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ADDIS ABABA UNIVERSITY COLLEGE OF BUSINESS AND ECONOMICS SCHOOL OF COMMERCE

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A Thesis submitted to Addis Ababa University, School of Commerce in partial fulfillment of the requirements of the degree of Master of Arts in Project Management (MAPM)

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Addis Ababa, Ethiopia

RISK FACTORS IMPACTING SUSTAINABLE CONSTRUCTION PROJECT PERFORMANCE: THE CASE OF EAST AFRICA SPECIALIZED ENGINEERING PLC (EASE) IN ETHIOPIA.

By Bezawit Tesfaye

Approved by Board of Examiner

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Internal Examiner	Signature	Date
External Examiner	Signature	Date

Declaration

I hereby declare that the project thesis entitled "*Risk Factors Impacting Sustainable Construction Project Performance: The Case of East Africa Specialized Engineering PLC (EASE) in Ethiopia."*, has been carried out by me under the guidance and supervision of Seifu M. (Ph.D.). This is to certify that this research project report is my original work and has never been presented for a degree or any other academic award in this or any other university.

Researcher's Name	**Signature**	**Date**
Bezawit Tesfaye	________________	________________

Certificate

This is to certify that the thesis entities “*Risk Factors Impacting Sustainable Construction Project Performance: The Case of East Africa Specialized Engineering PLC (EASE) in Ethiopia*”, submitted to Addis Ababa University School of Commerce for the award of degree in Master of Project Management and is a record of bona fide research work carried out by Ms. Bezawit Tesfaye, under my guidance and supervision. Therefore, I hereby declare that no part of this thesis has been submitted to any other university or institution for the award of any degree or diploma.

Advisor Name	Signature	Date
Seifu M. (Ph.D.).	__________________	__________________

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List of Acronyms and Abbreviations

- CIB- Conseil International du Bâtiment
- CMAA- Construction Management Association of America
- EASE- East Africa Specialized Engineering PLC
- EPCM- Engineering, Procurement, and Construction Management
- GDP- Gross Domestic Product
- HVAC- Heating, Ventilation, and Air Conditioning
- IEQ- Indoor Environmental Quality
- LCA- Life Cycle Assessment
- MLR- Multiple regression
- OLS- Ordinary Least-Squares
- PM- Project Manager
- PMBOK- Project Management Body of Knowledge
- PRM- Project Risk Management
- RII- Relative Importance
- RBS- Risk breakdown structure
- SPSS- Statistical Package for Social Sciences

ABSTRACT

Ethiopia's construction industry is crucial for the nation's economy, with billions of Birr annually. Sustainable construction aims to minimize environmental impacts while delivering economic benefits. However, these projects face unique uncertainties due to the rapid development of sustainable techniques and technologies. This study aims to identify and analyze risk factors influencing the performance of sustainable building projects. The study used primary and secondary data, including questionnaires and interviews, and the construction industry's annual reports. The study population was selected using cencus inquiry. The study design is quantitative and explanatory. 80 responses were gathered from 94 disseminated surveys. Descriptive and inferential data analysis methods were applied. The findings showed that all identified predictors (material and technology risks, stakeholder risks, technical risks, management risks, and regulatory and economic risks) have a significant relationship with project performance, with the five independent factors having a combined 38.7% influence. It is advised that East Africa Specialized Engineering PLC (EASE) endeavor to reduce the likelihood of these risk variables materializing to improve project performance.

***words**: project performance, Sustainable Construction Project, Risk, Risk analysis, Risk identification*

CHAPTER ONE

1. INTRODUCTION

1.1. Background of study

The construction sector plays a significant role in contributing to uplifts in economic stability by generating employment and providing standardized social development. (Wesam Salah Alaloul, 2022) However, The construction industry is a massive consumer of raw materials and natural resources, and it generates an estimated 39% of the world's carbon emissions according to the World Green Building Council.it is also a major contributor to environmental degradation and resource depletion. Sustainable construction practices aim to minimize these negative impacts while ensuring project success. Identifying and managing risks associated with sustainable construction projects is crucial for their successful implementation (Kibert, 2016).

