift any load so that its usefulness is effective in every area, even in public uses. Based on its role, in-depth studies, including structural analysis, must be carried out by qualified engineers with the intention of taking into consideration factors related to the aesthetics, economic and durability of the structure, as well as environmental determinants. To make concrete decisions for the final decision of the components of the structure, creativity and technique must also be considered to ensure that the study of the laws of mechanics ensures the quality of the materials to be used [22].

1.2.3.1 Sustainable construction

In 1992, in Rio de Janeiro, Brazil, at the United Nations Earth Summit, a plan called Agenda 21 was drawn up, which has implications for the 21st century. The plan emphasizes sustainable development in accordance with the environment, economy and social life, based on measures that govern all peoples, all regions of the world and all sectors of society, with the aim of reducing pollution and using the environment wisely [23]. When assessing the strength of a structure and its constituent materials, this structural analysis should not be limited to toughness only but should also consider environmental issues as described in Agenda 21. This brings us to what is called sustainable construction, which is defined as a technique used in the construction industry in accordance with healthy eco-conservation

based on ecological values and the observance of natural resources that must be applied to the maximum in the construction of buildings for a better future [24].

Based on Agenda 21, the German government created in 2002 what it called Outlook for Germany, which aims to achieve sustainable development based on a policy of 21 indicators, all related to the conservation of natural resources and the quality of life including in the construction activities of buildings [25, 26]. Impacts that can be considered positive in terms of buildings have already been observed in the country, for example, the efficient use of energy, both during construction and throughout the life of the building as well as in renovation works that significantly reduce the impact of these on the natural environment [27].

1.2.3.2 Reinforced concrete

Concrete that has been reinforced with steel reinforcement imparts tensile strength to the material, while the compressive strength of concrete is retained. Steel bars or meshes are implanted into concrete to increase its tensile strength and to increase its overall longevity, as concrete is weak under tension but robust under compression. For structural components such as foundations, columns, and walls, concrete is perfect because of its exceptional ability to withstand compressive stress, allowing it to support large weights without splitting. Steel reinforcement must be added to the concrete to give it the required tensile strength, as the concrete itself is not particularly strong. Reinforced concrete can withstand bending and stretching pressures thanks to this combination [28].

It is essential that reinforced concrete is resistant to environmental elements such as humidity, temperature changes, and chemicals. It is particularly well suited for construction in a variety of climates and situations due to its strength. Reinforced concrete buildings and other structures can last for decades or even centuries if properly designed and maintained. There is a lot of creative freedom in architectural design when using reinforced concrete, as it can be molded into many shapes and sizes [29]. It is used in many different contexts, ranging from basic houses to complex structures and bridges. Its adaptability encompasses a range of structural elements, including foundations, floors, beams, and columns. It is frequently used in infrastructure, commercial, industrial, and residential applications. For

many building projects, reinforced concrete is the preferred material due to its efficiency and cost-effectiveness. Its extensive use is facilitated by its accessibility and ease of use [30].

1.3 WHAT CAUSES OF THE OMISSION

A significant number of construction projects in Burundi, their structures are made of reinforced concrete and the omission of the structural analysis that manifests itself, according to the study done and various existing articles, this negligence is due in general to the current state and main challenges facing construction industry in Burundi.

1.3.1 Current State of Construction Sector

The results of the data from the first group of the sample composed of all the professional agents of the construction industry with clearly shows how the construction sector's present state, which partly explains the omission of the structural analysis in reinforced concrete in Burundi.

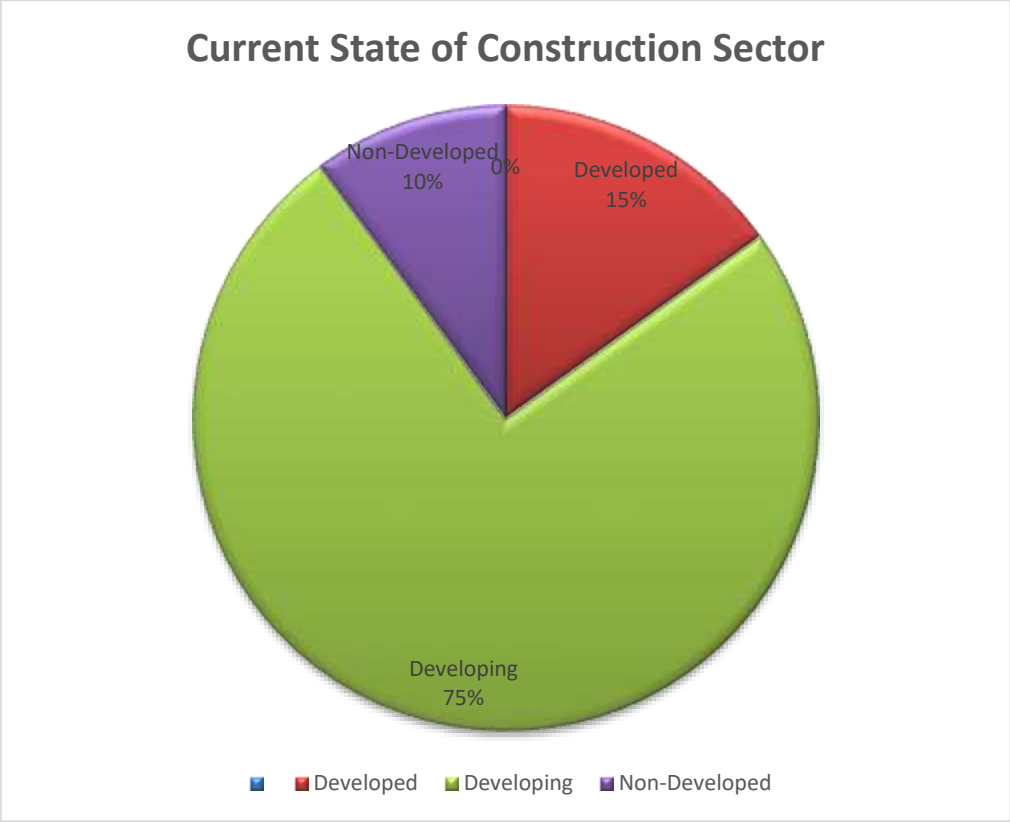

Figure 1.2: Current State of the Construction Sector in Burundi.

Table 1.1: Percentage of the Current State of the Construction Sector in Burundi.

State	Frequency	Percent
Developed	39	15.1%
Developing	193	74.8%
Non-Developed	26	10.1%
Total	**258**	**100.0%**

With the results of the largest percentage of 74.8%, this means that the construction industry in Burundi is developing.

1.3.2 Main Challenge Facing Construction Sector

An additional key challenge is the Financial Constraint for project owners, which prompts the omission of structural analysis for their projects as well as other necessary aspects for their buildings such as insurance. This is a major challenge, because the prices of materials and other elements necessary for construction are constantly increasing progressively, which means that construction project owners do not have the necessary resources to carry out the necessary work either, as the government does not have the necessary means to deal with this issue [31]. Also, there are challenges in the quality of construction materials which do not properly resist the different actions since they are used in reinforced concrete as well as their availability [32].

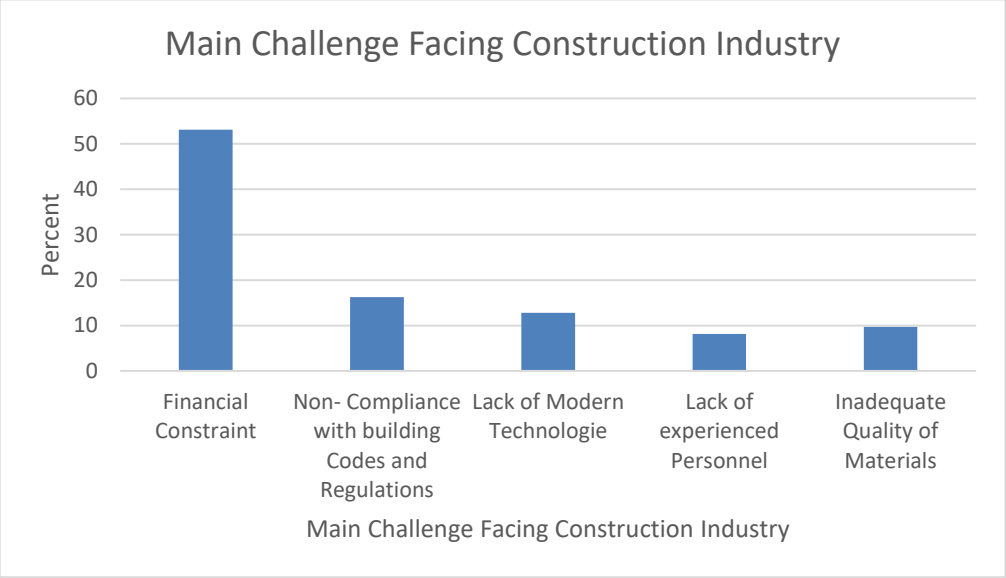

Figure 1.3: Frequency of Main Challenge Facing Construction Industry.

Table 1.2: Frequency and Percentage of Main Challenge Facing Construction Industry.

Challenges	Frequency	Percent
Financial Constraint	137	53.1%
Non- Compliance with building Codes and Regulations	42	16.3%
Lack of Modern Technologie	33	12.8%
Lack of experienced Personnel	21	8.1%
Inadequate Quality of Materials	25	9.7%
Total	**258**	**100.0%**

1.3.3 Lack of Qualified Professionals

One of the main reasons for omissions in the construction sector in Burundi is the unavailability of qualified professionals, namely structural engineers, architects, and professional construction managers. Most construction activities, especially residential and informal construction, are carried out without professional advice. Contractors in poor urban areas as well as rural areas rely significantly on unskilled people or even the so-called "local masons", whose technical ability is not satisfactory to perform simple engineering functions such as load calculation, structural analysis, or even quality control. This leads to the omission of crucial variables such as reinforcement details, considering the depth of the foundations, as well as acceptable load distributions, thus influencing safety as well as durability. As a result, structures are more exposed to the risk of collapse, mainly under normal in-service stresses such as heavy rainfall or soil compaction.

It results from the intersection of factors such as limited access to higher education in engineering fields, inadequate professional licensing regimes, and flawed incentives for skilled professionals to stay in the country (brain drain). According to research**,** the lack of skilled professional supervision was one of the main causes of structural collapses in Burundi, attributing that the buildings sampled exceeded 60% without being assessed by professional engineers. Not only does it threaten lives, but it also generates additional long-term costs in the form of recurrent repairs, court litigation and reconstruction. Investments in education, licensure and retention must be made as soon as possible to raise construction standards in Burundi and reduce technical oversights

1.3.4 Inadequate Education and Training Institutions

In Burundi, the construction industry experiences enormous gaps, largely blamed on construction players that generally lack relevant technical knowhow in the field of structural analysis, materials, and modern design techniques. Most professional schools and facilities of higher learning still utilize outdated software, have limited resources to modern software packages such as AutoCAD, ETABS, and SAP2000, and offer limited practical experience. Thus, the graduates join the construction industry without the practical experience necessary to undertake comprehensive and safe construction works. Lack of practical experience often leads to the omission of crucial structural features, such as proper reinforcement details, proper analysis of the load path, among others, that are likely to greatly affect the construction work. Some studies emphasize that the lack of professional training in civil engineering in Burundi has contributed to the increase in construction errors as well as structural collapses, mostly in the construction of towns. The collapse decreases the overall quality of construction works as well as the sector's ability to utilize efficient and sustainable construction techniques [33].

1.3.5 Cost Cutting Measures

Budget cutting exercises are among the chief reasons for omissions in Burundi construction projects. To minimize the entire project expenses, contractors, and builders usually omit crucial steps such as thorough structural analysis, purchase of quality materials, and proper field marshaling. The vice mostly takes place in poor communities where the budgetary consideration pushing the concerned parties to lead them to lean towards short-term savings at the expense of long-term durability and quality. Aggressive policies of reducing the budget usually mean construction shortcuts, thus the possibility of structural collapses as well as falls in buildings [34].

Impact of such cost-reducing measures can be seen in Burundi, where the greater amount of construction work is carried out without adhering to standard engineering specifications. For the sake of saving money, some construction work involves the use of sub-standard materials instead of approved materials, or they eliminate important design features that promote structural stability. Apart from jeopardizing the safety of clients, the process also results in greater repair works in addition to shorter lives of structures. Corners-cutting in construction

normally results in higher total construction costs due to frequent repairs, litigation, as well as loss of reputation [35].

Moreover, a decrease in expenditure has frequently linked to weak regulation and unsuitable supervision in the construction industry of Burundi. At times of lower expenditure, contractors will usually opt out of skilled engineers or fewer site inspections, allowing non-compliant agreements to prevail. Without appropriate controls, errors are concealed, thus supporting the high incidence of dangerous buildings. Absence of enforcement, alongside savings on expenses, remains the leading cause of construction defects and safety risk in the developing globe [36].

1.3.6 Poor Project Planning and Design

Poor planning and design of construction works in Burundi are the central reasons for the omission of important structural features. Most construction works are established without good feasibility studies, appraisals of the sites, or adequate engineering analysis. Poor planning normally results in inconsistent or incomplete design documentation, a factor that contractors may misinterpret or inaccurately execute. Without proper planning, one can hardly anticipate any problems that may arise, hence generating oversights in important features such as analysis of the load path, reinforcing detailing, or integration of the draining system of water. Structures constructed under the aforementioned conditions are therefore likely to experience structural collapses. Improper planning, in tandem with coordination, in early construction development has significantly increased the likelihood of construction omissions and errors in design [37].

These planning shortcomings in Burundi are further compounded by the absence of professional experience during the design phase, mostly in rural or budget developments. Developers are in the habit of employing draftsmen or technicians without professional engineering experience, often in the bid for savings. With this, crucial features like seismic provisions, soil-structure interaction, as well as serviceability provisions, are usually excluded. Not only does this compromise the safety of the structures, but excessive long-term maintenance costs are also incurred, together with early aging of the structure. Improper planning of the project has been termed one of the causes of delays, cost overruns, as well

as the technical inadequacies, largely in developing countries where the institutional capability falls short contexts that mirror the construction sector of Burundi [38].

1.4 AIM AND OBJECTIVES

Developing countries often face unstable sectors of activity. However, in some areas, there is a requirement that the work be carried out in accordance with current legislation and be subject to rigorous inspections, as failure to comply with these requirements can lead to a variety of problems, including loss of life. Burundi is one such country, where there are still gaps in the implementation of construction procedures. This thesis aims to highlight the negative consequences of the lack of structural analysis in reinforced concrete, based on the causes of the neglect of this important task in construction, and to propose measures to remedy it, as well as the importance of compliance with sustainable building rules.

1.5 BREADTH OF THE STUDY

The main objective of the work remains the assessment of the structural and environmental sustainability impacts that arise from the omission of structural analysis in reinforced concrete (RC) construction works in Burundi. With the increasing significance of sustainable construction in the war on global warming, the consideration of the environmental impact of the omission of important stages remains crucial. The work hopes to determine the magnitude to which the omission of the structural analysis causes environmental destruction, the loss of resources, and the reduction of the life of structures issues that are very pertinent in the Burundian context given the ascendancy of the use of reinforced concrete in construction work.

Another objective involves searching for the underlying reasons why there has been the absence of structural analysis in construction in Burundi. Some of the possible reasons include the absence of finances, inferior materials, weaknesses in engineering courses, non-compliance, and deficient monitoring systems. Using a comprehensive survey in three of the most important cities among 258 practitioners in the field, the work seeks to draw the opinions of engineers, architects, contractors, and even the policymakers about the technical, economic, as well as the institutional problems in the design process. The objective here involves determining the most crucial setbacks using valid statistical methods.