Sustainable building construction entails planning, building, and maintaining structures to reduce environmental impact, promote equitable distribution of resources, and assure long-term economic sustainability (BREEAM, 2016). With rising concerns about climate change, resource shortages, and urbanization, sustainable construction is critical to tackling global challenges (UNEP, 2007). Sustainable construction contributes to global sustainability goals by promoting resilient and sustainable growth. Building sustainably is not a transitory fad; rather, it reflects a fundamental shift in the design of built environments. By incorporating sustainability concepts into every phase of construction, stakeholders can reduce their adverse environmental impacts, increase societal well-being, and contribute to the global effort toward addressing important concerns such as resource depletion and climate change. (UNEP, 2007)

In parallel, the construction sector has experienced an increased emphasis on risk management, particularly in projects that incorporate sustainable methods. Such initiatives require comprehensive risk management solutions that are adapted to their specific challenges. Although sustainable construction projects and systems have many environmental benefits, they also pose financial and technical risks due to initial investment costs and technological advances limits. Using ecologically friendly materials may provide unique obstacles due to considerations like as availability, compatibility with other building materials, and durability, which influence selection. Furthermore, complying with environmental regulations is critical to avoiding fines, penalties, and project delays. Challenges such as the selection and performance of eco-friendly materials, adherence to environmental standards, and integration of renewable energy systems highlight the need for specialised risk management approaches (Kibert, 2016).

Risk remains an inherent problem in the construction sector, effecting project objectives like as adhering to schedules, controlling costs, and maintaining safety and quality standards (Wang, et al., 2004). Research has found a variety of risk variables across areas and countries, underlining the crucial need of confronting these risks to ensure project success. It also recognizes that project stakeholders, such as owners, contractors, designers, and regulatory agencies, must collaborate in a proactive and integrated manner to efficiently control construction risks. Stakeholders may successfully reduce interruptions, maximize project outputs, and improve overall project success by using a systematic approach to risk identification, assessment, and management throughout the project lifecycle. (El-Sayegh, 2008; Shen, 1997; Zou, P., Zhang, G., & Wang, J., 2007; Perera, B., Rameezdeen, R., Chileshe, N., & Hosseini, M., 2014).

Recent empirical studies have explored various aspects of sustainable construction and its associated risks, yielding insights into common challenges and potential strategies to overcome them. For instance, a study by (Hwang, Ng, and Shan, 2017) highlighted the financial risks in adopting green technologies, citing the high initial costs and longer payback periods as significant barriers. Another study by (Kibert, 2016) found that the use of eco-friendly materials could introduce technical risks due to issues such as availability, compatibility, and durability.

Furthermore, research by (Zou, Zhang, and Wang, 2007) emphasized the importance of effective risk management in the construction sector, noting that project delays, cost overruns, and safety incidents are common risk outcomes. In sustainable construction, these risks are exacerbated by the added complexity of integrating renewable energy systems, ensuring compliance with environmental standards, and maintaining high-quality outcomes (El-Sayegh, 2008).

Despite the growing body of research on sustainable construction, there remain gaps in understanding how these risks impact project performance, especially in the context of developing countries like Ethiopia. The majority of studies focus on developed countries, where regulatory frameworks and resource availability differ significantly. This leads to a research gap: there is limited empirical data on the risks and challenges faced by sustainable construction projects in developing countries and how these risks affect project success in terms of time, cost, and quality.

This study aims to fill the existing research gap by offering insights into the specific risks faced by sustainable construction projects in Ethiopia and how they affect project performance focusing on East Africa Specialized Engineering PLC (EASE) as a case study. The findings are expected to contribute to the broader understanding of sustainable construction in developing countries and inform better risk management practices in the industry

1.1.1 Background of the Organization

EASE Engineering Management and Trade PLC, a Grade I construction company based in Addis Ababa, Ethiopia, has been a significant player in the construction industry for over three decades. The company has diversified its services to include Engineering, Procurement, and Construction Management (EPCM), as well as design and technology. EASE is driven by a vision to deliver large-scale construction projects both in Ethiopia and internationally, emphasizing timely completion, client satisfaction, and continuous improvement in quality and production capabilities.

In recent years, the construction industry has faced increasing pressure to adopt sustainable practices to meet environmental and regulatory demands. As part of its commitment to innovation and sustainability, EASE has integrated post-tensioning technology into its projects to reduce reliance on traditional reinforcement materials, lower costs, and improve structural integrity. Notable projects utilizing post-tensioning include the renovation of the Omo River Bridge and the construction of a 33-meter bridge elevated 70 meters above ground level for Elilta Real Estate.

Despite these advances, the adoption of sustainable practices can introduce new risks and challenges. This research aims to examine these risks and understand their implications for project performance.

Through this study, EASE seeks to balance its commitment to sustainable construction with the need for efficient and successful project delivery. The findings will help EASE and other stakeholders in the construction industry to better understand the trade-offs and opportunities presented by sustainable construction practices, enabling more informed decision-making in future projects.

1.2. Statement of the Problem:

The construction sector is a complex ecosystem fraught with risks and obstacles that significantly affect project outcomes and hinder the industry's overall expansion. Numerous studies (Faridi A, El-Sayegh S. , 2006; Robichaud L, Anantatmula V., 2011) have demonstrated that these challenges encompass a wide range of issues, including schedule delays, cost overruns, quality defects, and safety hazards. These problems are exacerbated by rapid urbanization and economic growth, which exert immense pressure on the construction industry. The increasing demand for substantial infrastructure development occurs amidst scarce resources, intricate institutional dynamics, and regulatory frameworks, further complicating the situation (Faridi A, El-Sayegh S. , 2006; Wang, et al., 2004).

Sustainable construction projects face an additional set of challenges related to green building techniques and eco-friendly design solutions (Robichaud L, Anantatmula V., 2011) .The path to sustainability is lined with obstacles, such as procuring sustainable materials and adhering to stringent green building regulations. Moreover, there is uncertainty about the long-term performance and maintenance of these eco-friendly structures, posing new challenges for project stakeholders (Kibert, 2016). Despite a growing global awareness of these issues, there is a noticeable lack of thorough studies explicitly addressing the unique risk factors inherent in sustainable construction projects.

The construction industry in Ethiopia is experiencing rapid growth driven by government infrastructure projects and urbanization. Despite an increasing awareness of the need for sustainable practices, their implementation remains limited due to the associated risks. This study aims to identify, analyze, and mitigate these risks, providing stakeholders with targeted risk management strategies to enhance project resilience and optimize outcomes. Sustainable construction in Ethiopia faces unique challenges due to scarce resources, complex institutional dynamics, and regulatory frameworks. Understanding these challenges can offer insights into developing sustainable practices tailored to the Ethiopian context.

Current research has primarily focused on general industrial challenges, neglecting a detailed examination of the complex risks associated with sustainable building projects (Faridi A, El-Sayegh S. , 2006; Robichaud L, Anantatmula V., 2011). Therefore, there is a pressing need to identify, analyze, and mitigate the risk factors inherent in sustainable construction projects in Ethiopia. By gaining a thorough understanding of these unique challenges, stakeholders can develop targeted risk management strategies that enhance project resilience, optimize outcomes, and foster long-term growth in the construction industry (Wang, et al., 2004; Kibert C, 2016).

This study investigates the impact of various risk factors on project performance in sustainable construction projects conducted by East Africa Specialized Engineering PLC (EASE). These factors include higher than anticipated operating expenses, conflicting standards, construction schedule and cost impacts, failure to meet green code requirements, materials with reduced life cycles, and damage to environmental reputation. High operating expenses refer to unexpected increases in energy, water, and maintenance costs, while conflicting standards involve challenges in aligning with sustainability standards and regulations. Construction schedule and cost impacts encompass delays and cost overruns, including those in green buildings. Non-compliance with green building codes and certification requirements can lead to project delays, rework, and legal disputes. Materials with reduced life cycles affect project quality and durability, while reputational damage can undermine stakeholder trust and future business opportunities.

By addressing these specific risk factors, the research aims to foster long-term growth and sustainability in the construction industry, ensuring that the increasing demand for infrastructure and housing is met in an environmentally responsible and economically viable manner. The study provides a comprehensive analysis of the various risk factors affecting sustainable construction projects, aiding stakeholders in making informed decisions and developing strategies to mitigate these risks. By mitigating the identified risks, the study aims to improve project performance, thereby enhancing stakeholder trust and future business opportunities for companies like East Africa Specialized Engineering PLC (EASE). This is crucial for promoting sustainable construction practices in Addis Ababa and beyond.

Ultimately, this research aims to guide construction practices in Addis Ababa towards a more sustainable and resilient future by analyzing the interrelationship between these risk factors and their effects on project performance.