The study attempts to utilize the use of advanced data analysis techniques such as Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), Principal Component Analysis (PCA) and Relative Importance Index (RII) to validate the crucial determinants behind structural design omissions. With the findings, practical recommendations will be given to strengthen design processes to improve standard compliance in buildings, as well as enhance sustainability in the construction sector in Burundi. This will be helpful in directing the policies of the country as well as construction practitioners, on the optimal ways of improving construction standards, as well as environmental efficacy, through better planning as well as analysis.

1.6 THESIS FRAMEWORK

Chapter One: Introduction

Chapter Two: Background Research

Chapter Three: Research Methodology

Chapter Four: Critical Analysis and Findings Report

Chapter Five: Conclusion and Recommendations

2. LITTERATURE REVIEW

2.1 INTRODUCTION

Construction is at the center of the economic growth of any country as well as of the transformation of its cities. In emerging economies like Burundi, the use of reinforced concrete (RC) in construction work has long been dominant because of the material's inexpensiveness, durability, and flexibility. Of increasing concern in the construction sector, however, there has been the common absence of structural analysis in the design and construction stages of construction works. Structural analysis remains the primary process in the derivation of stability, strength, safety, and, by extension, the sustainability of any structure. The absence of the analysis, therefore, raises the risk of collapse, causes material over usage or underusage, as well as undermines the safety and sustainability of the built environment. What makes this problem even more serious in Burundi, in particular, has been the nonobservance of proper engineering standards, appropriate planning, among other problems, owing to social-economic difficulties as well as institutional weaknesses in the country.

In this literature review, the work that currently exists on the importance of structural analysis in sustainable construction, in the context of reinforced concrete structures will be discussed. It considers the best international practices in structural design, construction work environmental conditions, as well as the impact of weak planning on the useability of buildings. It also discusses the works on the common pitfalls in developing nations, such as funding constraints, inexperience of the professionals, deficient education systems, and inadequate regulatory systems. By discussing the relevant theories as well as the empirical results, this chapter hopes to provide a sound platform for appreciating the importance of the non-existence of structural analysis in the sustainability of the construction industry in Burundi, considering the filling of the gap by this work.

2.2 CONCEPT OF SUSTAINABLE CONSTRUCTION

The main goal of sustainable construction involves reducing environmental effects from buildings through efficient natural resource management to protect both present and future generations. The three-core element consist of environmental protection through energy

reduction and greenhouse gas emission control and non-renewable material reduction and waste management and economic optimization through building lifecycle cost reduction and social benefits that include safety and health and user comfort and community impact. The SDG uses sustainable construction as a solution to address climate change challenges. The LEED, BREEAM and HQE certification systems provide support for this approach. The implementation of sustainable construction faces significant barriers in Burundi because of economic limitations and insufficient awareness and proper policies which makes its adoption essential [39].

2.2.1 Definition and Goals of Sustainable Development

Sustainable development in the construction industry is defined as an integrated approach aimed at meeting current needs for shelter and infrastructure without sacrificing the ability of future generations to meet their own needs. It is a three-pillar based vision with an environmental, economic, and social pillar. In the case of construction, it means the rational use of resources, waste reduction, material durability, and minimizing the ecological footprint on the natural environment. According to Kibert (2016), a sustainable construction must ensure, in addition to structural safety and usage comfort, energy efficiency, building longevity, as well as respect for local ecosystems [40].

In developing countries like Burundi, the idea of sustainable growth is still not widely used in building mostly because of limited funds, lack of knowledge and holes in technical rules. One clear example is the design of concrete buildings that doesn't do enough to where many parties try to cut costs first but don't think about how this will affect security and sustainability in the long run. Such a structure designed without proper analysis is likely to exhibit defects in design work (e.g., uneven distribution of loads or local overloads) leading to early deterioration. This contrasts with one of the main objectives in sustainable development: extending the life cycle of structures while ensuring a reduction in negative economic and environmental impact [41].

In construction in Burundi, where reinforced concrete is a standard practice, the omission of proper structural analysis immediately adversely affects the objectives of durability. Inefficient use of materials, redundancy, and the possibility of foundation collapse all contribute to making buildings less environmentally friendly. Additionally, these activities

are averse to the health and safety of the residents as well as the resilience of the city in the event of a catastrophe like earthquake or flood. Therefore, encouraging long-lasting construction in Burundi demands the systematic inclusion of proper structural analysis while planning, improved skills for participants in the industry, as well as rigorous enforcement of construction standards.

2.2.2 Sustainability in the Environment, Economy and Society

Three important things such as environmental, economy and society must be considered for construction work to be sustainable. From an environmental point of view, houses need to be made in a way that doesn't harm the earth too much. This can be done by cutting down waste, carbon pollution, and the use of natural resources. Or not doing a structure study on reinforced concrete works makes this goal harder to reach because they often end up being too big or losing too much material which is very bad for the environment. If you don't think about an idea carefully, it could lead to cutting down trees, taking out too much raw material and polluting the environment when you make cement. According to Ding (2008), long term building practice includes careful planning in a way that makes the best use of resources and keeps things stable [42].

From an Economic and Social point of view, not doing structural analysis leads to secondary costs that are very expensive such as repeated repairs, upkeep that isn't done on time, or even rebuilding in the event of partial or total foundation failure. When these things happen, they put a lot of pressure on the budgets of households and communities, especially in developing countries like Burundi where money is tight. In addition, this practice has a negative effect on the comfort of users and makes communities more vulnerable to natural disasters like earthquakes and flooding. According to Kibert (2016), a building that is really sturdy should meet the needs of today's generations without sacrificing the needs of tomorrow's generations. This means that architects must make choices that are reliable, inclusive and in line with the standards. By skipping important steps like structural analysis, construction sites in Burundi not only ruin the look of the buildings they are working on, but they also put people's safety and sense of humanity at risk [40].

2.2.3 International Standards and Approaches

LEED and BREEAM are two world standards for green building. These set performance standards that make sure the building has the least possible effect on the world over its whole life. Structured analysis is a crucial step in ensuring materials are stable, durable, optimized, and these methods benefit it indirectly, although it's not an explicit requirement. Yet, a structure that doesn't adhere to basic principles for structural engineering can't boast any well-known name for durability. It's noted by Kibert (2016) that a structure can't endure if it's vulnerable or requires frequent repairs due to a poor design in the beginning [40].

In developed countries, rules that include standards like LEED and BREEAM push for careful planning which includes doing a thorough structural analysis during the building phase. On the other hand, building projects are often carried out in places like Burundi without paying attention to important steps like charge analysis, modeling of a structure's behavior or serviceability limited state checks. This kind of exclusion goes against the environmental goals set out in these guidelines because it causes too much material waste bad building performance and structures that last less time. Ding (2008) says that leaving out important steps in the design of a structure hurts the long-term environment goals of a building because it causes loss, wasteful use of energy and safety risks [43].

In addition, foreign methods emphasize how crucial long-term structural performance is, and this can't be ensured without a stable analytical foundation. As an example, LEED promotes efficient usage of resources through a clear understanding of the work put into them, how fees are apportioned, and how much space they can accommodate. All these are contingents on the structural analysis. Many individuals in Burundi omit the crucial step due to lack of proper digital resources (such as ETABS and SAP2000) or technical expertise. This often results in energy-hungry buildings, costly repairs, or risk of collapsing. As found in the research conducted by Ajirotutu et al. (2024), adoption of structural assessment tools right from the inception of the design exercise helps save on materials in addition to ensuring the building attains global durability standards [44].

If you want to apply world standards to a country like Burundi, you can't just copy them, you have to put them in the right place, considering their economic, institutional and human limits. To make the buildings industry in Burundi more environmentally friendly, structural

engineers need to get better at what they do analysis tools need to be easier to find and over time, simple but useful references need to be added. It is important for governments, academic organizations, and practitioners to work together to make structural analysis a key part of sustainability. Based on what Pretty (2020) says, the ideas behind foreign approaches can be changed to fit local situations and help people move toward more responsible behaviours even when resources are limited [45].

2.3 REINFORCED CONCRETE IN CONSTRUCTION OVERVIEW

Today, reinforced concrete is a very popular building material especially in emerging countries like Burundi because it is strong, lasts a long time and is easy to get. That being said how well it works as a good, stable structure and as an environmentally friendly building depends a lot on how well it was built, especially how well it was physically analyzed. Structure based analysis lets you make sure that the reinforced concrete parts will be able to hold up under the loads you want them to without falling apart. It also lets you make the best use of materials to reduce waste and damage to the environment. In Burundi, however, a lot of projects are initiated without this crucial step, typically due to cost considerations or a lack of skilled personnel. This omission renders buildings unsafe and shortens their usable lives considerably, contrary to the principles of long-lasting construction. In fact, as Neville and Brooks (2010) note, poor structural design tends towards wasteful material usage, faulty structures, as well as increased maintenance expenditures, something that impairs both the economic, as well as environmental, durability of a structure [46].

In Burundi, the fact that many armored concrete projects don’t have a real structure study shows not only technical problems but also a lack of understanding of what buildings need in the long term. Ultimately, this makes buildings more likely to sustain long-term damage from accidents, and they can’t adapt to new weather circumstances. This carelessness also leads to wasteful use of resources like water, metal and cement which puts more stress on the environment in the area. As Narasimhan et al. (2009) reported, integration of long-lasting principles in structural design, including a close analysis of work put into the design, is required for buildings to endure for a longer period with reduced energy usage. Thus, value for structural analysis in the overall planning process in Burundi needs much consideration to ensure the durability of the resulting building [47].

2.3.1 Properties and Advantages of Reinforced Concrete

Due to its remarkable mechanical features, in particular a high compression resistance, a long life and a moldability in different forms, reinforced concrete is among the most employed materials in the construction sector in Burundi. Coupled with steel, it also becomes efficient in traction making it a suitable choice for residential, commercial and administrative buildings. This material is also efficient in fire resistance and requires little maintenance during the course of time. However, in order to benefit fully from these advantages, careful analytical study must be done for the proper sizing of load-bearing elements with the purpose of ensuring the latter remain stable over time. In the case where this phase is overlooked, even the finest reinforced concrete properties cannot ensure the work's soundness as well as durability with a risk in part for early pathologies partial collapse.

When reinforced concrete is used without proper organizational control in Burundi, the lack of a proper structural study makes the material work much less well. Not doing accurate structural dimensioning can cause beams, columns and slabs to be too small. This means that too many materials are used, or worse buildings become weak. This goes against the ideas behind sustainable building which try to be as green as possible and use resources in the best way possible. As Rohden et al. points out (2018). In a developing country like Burundi, this shows how important it is to improve structural analysis methods to make sure buildings are strong and last a long time [48].

2.3.2 Use of Reinforced Concrete in Developing Countries

With low expenses, ease of construction, and availability of construction material locally, reinforced concrete can be incorporated into construction of infrastructure in developing countries. However, no generalization of its construction strictly abides with engineering design, especially with structural analysis. Most construction projects in Burundi omit meticulous consideration of structural stability, purportedly compromising safety and durability. Economic constraints, absence of technical expertise, or lack of regulating mandates often occasion this exclusion. Therefore, poorly designed reinforced concrete is a nexus of weakness. According to Orikpete et al. (2023), improper design criterion application in selected African countries yields no-durable constructions with high

possibilities of foundation collapse, waste of building material, as well as high maintenance costs [49].

2.3.3 Ecological Impact of Reinforced Concrete

Reinforced Concrete is a very popular building material in Burundi because it is easy to get, strong and cheap. It does however have a big effect on the earth especially when it comes to carbon dioxide CO_2 emissions from making cement which is a big part of concrete. The study by Gursel et al. (2014) says that making one ton of cement releases about 0,9 tons of CO_2 [50]. This makes cement a leading emitter in the building industry. This problem gets worse when structural analysis is not done for reinforced concrete construction projects; it only leads to over-dimensioning of carrying elements, where more concrete as well as steel is used unnecessarily. Such misuse of building resources is not only detrimental to an economy, but it makes the carbon footprint of the project bigger for no good reason.

Beyond its contribution to pollution, ineffective utilization of reinforced concrete causes a great amount of stress on natural resources, especially sand, water, and granules, which are exploited in colossal quantities to meet expanding industry demand. If a building is not analyzed structurally, those who devise design concepts lack information they need to procure optimum parts or costs with a resulting waste of material. Conditions are worse in Burundi, where quality control techniques are absent and natural resources are being exploited at a pace more fast-moving than planned without a long-term vision for their management. A building that lasts must utilize its contents in a way that makes structural sense for loads truly being imposed upon it. That cannot be guaranteed without extensive analysis of a building's structure. As Pacheco-Torgal et al. remind us in 2011, there is a need to optimize design of a structure if we hope to create building structures with a lower environmental footprint as well as steer their construction towards more sustainable directions [51].

2.4 SIGNIFICANCE AND FUNCTION OF STRUCTURAL ANALYSIS

Structural analysis is an integral step of design procedures that can be employed to establish a response of a structure's members to loads and solicitations to which they will be subjected for their entire service life. In beams, columns, slabs, and footings for reinforced concrete structures, this analysis allows for proper distribution of efforts, thus guaranteeing safety, a structure's stability, and longevity. It can also be used to make sure that the least amount of material is used, which cuts down on trash and costs while still meeting safety standards. If you don't do this step, buildings are more likely to be out of scale, over or under reinforced and to crack fail or deform too much. According to Naeim (2017) [52], designing a building without doing a thorough structure analysis can seriously damage its mechanical and useful performance especially when it comes to high variance load or seismic situations.

In Burundi, omission or non-performance of structural analysis in many projects with reinforced concrete is due to a lack of finances, a lack of specialized skills, or a desire to expedite construction. It was first thought that not adhering to this practice would be a cost-saver yet places long-term burdens on building quality. For the most part, structures that were not properly analyzed live shorter lives, more often need repairs, more resources are used, as well as more waste, in opposition to sustainable building ideals. If you fail to apply fundamental engineering principles in early planning, Khatib (2012) feels environmental, social, as well as project economic viability, will be compromised [53]. This is more crucial in resource-limited countries like Burundi because improper planning effects people of a place deeply.

2.5 FACTORS LEADING TO THE OMISSION OF STRUCTURAL ANALYSIS

There are several interrelated reasons why structural analysis is often excluded from armed concrete projects in Burundi, making buildings more perishable. Expenditure constraints compel promoters to be tightfisted as they can, eliminating some of the technical processes they find "not indispensable," like structural analysis. Besides, there are no adequate professionals, especially in peripheral towns, and no sufficient mechanism for keeping an eye on as well as regulating projects. Most of the projects are done by technicians who are not licensed as well as who have not acquired extensive education regarding fundamental elements of structural design. The limited education mechanism, employing improper

methods of allocating markets, as well as loopholes of non-adhering rules, normalize negligence. Agapiou and al. (2019) posits that within a vast majority of Africa, a deficiency of adequate governance as well as regulating procedures for building industry facilitates non-complying building practice, which accelerates structural failure hazards as well as disrupts long-term goals of sustainability [54].

2.5.1 Financial Constraints

For Burundi, finances are one of the main reasons why structural analysis was not done when structures were designed from reinforced concrete. As a method of keeping starting costs low, many real estate construction individuals, especially in fast-growing urban areas or on tight-budget projects, depend on short-term fixes. Through this method of frugality on costs, specialized engineering services like thorough structural analysis are considered unnecessary or redundant. Through this method of cutting costs, rough ideas weren't substantiated enough for costs, in-house efforts, or general structural behavior, which rendered structures more dangerous as well as short-term. According to Ajayi et al. (2017), for the majority of African environments, pressures for fast construction as well as cheap construction bid for individuals who trade in the industry to overlook tech specs. That puts a lot of structures with substandard structural details, a situation having a long-term environment as well as an economic effect [55].