1.3 Research Questions:

1. What sustainable construction practices are currently being implemented by EASE in their construction projects?
2. How do individuals within EASE (e.g., senior managers, project managers, engineers) perceive and rank the risk factors associated with implementing sustainable construction practices?
3. What is the potential impact of these perceived risks on project performance in terms of project efficiency (time, cost, and quality)?

1.3. Objective

1.4.1. General objective

- The general objective of this research is to assess risk factors impacting performance of sustainable construction projects in **East Africa Specialized Engineering PLC (EASE)**.

The overarching aim of this research is to assess risk factors in sustainable construction projects undertaken by East Africa Specialized Engineering PLC (EASE). The study seeks to examine the types of risks that arise in the context of sustainable construction, the impact these risks have on project performance, and the perceptions of various stakeholders involved in EASE's projects.

1.4.2. Specific objective

1. To identify the main sustainable construction practices being adopted by EASE.
2. To assess and rank the risk factors associated with sustainable practices from the perspectives of individuals involved in EASE's projects (e.g., senior managers, project managers, engineers) based on their perceived impact.

3. To analyze the potential impact of these risks on project performance in terms of project efficiency (time, cost, and quality).

1.5. Significance of the study

Beyond its ability to identify and prioritize risk factors in Ethiopia's sustainable building initiatives, this research has a significant impact. The findings of the study could lead to legislation and policies that are specifically tailored for Ethiopia's environmental friendly building initiatives, with a view to addressing specific challenges faced by them. Understanding the specific risk factors influencing these projects will help policymakers manage risks more skillfully and foster an environment that is more conducive to sustainable construction practices.

Many of the same objectives like Social justice, Economic Growth and Environmental Protection, are shared between sustainability development and sustainably built buildings. This study could help to achieve these objectives if it contributes to understanding the risks of Sustainable Construction Projects. It can help project stakeholders optimize project planning, design, and execution processes to achieve positive social, environmental, and economic outcomes.

As the global construction sector places a greater emphasis on sustainability, it will help Ethiopian builders to become more competitive by developing risk management skills for sustainable building projects. Businesses can stand out from competition, attract capital and participate in profitable sustainable building projects both domestically and abroad by setting up effective risk management plans.

Finally, for all stakeholders involved in the mitigation of project delays, overruns and reputational risk, a good risk management approach can deliver long term benefits through environmentally conscious building initiatives. By anticipating and proactive risk management, stakeholders can ensure the lifetime of infrastructure investment, improve project resilience and generate a favourable return on investments during the construction phase. The study's ability to enhance the knowledge and management of risks associated with Sustainable Building Projects in Ethiopia is thus a major factor that will bring about an encouraging change in the construction sector there. By working together, being innovative, and making informed decisions, stakeholders can work together to fully realise the potential of sustainable construction to promote equitable and sustainable development in Ethiopia.

1.6. Scope of study

This research is limited to Addis Ababa, Ethiopia, where East Africa Specialized Engineering PLC (EASE) conducts sustainable construction projects. The emphasis on this particular urban context enables a thorough assessment of the unique challenges and risk variables affecting sustainable construction in the local environment.

The conceptual scope of this study encompasses the identification, ranking, and analysis of risk factors that affect the performance of sustainable construction projects. It examines various aspects of sustainability in construction operations, including management, technical, stakeholder, green material and technology, and regulatory and economic factors. The study investigates how these risks impact project performance in terms of time, cost, and quality. The study's goal is to provide a comprehensive understanding of the potential and problems associated with sustainable building practices.

The study uses both qualitative and quantitative methodologies. It involves major stakeholders in EASE, such as project managers, engineers, architects, senior managers, and other necessary individuals. Data will be gathered via a combination of email and social media outreach, questionnaires, and in-depth one-on-one interviews between April and May 2024. The study examines the obtained data using descriptive and inferential statistical methods, with the goal of highlighting the relationships between identified risk variables and their impact on project performance.

1.7. Potential Limitations of the Study:

There were several limitations to this study. the ability to analyze long-term trends and developments in sustainable construction projects may have been limited by the research period. Extending the observation period for a longer time could allow for a more comprehensive study coverage and a better understanding of the impact of certain risk factors or management practices.

Despite efforts to maintain objectivity in data collection and analysis, inherent biases or subjective opinions from stakeholders' standpoints, responses, or interpretations may have impacted research results. While measures were taken to mitigate bias by rigorously applying methodologies and comparing data sources, it was not possible to completely eliminate these biases.