2.5.2 The Shortcomings of the Educational System

The engineering education system in Burundi is severely flawed, for which reason structural analysis often isn't included in reinforced concrete building projects. Aside from a deficiency of trained individuals, schools for technology as well as universities often cannot provide hardware or structural engineering software like SAP2000, ETABS, or Robot Structural Analysis that can be used for an up-to-date analysis. There isn't a sufficient amount of technology as well as professors, testifying to a mostly theoretical education with a minimum of real-world situations or tasks to be analyzed. As a result, not a few college graduates end up in the workplace without the ability to easily accomplish a decent standard-conforming analysis of structures or a sense of their value from a long-term point of view. In this regard, either no analysis is taken into consideration, or a sloppy one is made. According to Ameyaw et al. (2016), it was noted that construction project engineers from developing countries can't

make long-lasting as well as safe procedures because their education isn't very good. As a result, severe inaccurations in terms of conducted work as well as a loss of long-term quality for the infrastructure take place.

2.5.3 Poor Governance and Rule Enforcement

Poor governance and lack of adherence to technical requirements are chief weaknesses that render it impossible to construct a durable building in Burundi. Since there are no tight controls, no clear sanctioning, or institutional vigilance, a lot of projects are approved and constructed without observing the very important steps of conception, especially structural analysis. Technical requirements regulators are often without adequate funds or relevant expertise to adequately survey construction sites or ensure that regulations being utilized are observed. This laxity cultivates an environment of suspicion, whereby business operators can disregard regulations without any repercussions. This begets non-conforming buildings that are unstable short-lived. This problem is further compounded by cheating and fraudulent business practices of a market credit nature, whereby some projects cannot be evaluated technologically at all. Poor governance of construction sites renders them of lower quality and shorter standing, according to Hwang and Ng (2013), since it makes it harder for things to be regulated, for information to flow, and for responsibilities to be taken [56].

2.5.4 Impact of Informal Practices and Corruption

The repercussions of cheating as well as illicit action are among the main reasons for declining building construction industry technical standards in Burundi. Most of the building permits are granted without passing through formal procedures that require technical proof of the project, for instance, structural analysis. For cash bribes or favors, sleazy deals between promoters, government agents, and technicians make sidestepping problematic aspects of the creation process a reality. Such activities erode regulating authority strength and lower construction quality. In the absence of a specific set of procedures for transparency in calls for bids, for technical verifications, as well as temporary acceptance of construction sites, following procedures is optional. Kenny (2007) elucidates that corruption in the construction industry particularly in the southern countries results in faulty infrastructure real increases in project costs and the prohibition of the adoption of methods with rigorous technical analyses as a foundation [57].

2.6 BURUNDI'S STRUCTURAL DESIGN PRACTICES

There exists a great gap between what is theoretically necessary for structural design procedures in Burundi and what happens in practice. There are building rules, but they aren't always followed, especially when it comes to important steps like structure analysis. Most projects are constructed without the aid of computer software or professional engineers, especially in peripheral parts of towns or low-cost residential schemes. Designs are not commonly checked by technicians or artists for structural verification. This subjects the buildings to great risks from earthquakes, ground displacements, as well as charges. Also, geotechnical details are not frequently taken into consideration at planning stage, therefore making it harder for the building to blend with its environment. İn some African countries like Burundi, the planning process isn't well organized or has the right tools. Also, engineers, architects and government officials don't always work together, which makes it harder to include sustainability standards in building.

2.6.1 Current State of the Construction Sector in Burundi

The construction industry of Burundi is growing very rapidly due to very high demand for infrastructural as well as residential units but still, it is confronted with quite a few structural challenges to resolve. This fast growth is happening in a setting with few institutional controls, no strict quality control mechanics and a lot of unofficial players in the building chain. As a result, some projects are carried out without soil analyses, sanctioned plans as well as more importantly, standard complying structural analysis. That renders the construction vulnerable to premature failures as well as low durability. Keen lack of procedural coordination among professionals of the sector, as well as short supply of expert personnel, as well as rarity of construction as well as post-construction technical audits, complicate matters further. Kuoribo et al. (2024) believe that uncontrolled as well as unstructured construction sites in Africa tend towards yielding low quality building constructions [58]. That is because individuals lack or fail to adhere to very important construction techniques, like structural construction analysis, thus making that infrastructure much less durable.

2.6.2 Local Approach to Project Conception and Supervision

As construction projects in Burundi are planned, they are often based on simplistic, hand-crafted techniques where taking regulations into consideration is often ignored for convenience or economy. It is not uncommon for building plans to be drafted without using experienced technicians or artists in consultation with structural engineers. Because architectural concepts as well as structural engineering are separate, concept developmental processes are fragmented, as well as calculations for charge, equilibrium verification, or modeling not done at all or very immediate. Additionally, clients who are poorly educated do not value structured analysis as an important step, making professionals more inclined to disregard it in favor of pleasing clients' fiscal imperatives. As Anto (2024) suggests, for emerging countries, an interconnection deficiency among building fields as well as an obliviousness among stakeholders regarding technology of life cycle of constructions leads to brittle, short-lasted, subject-to-problems-before-they-start constructions [59].

There are further extensive challenges with project supervising. Delivered as a routine administrative verification more often than not for those who have no specialized engineering schooling, it is a mere casual verification in order to know everything is alright without keen observation of implementation or compliance with rigid procedural techniques. Such a failure to follow up generates wide points of divergence between plans as well as actual land, an especially larger problem when original plans suffer from a lack of a correct structural analysis. Further, territorial authorities who are supposed to be responsible for technical control have too few humans as well as material resources to guarantee well-coordinated projects in progress. Given as an explanation for frangible systems of supervision for Africa countries was Ikas' argument in 2012 that a lack of specialized technical know-how as well as dysfunctional public institutions were accountable for resulting non-conforming techniques as well as a lack of critical thinking steps like a structural analysis [60].

2.6.3 Institutional and Professional Constraints

Institutional weaknesses are a main challenge to the systematic inclusion of structural analysis during building construction projects in Burundi. Those government institutions that should regulate, monitor, and guide the building industry are mercilessly lacking well-trained human resources, logistical machinery, as well as a stringent enough law capable of inhibiting them. As a result, quality of buildings and technical specifications regarding safety of the works are not observed properly or not at all. Such susceptibility of the system creates an opening for real estate marketers to thrive with no real commitment to adhering to regulations, making it more expedient to skip very important procedures like structural analysis. According to Booth and Cammack (2013), in some developing countries, lack of technical leadership and institutional planning makes authorities struggle to adequately guide urban development and ensure amenities can be sustainable [61].

From a professional point of view, construction activity in Burundi is marked by a failure to standardize techniques in construction trades. As a result, there are not sufficient well-trained engineers, especially in rural areas, and small construction companies often have no professionals who are trained in construction. On top of this, no good systems for licensing or keeping current exist for individuals who operate in industry. This absence of professionalization begets empirical design procedures that depend on previous experience or duplication of previous projects, as opposed to a scientific approach using modelling software. Because of this, long-term thinking or hard-nosed analysis is hard to accomplish. Debrah and Ofori (2006) further posit that poor professionalization of Africa's building industry creates projects of low quality, ineffectual project management, and high long-term vulnerability of buildings [62].

2.7 SUSTAINABLE CONSTRUCTION AND STRUCTURAL DESIGN LINK

As it entails guaranteeing a sense of steadiness, safety, as well as resource optimization utilized in a construction activity, structural design is a pillar of sustainable construction. A tight design from a structural investigation makes possible precise dimensioning of reinforced concrete parts, reduction of unnecessary levies, material gaspillage reduction as well as extension of a construction activity's life. Through it, personally enables economic primitiveness reduction, carbon footprints reduction as well as infrastructure resilience from

natural disasters or degeneration. Conversation, as it is commonly the case in Burundi, this step is commonly neglected, hence leading to vulnerable constructions in need of frequent repair constructions, additional construction waste, as well as non-sustainable wear of natural resources. Resilience of construction activity not only relies on material or technology choices but more importantly on the quality of structural design, with embedded performance, durability, and environmental optimization concepts from design inception onwards.

The relationship between structural design and durability is often underestimated in rapidly expanding countries with high demands of economic pressures as well as high-speed demand for houses. Yet, with the application of structural analysis as an integral to design, safety is not only ensured for users, but more responsible construction practice is grounded on calculations of charges, a strength of material, as well as a sol-structure interaction. This makes possible an avoidance of premature enlargements, maintenance cost savings, as well as a long-term planning boost. Development of structural analysis as a function is necessary in a Burundian environment of restricted resources with wide-spread failures of conceptual thinking in order to get projects into conformance with sustainable developmental goals (SDG) particularly those of resilient infrastructure (SDG 9) as well as those of urban resilience (SDG 11) an integral construction durability approach is necessary with a significant structural design role towards an entire building functionality.

2.7.1 Structured Analysis Helps Books Last

Structural analysis is essential to building durability because it allows for a safe and optimized design that guarantees long term structural performance. Designers may create reinforced concrete structures that can endure mechanical and environmental pressures throughout their life cycle by accurately evaluating internal efforts, permanent charges, variables and deformation points. Through this approach, environmental impact concerning repeated reconstructions or repair works can be diminished, as well as premature failures, as well as maintenance costs. Since available financial and material resources are limited within Burundi, a design based on a deep structural analysis is inevitable in order to ensure building durability. According to Bullen and Love (2011), a well-conceived, well-analyzed, and well-built structure which respects sustainable engineering procedures offers a long duration of

life, uses fewer resources during its life, as well as better environmental and energy efficiency [63].

2.7.2 Waste Reduction and Material Efficiency

Reduction of building waste as well as more rational building material utilization are two of a long-term building strategy's fundamental pillar directly impacted by structural analysis. Through enabling precise dimensioning of porteurs' parts as well as optimizing required sections as well as armatures, she prevents concrete overdosing, excessive aluminum utilization, as well as reruns due to conceptual errors. That simplification entails a strong quantity reduction of waste generated during construction sites as well as a reduction of the general environmental project impact. On the contrary, an absence of structural analysis often entails using approximate building products, site adaptations, as well as partial destruction, all of which incur high economic as well as environmental losses. For Osmani as well as Glass (2008), a stringent amount planning approach, including structural analysis, enables it to control both structures' mechanical behavior as well as lower gaspillages, thus conducting a more responsible as well as durable construction [64].

2.7.3 Compliance with Durable Development Objectives

The lack of structural analysis in reinforced concrete construction projects is one of the biggest obstacles to accomplishing objectives of Sustainable Development (SDG), particularly SDG 9 (Industry, Innovation and Infrastructure), ODD 11 (Villages and communities sustainable) and SDG 12 (Consumption and production responsibilities). Buildings that skip this important phase are more vulnerable to natural disasters, use more resources than they should and produce more waste because of poor design and frequent maintenance. Strict structural design not only ensures building strength and safety, but it is more rational with regards to material, decreasing CO_2 emissions of cement as well as aluminum consumption, and increases the longevity of infrastructures. According to Akhtar et al. (2024), projects incorporating a sustainable design concept from its inception of construction are more aligned with SDG intentions, environmentally efficient as well as socially equitable [65]. Territorial governance is also a crucial element of successful SDG implementation, according to De Fátima Ferreiro et al. (2023), in part due to construction norms based on scientific methods like structural investigation [66]. Finally, Forés et al.

(2023) believe that with a view towards making international obligations for sustainability more solid, developing countries need a systematic approach based on resource stewardship, technical conceptualization, as well as environmental performance [67].

2.8 OTHER LITERATURES RELEVANT TO THE TOPIC

For a reduction in energy consumption a program of the renovation of buildings by a program of the renovation of buildings by a ZNEB method, during the study, the simulations revealed a significant reduction in energy which is 34% and this contributes to the reduction of saddle gases but also contributes to the sustainability of the buildings and during the construction on site by introducing strategies that allow this reduction [68, 69]. Waste Management through Sustainable Approaches starting with Waste Reduction From the planning stage Works through the prevention of waste Materials that leads to the implementation of reuse measures Materials for previous projects through a recycling method and this will be made easier and more efficient by the integration of modern techniques [70]. Prof. Dr. Jacqueline Cramer discusses the challenges faced by sustainable construction related to the high costs of materials that are ecofriendly as well as their technologies and poor implementation in different countries due to low awareness with incompetent professionals which is the cause of remaining in traditional practices [71]. As everywhere else, the construction industry in Burundi goes hand in hand with the economic situation of the country which, according to World Bank reports, in 2024, its GDP grows by 3.5% and therefore nominal, which makes this country among the 5 poorest in the world [72, 73]. Taking the example of other developing countries, George Ofori did a study on the construction situation in developing countries, pointing out that the industry faces challenges, including a lack of adequate materials and resources, as well as a small number of qualified professional actors, which leads to inadequate infrastructure [74]. Jill Wells points out the importance of the building industry as having an effective contribution, often by accounting for 50% in the establishment of fixed capital, but also some of the challenges it faces in developing countries, notably the restriction of new technologies and prime materials [75]. Theodore Goutier and Jean Claude Tchamba discussed that the omission of structural analysis in Developing Countries affects the sustainability of buildings by the collapse of a large number because of the challenges seen above, including also corruption and noncompliance [76]. A handful of articles look back at the strategies to be put into action

to overcome the causes of the omission of structural analysis that affects the sustainability of buildings as well as other financial problems due to maintenance costs. Kiziltepe suggests improving the university curriculum which will help in a better continuing education but also workshops for the promotion of practical techniques [77]. Updating building codes and a strong government body to implement work in accordance with established standards will also be of paramount importance. The integration of modern technologies plus the use of imitation software will involve better imitation of structural behavior [78]. Often in developing countries, because of other government concerns, awareness has no place for construction stakeholders. It is relevant to increase awareness of the importance of structural analysis to all parties Industry agents for sustainable construction [79]. Even if Burundi has gone through difficult times, the construction must be among the priorities and done in an adequate way because the world is going through difficult times that will later be harmful for the population including also damage that leads to the door of nobody's life. Durable construction must be regarded as necessary.

2.9 RESEARCH GAPS AND STUDY JUSTIFICATION

While Prior Studies have generally grappled with issues of longevity within the built economy, very few of these give specific attention to structural analysis being omitted particularly within sub-Saharan nation states like Burundi. Most research on sustainable construction use energy efficient, ecologically friendly or green building techniques without conducting an empirical evaluation of how structural analysis naturally supports reinforced concrete structures long term performance. Furthermore, studies that do exist assessing structural consideration within developing nations are rather generic and lack concrete specific data with local application. The current paper is an interesting scientific video due to the fact that Burundi has unique characteristics within creative practices: informality at a very high degree, unavailability of duly qualified engineers, pressures upon costs, as well as weak regulatory agencies. Based on Ayalew et al. (2022), contextualized as well as targeted research is at the heart of developing locally specific rather than translating foreign schemes that aren't quite applicable [80]. Furthermore, recent research mostly overlooks connections between structural examination and the three pillars of sustainability, environmental, economic and social. In those countries like Burundi, where constructions are mostly carried out without technical verification, there exists a need to illustrate how such oversight can

quicken constructions wear and tear, threaten users, and squander scarce resources. Furthermore, very few works employ powerful analytical tools like exploratory factor analysis, principal component analysis, or even the relative importance index to unveil those underlying factors behind such oversights. Thus, this research fills a gap in two ways: first, through an empirical appraisal unique to Burundi; and second, by rigorously applying with advanced quantitative methods the structural idea of durability. According to Jung et al. (2018), such unstructured pattern for examination significantly weakens the ability to yield useful and appropriate recommendations for durable constructions systems with lasting performance [81]. That is why this research is justified not only by its scientific novelty but by its public policy as well as professional practice appropriateness.