Finally, the findings of this research, while providing insight specific to Sustainable Building Projects in EASE, Addis Ababa, may not be universally applicable across different geographic areas and contexts. The generalizability of the study's unique findings beyond the particular context of the company may be limited by socioeconomic, environmental, and institutional factors.

1.8. Organization of the Study

This study includes five chapters. The first chapter introduces the study, covering its background, the organization being studied, the problem statement, research questions, objectives, significance, scope, limitations, and key term definitions. The second chapter reviews relevant literature on project management control systems, focusing on risk management in sustainable construction projects, including theoretical, empirical, and conceptual frameworks. The third chapter details the research methodology and design, including the research approach, study variables, target population, sampling methods, data collection tools, data analysis techniques, and considerations for validity, reliability, and ethics. The fourth chapter presents and interprets the study's findings, including data presentation, analysis, and descriptive, correlation, and regression analyses. The final chapter summarizes the results, presents conclusions, and offers recommendations based on the findings, along with discussing research limitations and suggesting areas for further study.

1.9. Definition of Key Terms:

Sustainable Construction: Sustainable construction, also known as green construction or sustainable building, refers to the practice of designing, constructing, and operating buildings in a manner that minimizes environmental impact, conserves resources, promotes energy efficiency, and prioritizes the health and well-being of occupants. (Apine, 2017)

Risk Factors: Risk factors in the context of this study refer to potential events, conditions, or circumstances that may adversely affect the successful outcome of sustainable construction projects. These factors may include but are not limited to, economic uncertainties, regulatory changes, material shortages, design inaccuracies, and environmental constraints. (Beasley, M. S., Clune, R., & Hermanson, D. R., 2005)

Risk Management Practices: Risk management practices encompass the systematic identification, assessment, prioritization, and mitigation of risks within construction projects. This involves the implementation of strategies and measures to minimize the impact of potential risks on project objectives, including cost, schedule, quality, and safety. (Project Management Institute, 2017)

Project Performance Indicators: Project performance indicators are measurable criteria used to assess the success or effectiveness of construction projects. In the context of this study, key performance indicators may include cost performance, schedule adherence, quality outcomes, and safety records, which are used to evaluate the overall performance and success of sustainable construction initiatives. (Mane, 2015)

Stakeholders: Stakeholders in construction projects refer to individuals, groups, or organizations with vested interests or roles in the planning, execution, or outcomes of the project. In the context of sustainable construction projects, stakeholders may include project owners, investors, government agencies, regulatory bodies, local communities, suppliers, contractors, and end-users. Understanding stakeholder perspectives and interests is crucial for effective risk management and project success. (Neyestani, 2016)

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Theoretical framework

2.1.1 Project

There are several definitions of project in the literature. According to (Kerzner, 2017) Projects are finite, time-bound endeavors aimed at achieving unique outcomes like creating a new product or addressing a need. They require coordinated efforts and resources for effective planning, execution, and control to ensure successful outcomes.

(David I. Cleland, Lewis R. Ireland, 2006) Classify projects according to their difficulty, size, and uniqueness. Projects are classified as simple, moderate, or complex based on the level of uncertainty and interdependence involved. Furthermore, projects are classed based on their magnitude, which ranges from minor to large-scale undertakings. Furthermore, projects are classified according to their uniqueness, whether they include routine tasks or inventive solutions to specific challenges. This classification system provides a foundation for recognizing the various types of projects and adjusting management approaches accordingly. This paper‘s primary concern is construction projects, with size, application, complexity, and uncertainty having no effect whatsoever.

2.1.2. Construction project

The construction sector plays a central role in the economy of any country, providing essential structures such as public and private infrastructure and housing. Even the most advanced economies would be incapable of maintaining a high standard of living without continuous investments in infrastructure, such as for waste management, water provision, or transport. (John Page (ed.), 2020)

GDP from Construction in Ethiopia increased to 468.44 ETB Billion in 2021 from 446.72 ETB Billion in 2020. GDP from Construction in Ethiopia averaged 299.27 ETB Billion from 2012 until 2021, reaching an all-time high of 468.44 ETB Billion in 2021 and a record low of 114.42 ETB Billion in 2013.