Based on findings from the literature review, not having carried out structural analysis for projects of armed concrete constructions has been discovered to be one of the chief barriers to long-term viability of constructions that are Burundian. Economic constraints, lack of special know-how, poor regulatory environments, as well as informality, have all been implicated as underlying factors for this non-existence. Few works have ventured as far as this with real empirical data within a context like that of Burundi, though. Here there is a need to carry out a narrow, methodologically rigorous, and systematic study to unravel these issues, to quantify this effect, and to make appropriate adjustments.

Therefore, research methodology used for this study is presented in the following chapter. The data collection tools, sampling population, questionnaire structure, as well as statistics used, such as exploration factor analysis (EFA), principal component analysis (PCA), confirmatory factor analysis (CFA), and relative importance index (RII), are all stated. With these, one will ascertain principal structural causes of analysis being excluded, analyze their impact at the same time making specific recommendations to be considered by stakeholders within Burundi's built sector industry.

3. RESEARCH METHODOLOGY

3.1 THE METHODOLOGICAL APPROACH

This study uses a quantitative approach based on the collection and analysis of empirically observable data to acquire insights into the prevalence and rationale for the lack of structural investigation within Burundian concrete building works. The need to produce objective, verifiable, and comparable results that can potentially clarify decision makers and professionals within the sector justifies this approach. It also makes it easier to extract important relationships between variables and conduct statical research on how such a deficiency affects the environment, economy, and society the three pillars of sustainability. Quantitative research makes hypotheses or theorical models available to testing with common tools ensuring the dependability and generalizability of results within a particular setting [82] and was used to better connect with the world of the construction industry in Burundi with the intention of overlooking the impacts on sustainable construction that buildings in Burundi are experiencing. The layout that illustrates all the approaches used for this work can be found here at the bottom in Figure 3.1.

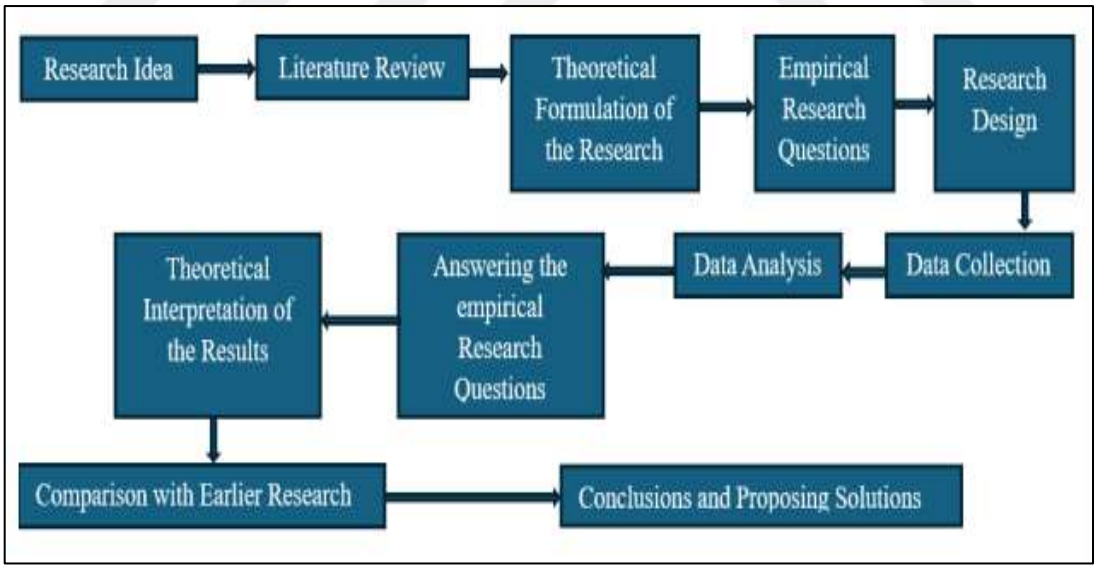

Figure 3.1: Research Flow Scheme.

Furthermore, this strategy borrows from a descriptive and analytical research design that not only sets out to describe current conception and supervision practices within the building industry, but also to identify and prioritize most significant factors associated with structural analysis omission. To do so, sophisticated statistics like the Principal Component Analysis (PCA), the Relative Importance Index (RII), as well as the Exploratory Factor Analysis (EFA), are used to holistically analyze data gathered from professionals within the trade. Quantitative descriptive studies are best suited to researching trends within broad and heterogeneous populations, most particularly when subjects are sensible or least explored within writings [83]. Hence, this approach is fit to fill lacunae found within previous works regarding structural durability within Burundi.

3.2 CONCEPT AND TYPE OF RESEARCH

This study combines a quantitative research approach and a descriptive and explanatory research design to analyze the causes and effects of neglecting to undertake structural analysis on reinforced concrete construction projects within Burundi. The core hypothesis behind this study is to find how technical negligence, especially during structural design, affects safety, material efficiency, longevity, and environmental effect of structures. This study aims to achieve a systematic empirical basis to promote construction levels and achieve sustainable development within Burundi by using descriptive measures to record existing practice and explanatory techniques to determine causality relationships. The strategy employed leaves room to study professional practice holistically with survey evidence and statistical modeling, which guarantees research rigor and relevance to context.

3.2.1 Nature of Research

The current study employs a descriptive and explanatory research design, consistent with a rigorous study to examine professional behaviors around structural analysis omission from Burundian concrete construction projects. The descriptive approach is to provide a meticulous situation of behaviors perceptions and realities seen across the many construction industry stakeholders, including engineers' technicians, architects, and decision-makers. This method gives a means of gathering factual data regarding a pattern regarding this omission, circumstances where it occurs and project attributes most likely impacted.

Descriptive research permits accurate portrayal of a phenomenon's characteristics where it is poorly documented within a particular area or setting [84].

Additionally, there are explanatory dimensions to the research since it strives to conceive the underlying causes behind the omission of structural analysis to assess the impact instilled on the elements of sustainability (security, environmental performance, and economic effectiveness) [85, 86].

3.2.2 Objective of the Concept

The technique used here is based on a cross-cutting research process made thanks to a formal questionnaire sent among construction specialists. It makes it possible to gather quantitative data concerning structural conceptualization habits from Burundi, such as a lack of structural analysis, at a specific moment. The goal is to have a timely and representative view of professional habits, technical boundaries, and perceptions concerning durability in the armored concrete market. Transversal studies are especially suitable to research concerning attitudes or habits within a specific environment without a requirement to permanently observe [87].

According to this idea, questionnaires aim to find a number to estimate the phenomenon's extent (rate of omission), identify explanatory factors (finance, education, governance, etc.), and find perceived effects on work life duration. This research design has the further benefit that a comparative analysis could be obtained between a number of professional groups (engineers, architects, technicians) and territorial sites (Bujumbura, Gitega, Ngozi) to better understand the phenomenon. A survey's strength lies within an extrapolation from a judiciously selected sample to a wider population, a requirement to make recommendations to national levels [88].

Third, such a concept provides an opportunity to utilize sophisticated statistical analysis techniques, including exploratory factor analysis (EFA), principal component analysis (PCA), or confirmatory factor analysis (CFA). Those techniques enable reconfiguring observed measures into reliable explanation dimensions and legitimating consistency among collected responses. Hence, the concept behind current study broadens beyond a descriptive phenomenon; rather, it tends to approximate causal relationships between sustainability principles and conceptualization techniques [89].

3.2.3 Rationale for the Quantitative Approach

The quantitative research methodology was used to provide a measurable, generalizable and objective assessment of attitudes, behaviors and factors around a deficiency of structural analysis in armed concrete construction from Burundi. It permits one to process enormous data from a diverse sample set of industry stakeholders and statistically assess it to determine correlations, trends and levels of significance around any multitude of study variables. She is especially well-suited to comparing points of view prioritizing factors by frequency or perceived seriousness and substantiating preconceived hypotheses with methodologies like the EFA, RII, or CFA. That quantitative scholarship eliminates subjectivity from analysis by converting social behaviors into measurable factors [90]. Moreover, it fosters reproducibility and reliability of outcome, two considerations key to attempting to change sectoral policy or professional practice.

3.2.4 Logical Reasoning

The study uses deductive reasoning, from general structural design and long-term durability hypotheses from building literature, to come up with hypotheses to be applied to the Burundian case. Deductive reasoning provides a critical analysis of whether international literature-defined concepts, including structural analysis-resource optimization-long-term performance association, apply to local conditions defined by institutional, economic, and technical constraints. The method provides a solid theoretical foundation to structure analysis's variables, construct a conceptual structure, and empirically confirm with data collated hypotheses. Deductive reasoning is especially suitable for quantitative research with a target to confirm causal relationships from a pre-existing body of theoretical work [91].

Under this, several hypotheses have been derived from literature review, such as those concerning factors surrounding omission of structural analysis (weakness in institutions, poor training, or financial pressure) and potential influences affecting their lifespan (loss of materials, lessened security, or lessened structure lifespan). Sophisticated statistical techniques including factor analysis and relative relevance index have been used to test hypotheses. A deductive research approach, according permits analysis to be drawn concerning abstract ideas by using measurable indicators, expanding external validity to

findings and their potential to inform practical recommendations within comparable scenarios [92].

3.2.5 Conceptual Reference Framework

Conceptual foundations are rooted in the three pillars of sustainable development models which presumes any sustainable path should balance social, economic, and environmental factors. In a construction context, that means developing projects that are efficient, safe, and economically feasible with a minimum adverse effect on natural resources and standard of life by future generations. All three spheres are immediately damaged by a failure to perform structural analysis: it results in wastage of material, higher long-term maintenance costs, and occupant vulnerability to injury. Consequently, a triangle of durability model gives a theoretical foundation to identify how a missed technical step can disturb a complete process to build a durable structure [93].

Additionally, research work here borrows from the systemological causality model, which allows analysis of relationships among diverse interdependent factors including education quality, regulation, professional practices, economic constraints, and governance. This tool assists in determining structural analysis omissions with their causes and direct and indirect effects on project sustainability. In his or her way, a conceptual approach with a focus on systems opens better understanding of organizational, institutional, and technical constraints to application of best practices. In the view of Meadows, a systematic understanding leads to development of useful policies in complex situations like the building sector in Burundi where technical considerations are influenced by non-technical considerations [94, 95].

3.3 STUDY ZONE

Bujumbura, Gitega, and Ngozi are the three major Burundian cities where this study was conducted. The sites were intentionally picked by virtue of their geographic, economic, and administrative position within the nation. The majority of urban projects, headquarters of major construction outfits, and several study and master's offices are all centralized within Bujumbura, former economic capital. Gitega, present political capital, has been experiencing fast urban development aided by new construction of public infrastructure. With several

residential and institutional construction projects, Ngozi is an active regional hub that has been experiencing vibrant demographic development.

By combining vast urban areas, national projects, informal initiatives, and semi-formal organizations, these three areas provide a balanced representation of construction activity within Burundi. The fact that these cities were also picked enables a broad variety of actors, from civil engineers and architects to technicians, entrepreneurs, authority representatives, and industry teachers, to be incorporated. This professional and geographic variability has facilitated the collection of diverse, relevant, and similar data, with further consideration of structural thinking and sustainability issues within several urban environments throughout the nation.

3.4 POPULATION AND SAMPLING

Professionals within the construction industry in Burundi form the study's target population. The respondents who participated in the survey were the actors of the construction sector in Burundi residing in the three major cities of the country (Bujumbura, Gitega, Ngozi) and were divided into 3 groups including professional agents in the construction sector, owners of houses as well as students of the Faculty of Civil Engineering in the various universities. These actors were targeted because they directly have a role to play in the planning, implementation, and management of reinforced concrete construction projects. Their exposure in the field provides them with an insight that reflects current practice, gaps observed, and institutional or technical explanations that dictate the exclusion of structural analysis. As knowing the total population was difficult due to the lack of documentation on this subject in Burundi, the sample size (n) was designed using the formula below [96]:

$$n = \frac{z^2 . p(1-p)}{e^2} \tag{3.1}$$

384 forms were prepared to be distributed face to face to the respondents who were in 3 groups of actors in the construction sector so as to obtain reliable results and these methods also help to use time appropriately. Among the questionnaires distributed, 67% of the responses were obtained, therefore 258 valid responses.

3.5 DATA COLLECTION TOOL

The primary data collection tool in this study is an automatically administered questionnaire designed to gather precise and structured information from building professionals. The questionnaire is divided into four sections:

a. Current conception and structural analysis practices

b. Factors thought to be responsible for the omission of structural analysis,

c. The impact of this omission on the durability of construction; and

d. Participant suggestions for improving the conception process.

To ensure its clarity, relevance, and reliability, the tool has been validated by industry professionals. A well-structured questionnaire makes it possible to collect comparable, standardized and usable data which is especially helpful in quantitative studies on heterogeneous populations [97].

The closed-ended questions also featured a Likert scale of five points, on a scale of 1 to 5, in order to determine the extent of agreement or disagreement of the proposed statements among the interviewees. The scale allows statistical processing of perceptions and attitudes and makes the task of replying less arduous for the participant. In social sciences and in engineering, the use of ordinal scales such as the Likert is widely accepted owing to its appropriateness in the measurement of opinions. This form of scale provides an effective means of measuring subjective sentiments [98]. Furthermore, the use of an automated questionnaire proved useful in the limited-resource environment such as Burundi's because the use of automated questionnaire increases wide reachability and dissemination via different dissemination channels (digital and paper). Auto-administration is of particular appropriateness for professional terrain studies, since it lowers the interaction bias and encourages frankness of response [99, 100].

3.5.1 Establishing Impacts on Sustainability Construction

To more accurately determine the different impacts that often occur on Burundi constructions, a survey was carried out, but also different documentation speaks of it. These consequences here below in Table 3.1[101-105] have been served as variables for this

research work and provide input in establishing impacts in order to imagine the various suggestions to mitigate the impacts.

Table 3.1: Impacts Often Occur in the Construction Sector.