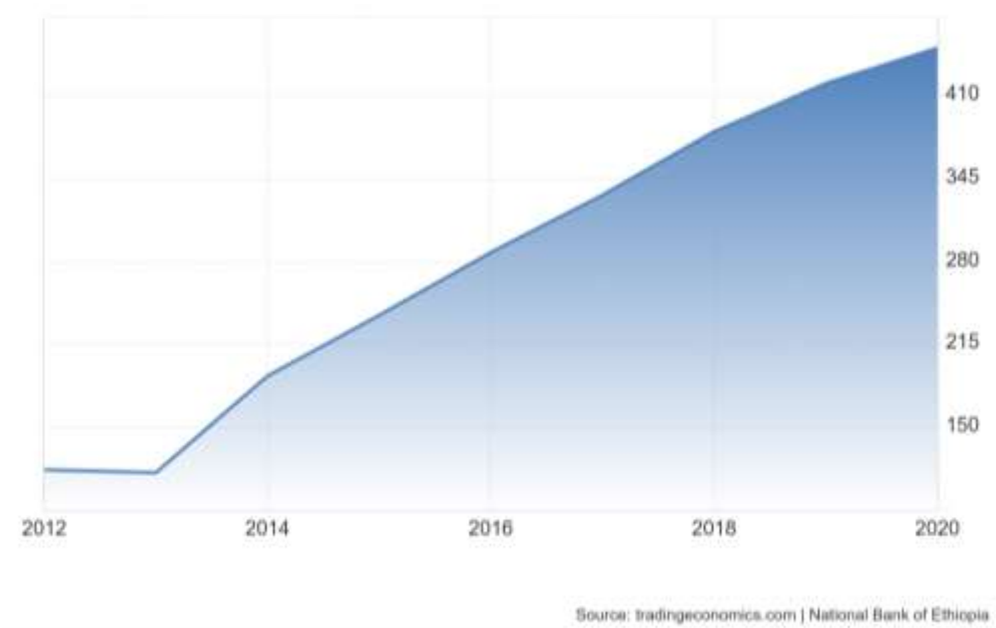


Fig. 2.1. ET GDP from Construction-ETB Billion

To be successful, every building project must be well planned. You must find the necessary resources and equipment, establish a timeframe and budget, and meet a variety of other challenging needs.

There are numerous methods for organizing your building project's phases. The Construction Management Association of America (CMAA) divides the construction project lifecycle into five stages: pre-design, design, procurement, construction and monitoring, and post-construction. (Belmont, 2023)

2.1.3. Project Management

In order to ultimately resolve and finish the project by the deadline, (Wysocki, 2019) states that project management comprises making plans, allocating roles, acquiring appropriate tools and materials, making and managing schedules, communicating information, encouraging good communication, achieving milestones, and demonstrating strong leadership abilities. Even with well-defined goals, project managers increasingly narrow the scope of their work from high-level data to detailed plans over the project life cycle. They create protocols to manage and contain changes while preparing for them (Lewis, 2022).

The goal of project management is to keep the team, procedures, and deliverables of the project on track. Effective project management makes it possible to be more predictable, increase the likelihood of success, deliver the right products on schedule, resolve issues and problems, respond promptly to risks, maximize the use of organizational resources, identify, recover from, or terminate failing projects, manage constraints, and balance the impact of constraints on various aspects of a project (Ebrahem, 2017). A project that is poorly managed or controlled, or one that is not managed at all, will inevitably result in missed deadlines, poor quality, rework, waste, uncontrolled project expansion, loss of the organization's reputation, unhappy stakeholders, and/or failure to meet project goals.

Project Management Process Group is a logical grouping of project management inputs, tools and techniques, and outputs where the activities of project management are congregated. The process groups of project management and their definitions are presented in table.

Table 2.1. Project Management Body of Knowledge (Project Management Institute, 2017)