	Deficiencies (Observable Problems)	**Impacts on Sustainability**
Financial constraints & cost-cutting	Omission or superficial structural analysis	Structural instability
		Collapse risk
		Shortened building lifespan
Weak regulatory enforcement & corruption	Non-compliance with building codes	Unsafe structures
	Lack of inspections	Reduced resilience
		Loss of public trust
Limited technical expertise & training gaps	Inaccurate reinforcement placement	Cracks
	Poor detailing	Settlement
	Weak soil investigations	Foundations failures
		Increased hazard vulnerability
Use of substandard or untested materials	Material inefficiencies	Frequent repairs
	Premature degradation	Waste of resources
		Higher lifecycle costs
Reliance on informal practices	Poor planning	Reduced structural reliability
	Absence of supervision	Unpredictable performance
Lack of modern tools & technology	Minimal use of structural Software	Low energy efficiency
		Barriers to sustainable certification
Overuse of temporary timber scaffolding	Unsustainable material uses in formwork and supports	Deforestation
		High carbon footprint
		Ecological damage

3.6 DATA ANALYSIS TECHNIQUES

SPSS version 30 and AMOS version 26 software were used to analyze the data collected, using sophisticated statistical methods that were customized according to the study objectives. The first step was a reliability test using Cronbach's Alpha coefficient for the internal consistency of the items used in measuring the different dimensions of the questionnaire. The data was then subjected to validity and suitability tests using the Kaiser-Meyer-Olkin (KMO) measure and the Bartlett sphericity test to ensure that they would be appropriate for factor analyses. The value of αC is interpreted so that once it is below 0.6 the reliability is low and requires some perfection and must be progressively and strongly reliable when it is between 0.6 and 1 [106]**.** These are critical for the robustness and organization of the data in empirical research involving latent variables. While Exploratory Factor Analysis (EFA), variables were categorized using the Principal Component Analysis (PCA) method to determine the number of factors that are defined by an Eigenvalue threshold greater than 1 (≥1) and the highly correlated variables group together to form Eigenvalues [107, 108]. After having excellent data and variable consistency from these tests, it's time to start the sequence of factor analysis

While Exploratory Factor Analysis (EFA), variables were categorized using the Principal Component Analysis (PCA) method to determine the number of factors that are defined by an Eigenvalue threshold greater than 1 (≥1) and the highly correlated variables group together to form Eigenvalues [109]. Through factor rotation, the relationship between variables and factors will become increasingly clear. For an effective and safe study, the conceptual bases must be adapted to the data analyzed and observed. Using the AMOS 26 software, this adaptation was evaluated through Confirmatory Factor Analysis (CFA) by different adjustment indicators including χ 2/df, GFI, CFI, RMSEA, TLI, SRMR and NFI [110]. To streamline the decision-making process to address the problems faced by the construction industry in Burundi, the classification of variables according to their importance was carried out by calculating the Relative Importance Index (IRI) through formula below [111]:

$$IRI = \Sigma \frac{W}{A \,.\, N} \tag{3.2}$$

3.7 ETHİCAL CONSIDERATONS

Strict ethical considerations have been followed in the case of this research in order to ensure the integrity of the data collection process and the rights of the participants. Information about the objectives of the study, the nature of the questions, and how the collected information would only be used academically was given to every participant prior to their taking part. Personal identifying information was not collected, and the answers were treated in an anonymized and confidential form. The free, informed, and voluntary consent of the participants was sought in accordance with the principles of social research ethics. Participant protection, confidentiality of the data, and transparency of research are key parts of every study that takes part in human subjects [112].

4. RESULTS AND ANALYTICAL DISCUSSION

4.1 RESULTS

4.1.1 Introduction

The statistical results of the survey data of the structured questionnaire used in the research among experts in three key Burundian urban centers are the substance of this chapter. The research's underlying themes in such as the prevalence of the absence of structural analysis, the reasons for such absence, and the alleged effect thereof on sustainability in reinforced concrete construction are reflected in the structuring of the composition of the data. In SPSS and in AMOS software, statistical techniques including reliability testing, factor analysis (EFA and CFA), Principal Component Analysis (PCA), and the Relative Importance Index (RII) are used to guarantee the results for accuracy and validity. Problem interpretation for the structural and institutional problems the Burundian construction industry faces is made easy through the outcome of this research. The results also form the basis of recommendations made in the following chapter.

4.1.2 Socio-demographic Profile of Respondents

It is important to be aware of respondents' sociodemographic features because these factors create a background against which to identify a study's findings. Respondents in this study are a variegated sample of practitioners across the Burundi construction sector, comprising engineers, architects, contractors, site officials and managers. Their profiles age, sex, level of education, work experience in number of years as a professional and geographic dispersion reveal the diversity of the sector and identify numerous divergent opinions that characterize structural analysis practice. Comparison of these attributes assists in interpreting subsequent findings against reality across the construction sector and gives a better idea how contextual determinants can influence attitudes and decisions to avoid structural analysis in a reinforced cement projection work.

Table 4.1 displays demographic data for the 258 respondents interviewed in the study, showing that most were aged 25–35 (45.3%), with the 35–45 age group (29.4%) as a close second. This suggests that mid-career professionals make up the majority of the sample. The gender disparity common in the building industry was reflected here, with the majority of

respondents being male (71.3%), females accounting for 27.1%, and others representing 1.6%. The economic center of Bujumbura included just under half of the participants (45.7%), while Gitega and Ngozi accounted for 29.1% and 25.2%, respectively, in terms of geographic locations. The respondents represented a diverse range of professions, with engineers making up 27.9%, contractors 28.3%, architects 20.5%, policymakers 10.5%, and others representing 12.8%. This distribution offers a comprehensive view of the voices within Burundi's building industry, encompassing various roles and regions.

Table 4.1: General Information on Respondents.

Ages of Respondents				
	Frequency	Percent	Valid Percent	Cumulative Percent
Under 25	43	16.7	16.7	16.7
25-35	117	45.3	45.3	62
35-45	76	29.4	18.2	80.2
Above 45	22	8.5	8.5	88.8
Total	258	100	100	
Gender of Respondents				
	Frequency	Percent	Valid Percent	Cumulative Percent
Male	184	71.3	71.3	71.3
Female	70	27.1	27.1	98.4
Other	4	1.6	1.6	100
Total	258	100	100	
Place of Main Practice				
	Frequency	Percent	Valid Percent	Cumulative Percent
	118	45.7	45.7	45.7
Gitega	75	29.1	29.1	74.8
Ngozi	65	25.2	25.2	100
Total	258	100	100	
Profession in Construction				
	Frequency	Percent	Valid Percent	Cumulative Percent
Engineer	72	27.9	27.9	27.9

Table 4.1: General Information on Respondents (Table Continued).

Architect	53	20.5	20.5	48.4
Contract	73	28.3	28.3	76.7
Policy Maker	27	10.5	10.5	87.2
Other	33	12.8	12.8	100
Total	258	100	100	

The sample is considered fair and unbiased because it includes a representative and diverse group of construction practitioners of all ages, genders, occupations, and regions within Burundi's construction sector. The primary locations chosen for this study are Bujumbura, Gitega, and Ngozi, as they are strategically crucial for Burundi's national development and have large populations. Bujumbura, the country's former capital and largest city, remains its main economic hub. It hosts numerous building companies, engineers, and skilled workers due to its high population and demand for infrastructure [113]. Gitega is currently both the political and administrative capital. This is where government-sanctioned construction projects are managed, which is why parliamentarians and regulatory agencies needed to be included in the sample. Ngozi is the largest city in northern Burundi. It has expanded rapidly and is a significant economic hub in the region, especially in housing and urban development. Because of this, it is an interesting location to study building practices beyond the capital region [114, 115]. The three towns together cover the full range of Burundi's construction industry. They illustrate changes from urban to rural areas, different types of projects, and various professional viewpoints needed for a comprehensive and accurate analysis.

4.1.3 RC Projects Structural Analysis Omission Frequency

Using a specific set of questionnaire questions about the exclusion of structural analysis of reinforced concrete (RC) building projects in Burundi, the prevalence of the exclusion was evaluated. The findings show that exclusion is relatively prevalent. More than 60% of the 258 respondents revealed that structural analysis is excluded from standard-issue RC building projects, and 19% revealed the opposite. Only 12% of respondents said that structural analysis is conducted on the most recent building projects that they have been involved in, and this implies that only larger or better regulated projects such as

infrastructure and donor-built projects are the only ones conducted properly using structural design procedures.

Additionally, the research implies that omission exists in rural contexts, low-rise buildings, and informal urban buildings all the usually involving minimal or no engineering control. In contrast, the rate of compliance for structural analysis is comparatively higher for monitored structures by the state and tall buildings. Even during periods of structural drawings being produced for permit releases, several respondents mentioned that they were frequently produced without legitimate check-ups through structural software or calculation, further weakening the design's integrity. These results indicate that omissions do not appear on single occasions but occur systemically in several realms of Burundi's building practices. Lacking the application of rigorous regulatory enforcement and technical control, the trend poses serious risks for the efficiency of resources, the environment, and the structural stability.

4.1.3.1 Views on structural analysis omission

This research report sets out that the study finds that a large percentage of Burundian building experts believe that the exclusion of structural analysis in reinforced-concrete (RC) works is prevalent and common. 55.4% of the respondents replied that structural analysis is often lacking, particularly from residential and domestic building works of small to medium size, based on the data gathered. This pattern is most pronounced in works on houses or slum settlements with low cost in the absence of regulatory control and restrictive conditions on the budget. As few as 10% of the interviewees replied that most of the works, they encounter on routine basis involves structural analysis. More still other respondents emphasized the point that even in the case of works where structural analysis is asserted to be performed, it tends to be superficial, performed in the absence of the proper tools, or not from the field load data and site conditions. These impressions point to us the finding that exclusion of this most crucial step is not the exception but the rule of the land. The structural stability, durability, and sustainability of the built infrastructure of Burundi come into doubt seriously in the face of this prevalent exclusion.

Table 4.2: Frequency of Views on Structural Analysis Omission.

	Frequency	Percent	Valid Percent	Cumulative Percent
Always	65	25.2	25.2	25.2
Often	143	55.4	55.4	80.6
Sometimes	17	6.6	6.6	87.2
Rarely	11	4.3	4.3	91.5
Never	22	8.5	8.5	100.0
Total	258	100.0	100.0	

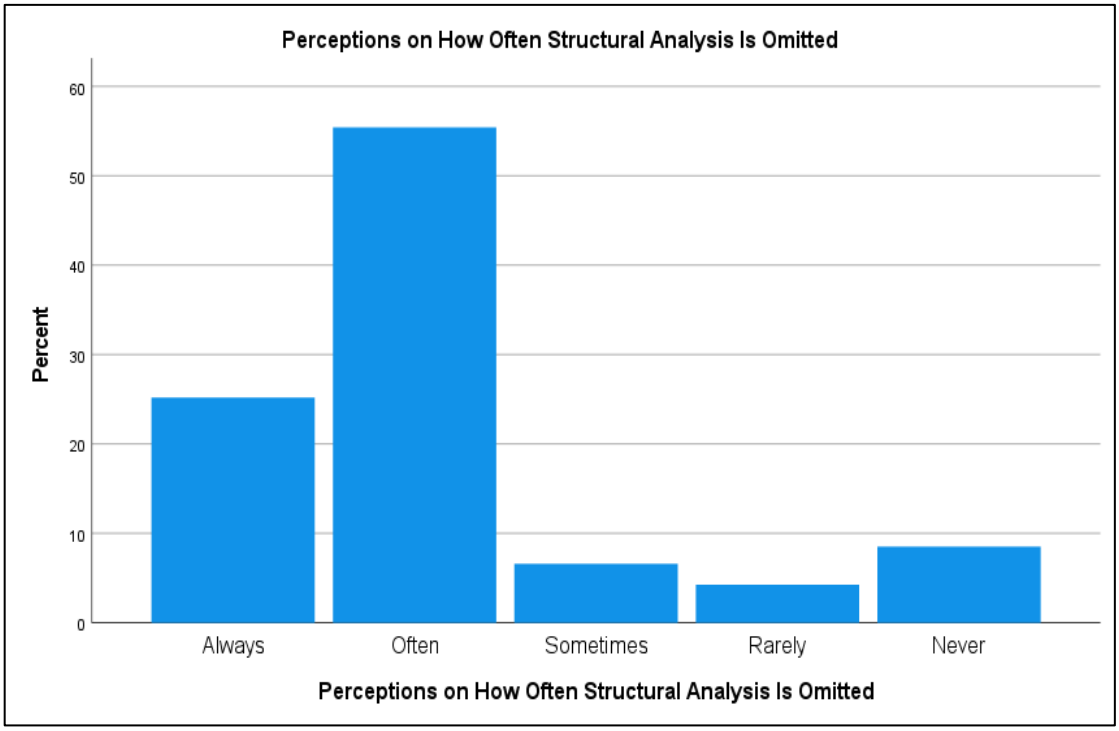

Figure 4.1: Percentages of Views on Structural Analysis Omission.

4.1.3.2 The stages where structural analysis is most often skipped

It is most typically encountered during the preliminary design and the pre-construction stages of the project life cycle. The interview respondents specified that the most typical omission case of structural analysis is the preliminary design. Instead of doing a proper structural analysis, many designers and constructors use empirical data or generic forms during informal or cost-saving projects.

Time constraints, cost reduction measures, or lack of knowledge about the technical consequences are most responsible. This second most impacted step of the detailed design

requires long hours of computation to check load routes, reinforcement details, and contact between structural elements. But a vast percentage of the interviewees reported that, especially for residential works on a private scale, this step is completely skipped or only considered in parts. In some cases, the work proceeds with estimates and design sheets with no calculations on the structure.

Lastly, several omissions also emerged in the construction documents and execution planning stages, in that structural elements were being adapted without the re-assessment of an engineer. These last-minute decisions so frequently made on the spot in the name of time or materials waste threaten sustainability and create safety hazards. This result aligns with prior research that the possibility of structural inefficiencies and malperformance following construction in developing nations is far greater once structural analysis becomes skipped during the initial and mid-design stages [116].

4.1.4 Reliability and Validity of the Data

Before undertaking further higher-level statistical analysis, reliability and validity tests were administered to authenticate the accuracy and consistency of the data gathered on the premise of this research. Cronbach's Alpha was used to test the internal consistency of the questionnaire on the main dimensions perceived effects on sustainability and absence of structural analysis reasons. The Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity, used to check the data's applicability for the purpose of factor analysis, were used to test validity. To ensure the robustness of later analyses like EFA, PCA, and CFA, the above preliminary tests played a crucial role in ensuring the statistical validity of the data set, the coherence of the constructs, and the significant relationships between variables.

4.1.4.1 Cronbach's Alpha values

Cronbach's Alpha was estimated for all main components of the questionnaire to measure the internal consistency of the questionnaire applied during the study. The degree to which scale items correlate and capture the same underlying construct is called internal consistency. The value of Cronbach's Alpha above 0.70 is deemed satisfactory, above 0.80 excellent, and above 0.90 exceptional from standard recommendations. These elements per thematic axis are statistically reliable according to these results and further investigated using multivariate methods like exploration and confirmatory factor analysis. For the data gathered not to be accidental but rather represent the professionals questioned in Burundi accurately in terms of opinions and practices, this reliability is required. Cronbach's Alpha is a common indicator applied in the social sciences that ensures the questionnaire instrument's reliability is validated, particularly in the exploration of complex practices like the behaviors of institutions and practices of professionals [117]. The guarantee of the reliability of the data collected for this work was a start-up work by measuring the Cronbach's Alpha coefficient (Cα) which was 0.846 so greater than 0.70 (>0.70); and this means that the data of this work are reliable and relevant.

Table 4.3: Cronbach's Alpha Values Results.

	N	**%**
Valid	258	100.0
Excluded[a]	0	0.0
Total	258	100.0
Cronbach's Alpha	**N of Items**	**N**
0.846	14	258

4.1.4.2 KMO and Bartlett's test

The next phase was to calculate the values of the Kaiser-Meyer-Olkin Test and the Bartlett Sphericity Test to arrive at the factor analysis. The results were 0.724 with a good rating as an interpretation of this value. For the Bartlett test, the results were 0.000 which is less than 0.05 (<0.05) and df=91. Bartlett's Test of Sphericity and the Kaiser–Meyer–Olkin measure of sampling adequacy was performed to verify whether the data obtained from the respondents was suitable for factor analysis.

These two are important procedures in the determination of whether the variables in the data set could be grouped into underlying factors and the extent to which they relate to each other. The usage of Exploratory Factor Analysis in the subsequent section is validated through the large Bartlett's test evidencing the dataset is in a state appropriate for structure discovery and factor extraction. The two tests together offer convincing statistical evidence that the dataset possesses the assumptions multivariate analysis requires.