Knowledge Area	Description
Integration Management	Focuses on coordinating all aspects of a project, ensuring that various elements work together seamlessly to achieve project objectives.
Scope Management	Involves defining, controlling, and managing what is and is not included in a project, ensuring that the project delivers the intended outcomes within the defined scope.
Time Management	Concerned with scheduling project activities, establishing timelines, and ensuring that the project is completed on time by managing resources, dependencies, and constraints.
Cost Management	Involves estimating, budgeting, and controlling project costs, ensuring that the project is completed within the approved budget while managing cost variances effectively.
Quality Management	Focuses on ensuring that project deliverables meet the required standards and satisfy stakeholder expectations through quality planning, assurance, and control processes.
Human Resource Management	Involves managing the people involved in the project, including acquiring, developing, and managing the project team to optimize individual and team performance.
Communications Management	Focuses on planning, managing, and facilitating communication within the project team and stakeholders to ensure that information is shared effectively and efficiently.
Risk Management	Involves identifying, analyzing, and responding to project risks to minimize their impact and maximize opportunities, ensuring the successful completion of project objectives.
Procurement Management	Concerned with acquiring goods and services from external vendors or suppliers, including procurement planning, solicitation, contract administration, and contract closure.
Stakeholder Management	Involves identifying, engaging, and managing stakeholders throughout the project lifecycle to ensure their needs and expectations are understood and addressed appropriately.

2.1.4. Construction Project Management

Due to their significant advantages and strategic importance to organizations, project management principles have been implemented extensively across a wide range of industries including the construction industry. According to the Project Management Institute (Project Management Institute, 2017) project management professionals need to have a variety of competences in addition to skills and general management knowledge to enable efficient project management.

Construction companies basically accomplish their objectives and carry out their plan through projects. Every construction project has distinct phases, which are depicted in the model below. These phases are typically covered in the majority of the literature that is currently available about the field of expertise.

Fig. 2.2. Construction Project phases

Over the course of a facility's life, a Construction project is the result of several expected and un expected events and interactions with various participants and processes in a dynamic environment. Construction project management is a difficult profession. One could argue that this is because building projects have a major negative influence on the local economy, ecology, and community (Hwang, B., & Ng, W. , 2013). Project managers have an obligation to minimise these effects over the course of the project. In addition to managing different resource restrictions, the project manager must also oversee a multitude of stakeholders (Jian Zuo, Xianbo Zhao, Quan Bui Minh Nguyen and Tony Ma & Shang Gao, 2017). In order to ensure the success of the project, the project manager must handle each of these difficulties.

Studies already conducted on the construction sector have demonstrated how project managers' roles are evolving and how they must carry out tasks outside the traditional scope of project management. Effective project management is facilitated by hard project management skills. However, project managers now have to handle more complicated projects and people-related problems due to globalisation and economic uncertainty. To ensure project success, it may be more important to coordinate the efforts of internal and external stakeholders than to carry out the technical aspects of the work. The efficiency of a project team plays a critical role in the construction business as it contributes to the team's capabilities, knowledge, and skills in finishing the project. (Jian Zuo, Xianbo Zhao, Quan Bui Minh Nguyen and Tony Ma & Shang Gao, 2017)

A typical Construction project has a significant number of stakeholders who are active in the project, or those whose interests may be affected by project implementation or successful completion of the project. It is not out of the ordinary for various parties to have divergent objectives and diverse visions (Project Management Institute, 2017). When it comes to sustainable construction Stakeholder groups include: (1) end users; (2) non-statutory consultees; (3) property developers and their professional advisors; (4) regulators, statutory consultees, and service providers; and (5) non-statutory consultees, interest groups, and individuals. Frequently have a significant impact on sustainable construction, making them the most influential.

Many researchers have focused on the idea of incorporating sustainability into construction. According to (Marios Stanitsas & Konstantinos Kirytopoulos, 2021) sustainability indices and performance indicators that measure sustainability performance needs to be shared even more, and it is concluded that this is the area in which researchers should focus their attention. Creating a suitable method for evaluating sustainability is crucial for building projects. After a thorough analysis of the literature, they arrive at four main conclusions that will make such a plan feasible: (1) a holistic approach to sustainability that takes into account the organisation of the product, important stakeholders, and economic considerations; (2) a limited set of indicators for realistic and affordable implementation; (3) a lifecycle concern; and (4) project focus.

(Marios Stanitsas & Konstantinos Kirytopoulos, 2021) Demonstrated the development of a set of 82 sustainable PM indicators for building projects in their study. They also highlighted the preferences of stakeholders for sustainable PM-related construction project measurements. By assigning the most suitable tasks to stakeholders who have important connections to key indicators, sustainable project management practitioners can enhance their capacity to successfully contribute and raise the sustainability of building projects even further.