These results demonstrate that there is ample common variance within the data structure for deriving logical explanations for why structural analysis was not performed on Burundi's reinforced concrete building. As such, the resulting factor analysis performed later in this chapter is supplemented with strong statistical justification. These diagnostic statistics support the research methodological rigor and lend validity and reliability to the results.

Table 4.4: Bartlett's Test of Sphericity and the Kaiser–Meyer–Olkin Results.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.724
Bartlett's Test of Sphericity	Approx. Chi-Square	3412.162
	df	91
	Sig.	0.000

4.1.5 Exploratory Factor Analysis

To isolate the underlying dimensions affecting the non-apprehension of structural thinking in reinforced concrete construction in Burundi, an exploratory factor analysis was performed. This type of approach is particularly suitable for studies designed to reveal hidden structures among the observed variables and to compress the data into significant factors to explain correlation patterns. To apply the AFE (Let's Overcome the Limitations), this study aims to bring together the associated causes and effects into separate concepts that better evoke the realities of the field of study in construction. This kind of approach helps to better understand the ways in which institutional, financial and technical challenges contribute to affecting both the non-apprehension of structural thinking and its effects for sustainable construction. Conduct was performed with SPSS v30 suitability tests like Kaiser-Meyer-Olkin test and spherical test at Bartlett to ensure the suitability of the given batch in taking it to its extraction from the factors.

4.1.6 Principal Component Analysis

PCA is a statistical procedure used in decreasing the level of dimensionality for large datasets by preserving as much variability (information) as possible. It consists of the reconstruction of a narrower palette of uncorrelated variables not shared by the originals from the original correlated variables in linear combinations in the form of a number called the principal component. The first principal component recaptures the maximum variance of the data information; the second recaptures the residual high maximum variance orthogonal to the first; The rest continues to film. It is widely used by researchers to highlight the underlying structures from the complex data to obtain the most important factors responsible for variation in each set [118].

Principal Component Analysis was used in this study as a dimension-reducing technique to extract influential components behind reasons for structural analysis omission in reinforced concrete structures. PCA acquires a special application in this case owing to its power to transform many correlated variables into a tractable number of uncorrelated components such that a large portion of variance within the original variables will be preserved while interpretation will be simplified. With this approach, dimensionality reduction can be attained that can highlight overriding dimensions behind sustainability concerns in the Burundi construction sector while ensuring statistical soundness and validity in findings.

4.1.6.1 Reduction of data to key components

The use of application of PCA has served to reduce a wide range of observed variables in a fewer number of principal components, purifying data richness to the extent that they retain quasi-totality power to explicate. Such a process has clustered tightly correlated variables in principal components, each retaining a dimension inherent having influence in non-omission in realized in reinforced concrete projects. Commenting on own values and factor weightings has served to facilitate selection of only listed components enumerating largest variance, thus providing obvious structure of most essential factors. Such reduction has not only served to facilitate optimal inter-duplicability interpretation of purported results but has further served a solid foundation to lead to a factor analytical confirmatory analysis later due consideration to secure enumerated components both statistically valid and concretely

relevant to capture Challenges into sustainability in range of constructions in the Republic of Burundi.

4.1.6.2 Scree plot and component matrix interpretation

A scree plot is a graphical representation employed in PCA to grasp how many factors or components retain. It plots the eigenvalues corresponding to each component in the decreasing order. Figure 4.2 shows a scree plot plotting the eigenvalues versus number of components extracted and determining where explained variance begins to level off. Eigenvalues are extremely notable funded in the first two components (roughly 5 and 2) and hence suggest that these hold the largest amount of variance within the dataset. For components after the third component, we can see that the curve levels off and slowly has eigenvalues approaching or below a unit level, which demonstrates a reduction in power to explain. According to both Kaiser criterion (eigenvalue > 1) and elbow rule requirements, five components will be kept because this holds most variance and remaining components hold minimal variance in factor structure in general.

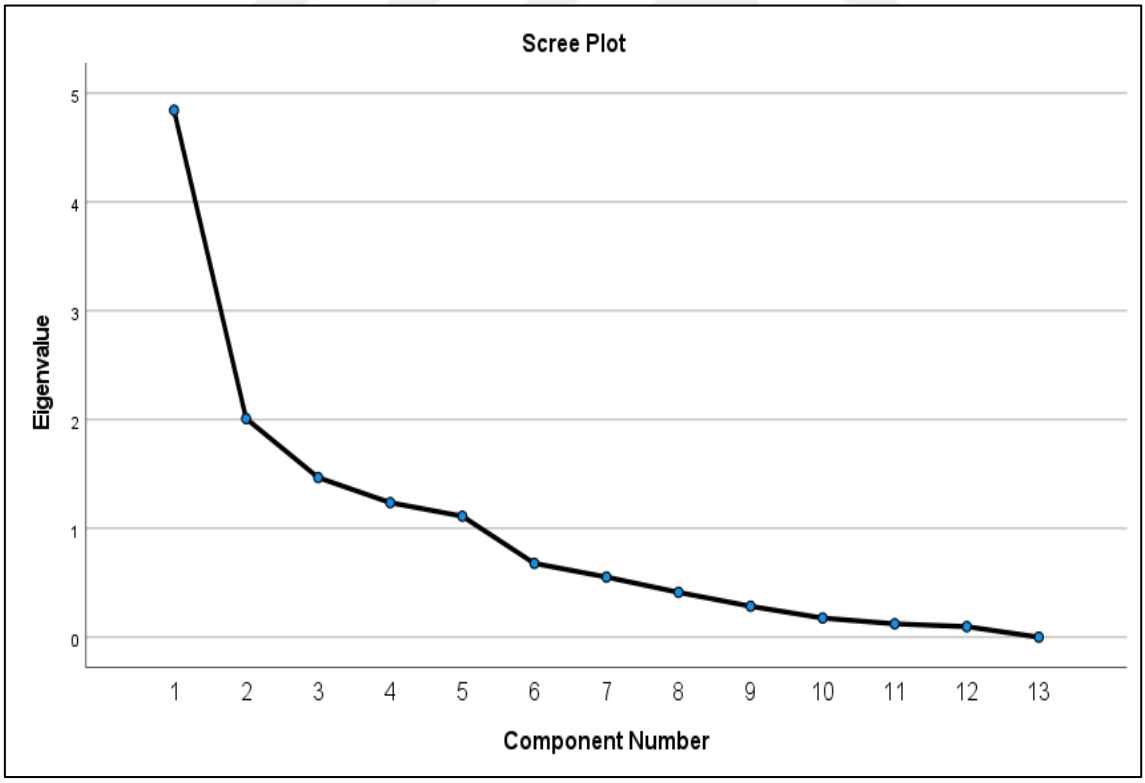

Figure 4.2: Eigenvalue and Component Number Scree Plot.

As for the Component Matrix, it is a statistical table that refines the relationships (or factor weights) between the observed ejectives and the main components removed from a principal component analysis. In short, it gives the proportion contributed by each of the ejectives to each of the components in order to enlighten researchers on the structure of the data and suggest the existence of a trend among the ejectives. High positive or negative relationships mean that the presence of jewelry is tenuous with a particular component; however, weak relationships suggest a weak bond. Component matrix is crucial to decrease a large plurality of ejectives to a smaller of the underlying dimensions to facilitate the understanding of the data while preserving the variance as much as possible.

Using the varimax rotation method selected for this work, as shown in Figure 4.2, 13 variables out of identified in this research contributed to the creation of 5 factors. Each variable primarily loaded on a single factor, resulting in a clearer factor structure that reflects the purpose and theory of this study. The identification and naming of these components are as follows: 1st, Structural Integrity Risks; 2nd, Environmental and Material Efficiency; 3rd, Compliance and Technologies; 4th, Resilience and Sustainability; and 5th, Economic and Material Waste.

The five primary contributing factors identified through factor analysis are listed in Table 4.5. Each factor comprises variables that represent different categories of effects resulting from the lack of structural analysis in reinforced concrete buildings. Structural Integrity Risks is the most significant factor, accounting for 37.254% of the variance. Variables such as improper reinforcement placement and the risk of collapse have high loadings on this factor. The internal consistency among these variables and their role in assessing barriers to sustainable building in Burundi are confirmed by the fact that all five factors demonstrate acceptable to high reliability (Cronbach's Alpha ≥ 0.735).

Table 4.5: Factor Constructs with Associated Matrix.

Factors And Variables Name	Factor Loadings	Eigenvalues	% Of Variance	Cronbach's Alpha
Factor 1				
Structural Integrity Risks		4.843	37.254	0.8
Inaccurate Reinforced Placement (SIR1)	0.905			
Increased Probability of Building Collapse (SIR2)	0.891			
Poor Energy Efficiency Due to Structural Deficiencies (SIR3)	0.829			
Factor 2				
Environment And Material Efficiency		2.01	15.461	0.735
Increased Carbon Footprint from Frequent Repairs (EME1)	0.824			
Weak or Overloaded Structural Members (EME2)	0.795			
Increased Risk of Structural Failure or Collapse (EME3)	0.668			
Factor 3				
Compliance And Technology		1.468	11.291	0.999
Lack of Compliance with Building Codes and Standards (CT1)	0.991			
Limited Use of Modern Analysis Technologies (CT2)	0.99			
Factor 4				
Resilience And Sustainability		1.237	9.516	0.939
Reduced Resilience to Environmental Hazards (RS1)	0.923			
Negative Impact on Sustainable Building Certification (RS2)	0.917			
Factor 5				
Economic And Material Waste		1.113	8.559	0.739
Waste of Construction Materials Due to Failures (EMW1)	0.823			
Lower Return on Construction Investments (EMW2)	0.805			
Risk of Cracks and Settlement (EMW3)	0.659			

4.1.7 Confirmatory Factor Analysis

Confirmatory Factor Analysis is one of the statistical techniques that is used to test the gathered data against a hypothesized measure of measurement. Unlike the theory-independent EFA, which focuses on the underlying structure that could be present with no pre-hoc hypotheses, the theory-based CFA is used to validate or reject pre-established relations between observed measures and their underlying latent constructs factors. In practice, the CFA is used by researchers to test the validity and reliability of measures, making sure that the indicators (variables or items of a survey) reflect the concepts the indicators seek to measure accurately. CFI, RMSEA, and the Chi-square tests to assess the goodness of the model representation of the data.

Confirmatory Factor Analysis was employed to determine if the data in this study exhibits a factor structure consistent with the concept being examined. Validation tools were utilized to compare adjustment indices with theoretical expectations and support decision-making through data analysis, thereby confirming the credibility of the models. The model fit results of the Confirmatory Factor Analysis are shown in Table 4.6, which evaluates how well the proposed model aligns with the survey data collected in the context of this study.

4.1.7.1 Model fit indicators

Model fit indices encompass statistics used in Confirmatory Factor Analysis CFA and Structural Equation Modeling SEM to gauge the goodness of the hypothesized model at representing the observed data. Absolute indices such as the Chi-Square (χ^2) and the ratio of chi-square to the degrees of freedom (χ^2/df) test the proximity of fit between the model and the real world where smaller numbers reflect better compatibility. Similarly, the Goodness-of-Fit Index (GFI) and the Standardized Root Mean Square Residual (SRMR) test the percentage of the variance covered by the model and the size of residual errors respectively. These indices provide the preliminary insight on the applicability of the model where such values such as those of χ^2/df of below 3, GFI of above 0.90, and those of the SRMR of below 0.08 generally show satisfactory compatibility.

Incremental and parsimony indices further refine the measure by comparing the model against a base level and adjusting for complexity. The CFI, NFI, and the TLI all evaluate relative improvement against a null model, with more than 0.90 showing good fit and more

than 0.95 showing excellent fit. The Root Mean Square Error of Approximation, by contrast, gives an indication of the quality of the model at predicting the population matrix of covariances, with below 0.06 showing strong fit. As a group, these indices collectively help both to determine not only if a model is statistically tenable, but also if it is parsimonious, efficient, and practically interpretable when used on real-world data.

Each fit index assesses a different aspect of model adequacy. The statistically significant difference between the observed and expected covariance matrices is indicated by the Chi-square (χ 2) value of 157.785 with 51 degrees of freedom ($p < 0.001$). Although large samples often show a significant chi-square, it typically suggests some degree of model misfit. The model's marginal but acceptable fit to the data is shown by the χ 2/df ratio of 3.094, which, although not ideal, is within the acceptable range (less than 5).

Other indices provide additional information. The Tucker-Lewis Index (TLI = 0.951) and Comparative Fit Index (CFI = 0.968) exceed the cutoff value of 0.95, thus indicating an excellent fit of the model. The good to excellent fit of the structural model is confirmed by the Goodness of Fit Index (GFI = 0.916) and Normed Fit Index (NFI = 0.953), both surpassing 0.90. The 0.09 values of RMSEA and SRMR, however, slightly exceed their optimal cutoff points, indicating a minor error in fit approximation. The overall validity and reliability of the presented model are supported by the strong values of CFI, TLI, and NFI, despite these slight deviations. This suggests that the factor structure adequately represents the survey data within the context of sustainability.

To analyze those results, a software AMOS was used, the model fit analysis was made by specifying the hypothetical model of measurement and performing Confirmatory Factor Analysis (CFA). Several goodness-of-fit indices were computed automatically by the software, including Chi-Square (χ^2), χ^2/df, CFI, TLI, RMSEA, GFI, NFI, and SRMR, to identify the degree of correspondence between hypothesized model and observed data. Path diagrams were produced to show latent variables and their corresponding relations with observed indicators, and the software computed the parameters by MLE. The result outputs provided standardized regression weights, residual, and fit indices, which were interpreted by reference to conventional thresholds.

Table 4.6: Model Fit Indices Results for Confirmatory Factor Analysis.

Fit Index	Model's Value	Threshold for Good Fit	Interpretation
χ 2 (df)	157.785 (51)		Significant (p<0.001)
χ 2/df	3.094	< 3(Ideal), <5 (Acceptable)	Marginal
CFI	0.968	≥0.95	Excellent
TLI	0.951	≥0.95	Excellent
RMSEA	0.09	≤0.06 (Ideal), ≤0.08 (Acceptable)	Marginal
GFI	0.916	≥0.90	Acceptable
NFI	0.953	≥90	Good
SRMR	0.09	< 0.08	Marginal

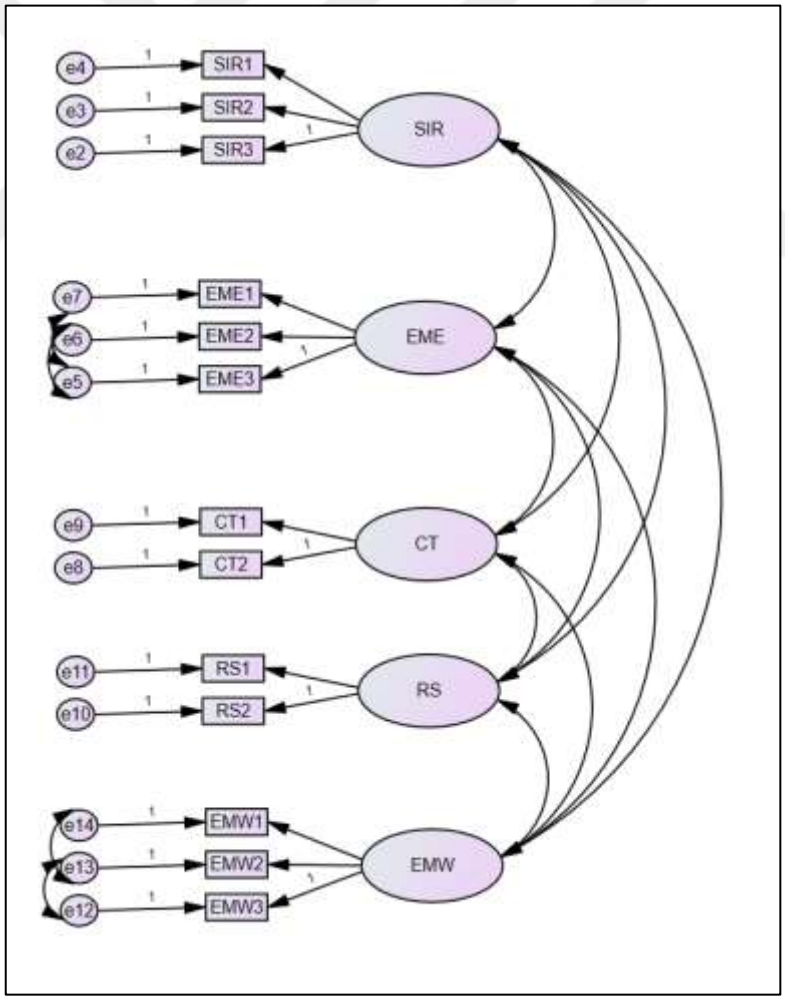

Figure 4.3: Confirmatory Factor Analysis Path Diagram.

Figure 4.3 illustrates a Structural Equation Model that shows the relationships among five latent variables. These include SIR, EME, CT, RS, and EMW. Several observable indicators are used to assess each latent variable. For instance, SIR is measured by SIR1 through SIR3, and EME is gauged by EME1 to EME3. The arrows from each indicator to the latent variables indicate the strength of that indicator's influence on the construct. The curved arrows between the latent variables depict the suspected relationships or influences they have on each other. The model aims to examine how various construction issues, such as structural risk and wastage, impact broader sustainable building practices.

4.1.7.2 Classification of Components According to Importance

The RII calculations for each variable demonstrated the significance of each factor and helped rank these components accordingly: the results of these calculations. The values from the results, along with the list of factors, are shown in Table 4.7 below.

Table 4.7: Model Fit Indices Results for Confirmatory Factor Analysis.

Factors Code	Variables Code	Eigenvalue	Rank by Eigenvalues	Overall IRI (%)	Avg. IRI (%)	Rank by IRI
SIR	SIR1	4.843	1	90.5	87.5	3
	SIR2			89.1		
	SIR3			82.9		
EME	EME1	2.010	2	82.4	76.2	4
	EME2			79.5		
	EME3			66.8		
CT	CT1	1.468	3	99.1	99.1	1
	CT2			99.0		
RS	RS1	1.237	4	92.3	92.0	2
	RS2			91.7		
EMW	EMW1	1.113	5	82.3	76.2	5
	EMW2			80.5		
	EMW3			65.9		

Compliance and Technology (CT) factors are the most prominent among all the factors identified here. It has an Average Relative Importance Index of 99.1%, the highest among all the factors. This indicates it holds the greatest importance, even though it has the lowest eigenvalue compared to Structural Integrity Risks (SIR) and Environment and Material Efficiency (EME). This suggests that while CT has less influence on the statistical variation in the dataset, most respondents consider it the most critical for sustainable building in Burundi. The two CT factors, CT1, failure to comply with building codes, and CT2, insufficient use of current analytical tools, are closely related to the main issue examined in this study: failure to conduct structural analysis. These reflect systemic and institutional problems rather than just technological issues. This greatly influences whether structural analysis is considered during the design process.

Their influence goes beyond mistakes made at the project level; it points to broader issues with rules, education, and technology that make sustainable building on a national scale more difficult. This strategic importance sets CT apart from all other factors. It is not just poor practice as a result; it is the fundamental cause behind all the decisions the Burundi construction sector has made.

The cases of Burundi, Ghana, and India were compared, as their compliance with structural design standards is more strictly enforced, to gain insight into the severity of the consequences of not conducting structural analysis in reinforced concrete construction. The following table, Table 4.8 [119-121]shows the extent to which major structural and sustainability issues were prevalent in each country. This comparison indicates that structural failures, material waste, and ecological vulnerabilities are more frequent in Burundi. It highlights how crucial achieving a healthy structural study is for sustainable construction results.

Table 4.8: Comparing Impacts of Design Omissions in Burundi, Ghana, and India.

Impact Variable	Burundi	Ghana	India
Cracks and Settlement	65.9%	25%	18%
Material Waste due to Failures	82.30%	40%	30%
Risk of Structural Collapse	66.8%	35%	22%
Code Non-Compliance	99.10%	15%	5%
Reduced Resilience to Environmental Hazards	92.3%	45%	28%
Poor Energy Efficiency	82.9%	38%	25%
Building Certification Eligibility Issues	91.7%	33%	20%

The study outcomes reveal that the lack of proper analysis of reinforced concretes is pervasive in Burundi, and the greater majority of the practitioners embrace the prevalence of the practice, particularly in small- to medium-scale residential and commercial construction. Financial constraint, inadequate proper technical know-how, weak regulations enforcement, and prevalence of customary construction practices were the determinants that were revealed to be the most important drivers of omission. Statistical analysis also confirmed the validity of the information, where the Cronbach's Alpha statistics were above satisfactory levels, and the KMO and the Bartlett's test proved the effectiveness of factor analysis. Factor exploratory and confirmatory analysis confirmed five central dimensions of omission pushers to be comprised of cost-consciousness, poor schooling, lack of institutional control, restriction to designing tools, and corrupt approval of projects. Moreover, the Relative Importance Index also confirmed financial constraint and weak regulations as the determinants having the highest influence level. These remarks reflect the high correlation between technical negligence and environmentally hazardous practices like resources wastage, lower structure duration, and high community resilience and safety risk level.

Failure to have structural analysis of reinforced works has a direct correlation with sustainability risk because it has negative impacts on the three sustainable construction pillars of environmental, economic, and social performance. Failing to have proper analysis makes the structure either overdesigned, which translates into excessive usage of materials such as cement and steel and more carbon emissions, or weak with lower service life and

more maintenance needs. This not only facilitates faster loss of resources, but it also generates more construction rubble. Economically, poor structural planning begets premature maintenance and high life-cycle costs, and socially it impacts negatively on safety and places society at risk of collapse and forced evictions. In the Burundian case where the resources are scanty and the regulatory framework is weak, the failure to have structural analysis exacerbates these sustainability challenges, and the buildings become more brittle and not development-oriented on the long term.

The results detailed in the current chapter provide a detailed explanation of the nature of the omissions of structural analysis that happen on Burundian reinforced concrete construction works, the motivations that lie beneath such omissions, and the impacts of such omissions on sustainable construction practice. Bringing together descriptive statistics with more advanced analytical methods such as factor analysis, principal component analysis, and indices of fitness of models, the study defines both the validity and the reliability of the results. These results detail not only the underlying recurring technical, financial, and institutional issues, but also the underlying linkages between these sustainability issues and the overarching sustainability problem. The next section develops these results by including an analytical commentary that links the empirical results with the theoretical framework and the literature, and which draws out the policy, practice, and research-based implications of the study that have application to the Burundian construction sector.

4.2 ANALYTICAL DISCUSSION

In Burundi, the long-term durability of reinforced concrete buildings depends on more than just the omission of structural analysis; it is affected by a wider range of system deficiencies that impact safety, efficiency, and sustainability. These deficiencies include poor planning, lack of proper monitoring, use of inferior construction materials, weak enforcement of building codes, and financial constraints that lead to cost-cutting. The absence of structural analysis is best seen as one example of these broader issues rather than the sole cause of negative outcomes.

This section explains how all these factors together make Burundi's built environment less sustainable. The argument presents three main points: environmental effects and resource loss, structure lifespan and integrity, and ethical, legal, and social issues. The research helps

deepen understanding of how Burundi's building sector can shift toward safer, longer lasting, and environmentally friendly practices by highlighting the related failings and their impact on sustainability outcomes.

4.2.1 Environmental Impacts and Resource Depletion

The omission of structural analysis of reinforced concrete construction in Burundi not only decreases building performance quality but also raises environmental pressure and wastage of resources. Poor design strategies, heavy reliance on temporary timber scaffolding, and uncontrolled extraction of sand, gravel, and bricks accelerate deforestation, increase greenhouse gas levels, and destabilize ecological balance. These unsustainable measures decrease the longevity of structures, with repetitive repairs and reconstruction that eventually use still more natural resources. With this, unsustainable construction practices that fail to respond to proper analysis of buildings contribute to sustainable environmental degradation over the long term, enhance climate exposure, and restrain a shift towards sustainable urban development.

4.2.1.1 Deforestation, CO_2 emissions, and the overuse of timber scaffolding

Environmental impacts and resource loss are major sustainability issues caused by construction practices in Burundi. The country's building sector relies heavily on environmentally harmful methods, such as using wood for scaffolding and short-lived formwork [122]. Questionnaire findings and national statistics reveal that one reinforced concrete slab for a small house uses as many as 500 young trees, which is nearly half a hectare of woodland [123]. Over 1,350 trees are lost each year to make way for homes in Kayanza Province. Building in Ngozi from 2021 to 2023 cleared 279 hectares of native forest, releasing emissions equivalent to nearly 141,000 tons of CO2 into the atmosphere [124]. These types of action accelerate deforestation, reducing the ability of trees to absorb carbon, which already accounts for nearly 10% of all emissions.

Using metal scaffolding can further lower environmental impact. Replacing wooden forms with recyclable steel systems for temporary works could prevent deforestation, last longer, and cut greenhouse gas emissions by 30-40% [125]. However, its high prices and limited supply within the market render its adoption difficult. Policy interventions, such as reduced import taxes or specific subsidies, would be highly significant to get people to adopt its use.

These findings indicate that environmental damage to Burundi's building sector is caused not by a single technical failure but by a series of systemic issues, including excessive reliance on timber scaffolding, uncontrolled material extraction, and weak enforcement of building codes. Addressing these problems is essential for preventing deforestation, reducing climate risks, and ensuring that building practices support long-term urban growth [126].

4.2.1.2 Poor material utilization and indoor air quality challenges

Besides timber, the illegal extraction of materials like burnt bricks, gravel, and river sand also causes much greater environmental pollution. Poor or inaccurate design calculations often lead to inefficient use of materials, resulting in excessive consumption and subpar building performance [127]. The World Bank ranked Burundi among its top 25 most vulnerable countries to climate change. This is partly due to environmentally harmful methods used to obtain building materials, which damage ecosystems and lead to short-lived structures.

Environmental issues can also affect indoor air quality. Due to failure to meet design standards, many buildings in Burundi show signs of water penetration, poor insulation, and material decay. These problems can cause higher releases of volatile organic compounds (VOCs) from damp walls, paints, and adhesives. VOCs are linked to asthma, respiratory problems, and neurological symptoms. The World Health Organization reports that poor indoor air quality causes about 3.8 million deaths worldwide each year. In Burundi, where much construction is informal, this aspect of environmental sustainability is often overlooked during material selection and building design [128, 129].

Global best practices encourage us to use more eco-friendly methods. For example, Belgium follows the NBN EN 13829 airtightness standards to lower indoor pollution. Additionally, the use of low-VOC paints, water-based adhesives, fly ash concrete, and adobe bricks helps improve air quality and reduce embodied carbon [130]. Burundi's urban planning code already discusses ways to reduce buildings' energy usage, conserve the environment, and utilize materials more effectively. Incorporating such types of approaches to the building industry would align with such notions.

4.2.2 Impacts on the Lifespan of a Structure

Sustainability of reinforced concrete structures lies in durability because it calculates how long it will take a building to remain in safe occupation without extensive repair work or rebuilding. In Burundi, however, the absence of adequate structural analysis, coupled with inadequate soil investigations, inferior materials, and poor design supervision, has had the devastating effect of shortening much of its building stock durability. Those are factors that accelerate crack formation, settlement, and early age deterioration, placing people at risk as well as inflating maintenance costs in the long run. By endangering both people's safety as well as economic viability, both of these practices directly violate both sustainability of the built environment as well as community resilience.

The durability of buildings and their lifespan are key to sustainable construction because they affect both occupant safety and the long-term financial success of projects. In Burundi, however, various construction issues contribute to reinforced concrete buildings being less durable. Poor design processes, insufficient soil testing, inadequate material quality control, and failure to perform proper structural assessments all decrease a structure's expected lifespan and increase the risk of damage from hazards readily.

4.2.2.1 Cracks, settlement, and collapse risk in R.C. structures

The survey results reveal how serious this problem is: Sixty-four percent of homeowners reported that their structures had cracks, settled, or subsided. Many of these issues were caused by poor design and insufficient oversight. Local examples demonstrate how these kinds of mistakes can harm people and lead to costly repairs. Design errors and a lack of monitoring contributed to the Gitega collapse in 2009, which resulted in 15 deaths and 39 injuries. Also, when concrete was poured in Bujumbura's Buterere district, the building collapsed, resulting in multiple deaths and injuring several people [131]. These cases illustrate how problems with planning, design, and monitoring make communities less resilient, costing them a lot of money and time.

These patterns are supported by international case examples. The Sampoong Department Store in South Korea in 1995, Grand View Hotel in Ghana in 2012, and the Dar es Salaam building disaster in Tanzania in 2013 demonstrate worst-case outcomes of inadequate design and code noncompliance under various conditions [132, 133]. Burundi stands out as an

exception because such collapses are more common with limited finances, little professional exposure, and traditional building practices rather than technical errors.

4.2.2.2 Socioeconomic costs challenges

From a sustainability perspective, structural failures that occur too rapidly shorten the lifespan of buildings, requiring more frequent repairs or rebuilding. This leads to increased material use, higher carbon emissions, and greater financial burden on households. For most Burundians, who pay out of pocket or through loans for construction, these additional costs make it more difficult to repay loans over time and weaken socio-economic resilience. Consequently, structural issues related to resilience and longevity not only endanger lives but also worsen inequality and slow the country's progress.

Solving this issue involves changes at both technical and institutional levels. Investment in engineering studies, innovative design software, and quality laboratories need to be undertaken to upgrade professional capacity [134]. Enhancing enforcement of building codes, implementing more rigorous validation processes for construction permits, and imposing fines for non-compliance are crucial at the institutional level. Government-sponsored training and subsidized housing programs could encourage safer and more resilient construction practices. Promoting these reforms might help Burundi eliminate structural issues, strengthen buildings, and better protect against natural disasters and long-term environmental threats. This study contributes to the literature by not only reaffirming the importance of planning but also assessing the relative importance of various deficiencies experienced by practitioners in Burundi, demonstrating their cumulative effects on safety, the environment, and the economy.

4.2.3 Ethical, Legal, and Social Issues

The omission of structural analysis in reinforced concrete building projects in Burundi also creates ultimate ethical, legal, and social concerns that go beyond technical failure. On an ethical level, professionals must guarantee human life and promote sustainable measures, while omitting proper analysis jeopardizes security and exposes communities to preventable hazards. On a legal level, weak enforcement of building codes, corruption, and weak accountability structures sustain non-compliance and institutionalize dangerous building practices. On a social level, repeated building collapses and early building aging erode

confidence in the building industry, expand environmental inequalities by exposing socially vulnerable individuals to highest risks, and discourage confidence in governing institutions. These concerns demonstrate that implications of omitting structural analysis extend beyond technical, to related concerns of justice, accountability, and governance in Burundi's building sector.

4.2.3.1 Ethical and legal issues

The failure to carry out structural analysis in reinforced concrete constructions is a serious ethical and legal violation in Burundi. Professionally, specialists who willfully exclude fundamental design procedures compromise public safety, destroy trust in the construction profession, and expose vulnerable groups to preventable chances of injury and collapse. Legally, the failure to effectively enforce architectural codes and pervasive corruption encourages constructors to disregard standards with impunity, and it compromises the effectiveness of institutions and discourages voluntary compliance. Socially, successive collapses cause loss of life and property and further entrench poverty because low-income households occupy unsafe and poorly regulated buildings disproportionately. This loss of confidence diminishes public will to invest in construction and thus stunts urban growth [135].

In order to cover these gaps in ethical and legal spheres, Burundi must improve institutional accountability through stricter enforcement of the 2016 Urban Planning and Construction Code and introduce sanctions for non-compliance, similar to international experiences in countries where legal sanctions reduced incidents of building collapses [136, 137]. Introduction of clear systems of permits and regular third-party inspections and anti-corruption policies will ensure qualitative analysis of structure is mandatory in every undertaking. At professional levels, inclusion of ethics modules in professional courses and demanding continuous professional upgrading may inject in engineers with the sense of duty to ensure safety to lives. Awareness campaigns at community levels on safe constructions may educate and empower the client to demand compliance and reduced tolerance towards unsafe and non-conventional constructions [138]. Cumulatively these reforms will improve legal compliance and reestablish public trust and make Burundi’s constructions industry socially responsive.

4.3 SUMMERY

This chapter reports survey evidence from 258 Burundi Bujumbura, Gitega, and Ngozi construction professionals of pervasive omissions of structural analysis in RC projects—over 60% overall, with 55.4% saying it occurs "often" and specifically in low-end lightly regulated domestic works—most often omitted at initial and detailed design. The dataset is robust and factorable (Cronbach's α=0.846; KMO=0.724; $p<0.001$ in the Bartlett test). EFA/PCA captured five impact dimensions—Structural Integrity Risks, Environmental & Material Efficiency, Compliance & Technology, Resilience & Sustainability, and Economic & Material Waste—while CFA evidenced an overall good fit (CFI=0.968, TLI=0.951, RMSEA=0.09). Compliance & Technology emerged highest in RII ranking (avg. 99.1%), pointing to systemic code-enforcement failures and limited analysis software deployment as underlying reasons. Empirically and through local case scenarios, the findings link omissions to environmental degradation (over-reliance on timber and material inefficiency), reduced service life (cracks, settlement, risk of collapse), and ethical-legal-social pathologies (harm to public safety and trust and to societal governance). The findings call forth specified reforms: intensified code enforcement and inspection regimes and anti-corruption and permitting clarity and professional capacity-building and life-long professional education and training and greater analysis software adoption and quality testing and policy support in sustainable approaches and products.

5. CONCLUSION AND RECCOMENDATIONS

The findings of this study emphasize that the lack of structural analysis in Burundian reinforced concrete constructions is not a solo problem but a signal of system-wide technical, institutional, and environmental defects in the construction sector. The defects on their own compromise safety, shorten the lifespan of buildings, and accelerate environmental degradation. Following an in-depth analysis of the empirical evidence and their sustainability consequences, it is now important to present an overview of the significant findings, highlight their broader application, and offer practical recommendations. The following section presents the key inferences derived from the exploration and advises applicable strategies to be undertaken by professionals, policymakers, and stakeholders to achieve safer, longer lasting, and sustainable Burundian constructions.

5.1 CONCLUSION

This study examined what happens to the long-term structural integrity of buildings in Burundi when structural analysis is omitted from reinforced concrete designs. It demonstrated that this lack of responsibility in planning results in technical, environmental, and financial issues within the construction industry. Due to shortages of funding, professional expertise, or strict regulations, structural analysis is often excluded, despite being part of the assurance of safe, well-performing designs. This is especially concerning in developing countries like Burundi, where resources are limited and construction policies are frequently not enforced.

Through a well-structured questionnaire survey, the study identified 14 key effects of neglecting structural analysis. These effects were grouped into five influential factors, such as risks to structural integrity, material and environmental inefficiency, non-compliance with codes of practice, lack of modern technology, decreased hazard resilience, and material and economic waste. The RII analysis showed that the most common problems were lack of code compliance (IRI=99.1%), reduced hazard resilience (IRI=92%), and the risk of building collapse (IRI=89.1%). These quantitative findings confirm that neglecting structural analysis significantly impacts the sustainability of buildings.

The survey revealed that 64% of owners observed cracks and settling in their buildings. Most engineers and construction contractors reported that frequent repairs, rebuilding, and reconstruction were caused by inadequate or nonexistent structural design. Moreover, the report pointed out that indirect but significant effects included a higher carbon footprint from frequent repairs, wasteful material use, and a decline in investor confidence. These survey results highlight the need to promote building design practices that incorporate technical excellence with environmental sustainability.

This research contributes to existing literature by demonstrating how the absence of structural analysis leads to sustainability issues in building construction. This is supported by actual data and case studies from cities in Burundi. Unlike previous studies, it emphasizes structural analysis as a key factor contributing to long-term threats, rather than just examining the general causes of building failure. The factor-based approach used in this research can also serve as a model for similar cases in other developing countries.

While the importance of structural analysis has been established in international literature, this study's contribution is to detail how systemic failings- particularly, but not limited to, shortcomings in structural analysis- manifest in Burundi. Among the greatest threats to sustainability are deficiencies in technical competency and material quality, with excessive timber scaffolding use and ineffective building code enforcement closely following (99,1% importance index). Empirical evidence supports this. These findings surpass general claims by providing site-specific, data-driven insights relevant to international discussions on sustainable construction in resource-limited settings, as well as to proposed policy reforms.

5.2 RECOMMENDATIONS

From these findings, it is apparent that the omission of structural analysis among other system defects jeopardizes sustainability in Burundi reinforced concrete construction. For these challenges to be addressed, the following are necessary recommendations:

a. Based on these results, the national and regional governments should incorporate structural analysis into RC building code applications,

b. Training programs for professionals need to be updated so that engineers and architects can utilize new analytical tools and programs,

c. Sustainable activities can further be promoted by raising awareness among people and encouraging them to follow the rules and consistently incorporating structural analysis into the design of RC buildings would make the structures safer, less harmful to the environment, and more sustainable for the Burundi construction industry.

d. Burundi's construction industry should move away from traditional wood-based formwork and scaffolding to recyclable metal options as part of sustainable building practices, reducing the environmental impact of wood usage. Metal systems, for instance, are more durable, safer, and ultimately save money over time, all while significantly decreasing deforestation. India's use of steel modular formwork in cities, for example, reduced construction waste by over 70% and accelerated project timelines [139].

e. Offering tax breaks or reduced import levies on sustainable building materials to encourage the shift. Tax incentives in Rwanda, for instance, have been effective in attracting sustainable building materials [140].

f. Specifying how to incorporate sustainable materials into Burundi's national building code, similar to South Africa's SANS 10085-1 scaffolding code, would make enforcement easier and better align it with international standards [141].

g. Practical training for builders and contractors on how to operate and maintain metal scaffolding systems is essential. Trade schools and technical programs can deliver this training. For example, the TVET program in Ethiopia includes green building training in its national curriculum [142].

h. Public-private partnerships should be established to promote local manufacturing and leasing options, making metal systems more accessible and user-friendly.

i. Public-private partnerships should be established to promote local manufacturing and leasing options, making metal systems more accessible and user-friendly.

This study relies on the perspectives and experience constructions of experts rather than actual project-level case studies. The resulting defect sustainability correlations are based on expert opinions supported by published research, rather than real-time observations of building performance. It provides useful information about how systemic challenges are perceived and valued in Burundi. However, future research should include survey-based

results along with in-depth project audits, structural analyses, and longitudinal case studies. This would make it possible to more accurately confirm cause-and-effect relationships as presented here and to better understand how specific challenges influence quantifiable sustainability outcomes.

This research provides local empirical data on construction defects in Burundi, categorizing them into systemic causes, observable behaviors, and sustainability impacts, and uses statistical analysis to rank these challenges. This systematic approach offers Burundi valuable recommendations and insights that can be applied to other developing countries. When case studies from different nations are compared with similar social, economic, and environmental conditions, broader conclusions can be drawn. Additionally, more research should explore how cost-effective structural analysis technologies might be integrated into local building practices and how often small construction companies use them. It would also be useful to examine how effectively laws and educational programs aim to improve engineering design practices. This knowledge could help make building construction more sustainable.

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APPENDIX

A.1 SELF-ADMINISTERED QUESTIONNAIRE

This questionnaire is intended to collect data

Section A: GENERAL INFORMATION (Optional)

1. Age
    a. Under 25 ☐
    b. 25-35 ☐
    c. 35-45 ☐
    d. +45 ☐
2. Gender
    a. Male ☐
    b. Female☐
    c. Other☐
3. Profession in the Construction
    a. Engineer ☐
    b. Architect ☐
    c. Contractor ☐
    d. Policy Maker ☐
    e. Other ☐
4. Years of experience in Construction
    a. 0-5 ☐
    b. 5-10 ☐
    c. 10-20 ☐

d. 20-50 ☐

e. +50 ☐

5. Place of Main Practice: _____

SECTION B: GENERAL QUESTIONS FOR THE CONSTRUCTION INDUSTRY IN BURUNDI

1. How is the current state of the construction sector in Burundi? Quel est l'état actuel du secteur de la construction au Burundi ?

    a. Developed ☐

    b. Developing ☐

    c. Non-Developed ☐

2. What is the main challenge faced by the construction sector in Burundi?

    a. Financial Constraint ☐

    b. Lack of experienced Personnel ☐

    c. Lack of Modern Technology ☐

    d. Inadequate Quality of Materials ☐

    e. Inadequate Construction Management ☐

3. What are the main technologies and Innovations used in the Construction industry in Burundi?

    a. Building Information Modeling ☐

    b. Prefabrication and Modular Construction ☐

    c. Advanced Materials and Construction Techniques ☐

    d. Digital Construction Tools ☐

    e. Green Building and Sustainable Design ☐

4. How many construction projects that have not undergone structural analysis have you already completed?
    a. 0-5 ☐
    b. 5-10 ☐
    c. 10-20 ☐
    d. 20-50 ☐
    e. +50 ☐
5. Have you ever witnessed or experienced a building collapse or any other damage?
    a. No ☐
    b. Yes ☐
6. The collapse or damage that you Experienced would be due to what?
    a. Quality of Materials ☐
    b. Ignorance of Structural Analysis ☐
    c. Geographical Condition ☐
    d. Insufficiency of Means for Building Owners ☐
    e. Insufficient Knowledge for Construction Personnel ☐
7. What is the long-term effect of neglecting structural analysis on the sustainability of buildings in Burundi?
    a. Increased Repair and Maintenance Costs ☐
    b. Safety Risks ☐
    c. Legal and Liability Concerns ☐
    d. Reduced Durability and Resilience ☐
    e. Public Health and Social Implications ☐

8. . Are there any specific challenges related to the quality of construction materials used in reinforced concrete in Burundi?

    a. Cost Considerations ☐

    b. Availability ☐

    c. Quality Control ☐

    d. Poor Quality ☐

    e. Standards Compliance ☐

SECTION C : CORE QUESTIONS ON STRUCTURAL IMPACTS

Please rate the frequency or severity with which the following issues occur in the Burundian construction Sector, using the scale below:

- 1 = Very High
- 2 = High
- 3 = Moderate
- 4 = Low
- 5 = Very Low

No.	Impact	1	2	3	4	5
1	Inaccurate Reinforcement Placement	☐	☐	☐	☐	☐
2	Increased Probability of Building Collapse	☐	☐	☐	☐	☐
3	Poor Energy Efficiency due to Structural Deficiencies	☐	☐	☐	☐	☐

4	Load Bearing Capacity eduction	☐	☐	☐	☐	☐
5	Increased Carbon Footprint from Frequent Repairs	☐	☐	☐	☐	☐
6	Weak or Overloaded Structural Members	☐	☐	☐	☐	☐
7	Increased Risk of Structural Failure or Collapse	☐	☐	☐	☐	☐
8	Lack of Compliance with Building Codes and Standards	☐	☐	☐	☐	☐
9	Limited Use of Modern Analysis Technologies	☐	☐	☐	☐	☐
10	Reduced Resilience to Environmental Hazards	☐	☐	☐	☐	☐
11	Negative Impact on Sustainable Building Certification	☐	☐	☐	☐	☐
12	Waste of Construction Materials Due to Failures	☐	☐	☐	☐	☐
13	Lower Return on Construction Investments	☐	☐	☐	☐	☐
14	Risk of Cracks and Settlement	☐	☐	☐	☐	☐

SECTION C: ADDITIONAL COMMENTS (Optional)

Please use the space below to share any further insights on structural challenges in construction projects in Burundi: _____

A.2 DECISION OF THE ETHICS COMMITTEE OF ALTINBAŞ UNIVERSITY

Date and Number of Documents: 11.08.2025-83028

ALTINBAS UNIVERSITY

T.R
ALTINBAŞ UNIVERSITY PRESIDENT'S OFFICE
Altınbaş University Rectorate
Institute of Graduate Studies

2025 AİLE YILI

Number : E-96136591-100-83028 11.08.2025
Subject : Decision of the Ethics Committee of Altınbaş University

TO WHOM IT MAY CONCERN

Regarding the research survey entitled "The Impact of the Omission of Structural Analysis in Reinforced Concrete on Sustainability in Construction in Burundi", to be supervised by Prof. Dr. Sepanta Naimi, the Ethics Committee has reviewed the proposal and found no elements contrary to ethical principles.

Accordingly, it has been decided that the research may proceed as proposed.

Assoc.Prof. Doğu Çağdaş ATİLLA
Dean of Institute of Graduate Studies

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Evrak Tarih ve Sayısı: 11.08.2025-87755

ALTINBAŞ ÜNİVERSİTESİ
BİLİMSEL ARAŞTIRMA VE YAYIN ETİK KURUL TOPLANTISI
KARAR TUTANAĞI

Toplantı No: 2025/17
Toplantı Tarihi: 06/08/2025
Toplantı Yeri: Çevirim içi

Kurul Başkan ve Üyeleri:
Prof. Dr. Saim KILIÇ -İşletme Fakültesi/Öğretim Üyesi- Başkan
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Prof. Dr. Yasa EKŞİOĞLU ÖZOK- Mühendislik ve Mimarlık Fakültesi/Öğretim Üyesi- Üye
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Dr. Öğr. Üyesi Yalda HEKMATSHOAR -Tıp Fakültesi/Öğretim Üyesi -Üye
Dr. Öğr. Üyesi Cansu KÖSEM IŞIK -İletişim Fakültesi/Öğretim Üyesi -Üye
Doç. Dr. Hakan KAYGUSUZ- Araştırma Dekanı/Dekan- Üye

Kararlar:

1. Mühendislik ve Doğa Bilimleri Fakültesi'nde görev yapmakta olan **Prof. Dr. Sepanta Naimi**'nin "*The Impact of the Omission of Structural Analysis in Reinforced Concrete Related to the Sustainability on Construction in Burundi*" adlı araştırması kapsamında anket yoluyla veri toplama önerisi görüşüldü. Araştırmanın bilimsel içeriği, metodolojisi, orijinalliği ve kaynakları etik onay kapsamı dışında olup, başvuru sahibinin sunduğu belgeler ışığında "belirtilen yöntemle veri toplamada ve araştırma yapmada herhangi bir sakınca bulunup bulunmadığı" hususuyla ilgili değerlendirme yapıldı. Bu yönüyle yapılan değerlendirmede, araştırma önerisinde etiğe aykırı bir unsur tespit edilmediğinden uygun bulunmasına ve Rektörlük Makamına arz edilmesine karar verildi.
2. [redacted]

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