2.1.5. Risk Management

In order to guarantee that stakeholder value is maintained and increased, project stakeholders call for increased oversight of the major risks confronting the project. Stakeholder value is at danger if project management procedures aren't in place to manage the enterprise's constantly shifting risk portfolio. If this goes unchecked, it could raise serious public policy issues. The goal of risk management, is to improve senior management's and the board's capacity to supervise the range of hazards that an organisation faces. Risk Management offers a substantial source of competitive advantage to those who can prove they have a strong Risk Management discipline and capability. (Beasley, M. S., Clune, R., & Hermanson, D. R., 2005)

The scope of events that threaten a project is likely to change in nature, timing, and extent as it grows in size. According to (Beasley, M. S., Clune, R., & Hermanson, D. R., 2005) larger projects may be better able to adopt risk management due to their bigger resources, in addition to their increased requirement for more effective project-wide risk management strategies. Larger projects are actually more likely than smaller businesses to implement integrated risk management procedures.

Effective risk management and the identification of threats that may have an influence on the project's scope are two factors that positively affect project outcomes. Project management requires effective risk management, and the construction sector is no exception. It is becoming more and more important because projects frequently go over budget or miss deadlines. Risks are present in construction projects from the beginning. First, it is important to assess the risks at each level, followed by the actions that might be performed and their associated costs. (Anete Apine & Francisco José Escobar Valdés, 2017)

Implementing sustainability concepts inside the deeply ingrained traditional construction industry presents challenges, regardless of the general success of the sustainable construction movement (Kibert C, 2016). The building industry grows in a setting that is constantly unstable and the market for sustainable construction projects is growing, and green rules and standards are progressing, providing the foundation for the advancement of materials and technology. As new materials and technologies are employed in the industry, risks also increase. Therefore, there is a growing need for knowledge and skill in risk management for sustainable construction projects (Anete Apine & Francisco José Escobar Valdés, 2017).

2.1.5.1. Risk Management Techniques

Construction organizations in various nations use a variety of risk management approaches to address the risks discussed in the preceding chapter, as no single solution is appropriate for every case. Several techniques used in the risk management process can be identified, including brainstorming, checklist, sensitivity analysis, and risk register; these techniques can then be used in two different situations to address risks: preventive and remedial actions. (Iqbal, 2015) This will depend on whether the risk is known or unknown, as explained in the preceding chapter. All of the strategies can be divided into two distinct: quantitative and qualitative.

a. Qualitative Risk Management Approach

The qualitative risk management strategy addresses risk likelihood and impact on project objectives (PMBOK, 2008). As an initial phase, assessing important risks and creating a risk register is typically a faster and less expensive risk response plan. The qualitative risk management process begins with inputs such as the risk register, risk management plan, project scope statement, and organizational process assets. For such inputs, the methods and techniques widely used in qualitative risk management are risk probability and impact assessment, probability and impact matrix, risk data quality assessment, risk categorization, risk urgency assessment, and expert judgement. After applying all the tools of the qualitative risk management approach, the output is an Updated Risk Register, (PMBOK, 2008) which can be used further on in a quantitative approach.

b. Quantitative Risk Management Approach

Quantitative risk management involves a numerical assessment of the project's risks. This technique enables more complex data collection and risk management. Normally, the quantitative strategy follows the qualitative approach because it already incorporates only the most critical hazards. Quantitative risk management uses the following inputs: risk register, risk management plan, cost management plan, schedule management plan, and organizational process assets. (PMBOK, 2008) suggests the following tools and approaches for quantitative analysis: data collection and representation techniques, quantitative risk analysis and modeling techniques, and expert judgment. As previously mentioned, one strategy complements the other. A qualitative approach, followed by a quantitative approach, should be considered for effective risk management within a project.

2.1.5.2. Risk Management Process

According to the Project Management Body of Knowledge (PMBOK), the risk management process includes specific parts during project management. These steps include: planning risk management, which involves developing a risk management plan and strategy; Identify hazards by categorizing them, identifying their causes, and creating the first risk register. Perform qualitative risk analysis, where the chance of occurrence and the severity of each risk are appraised qualitatively, and the risk register is updated; execute quantitative risk analysis, where the incidence and severity before analyzed is given a quantitative value, and then the register is updated; Plan risk responses, where a risk response plan is created based on the risk register evaluation; Monitor and control hazards, where corrective and preventive measures are indicated. These processes are relatively general because they are only a guide for how risks can be addressed inside projects; yet, they allow for more specific industry details and provide guidance for project risk management.

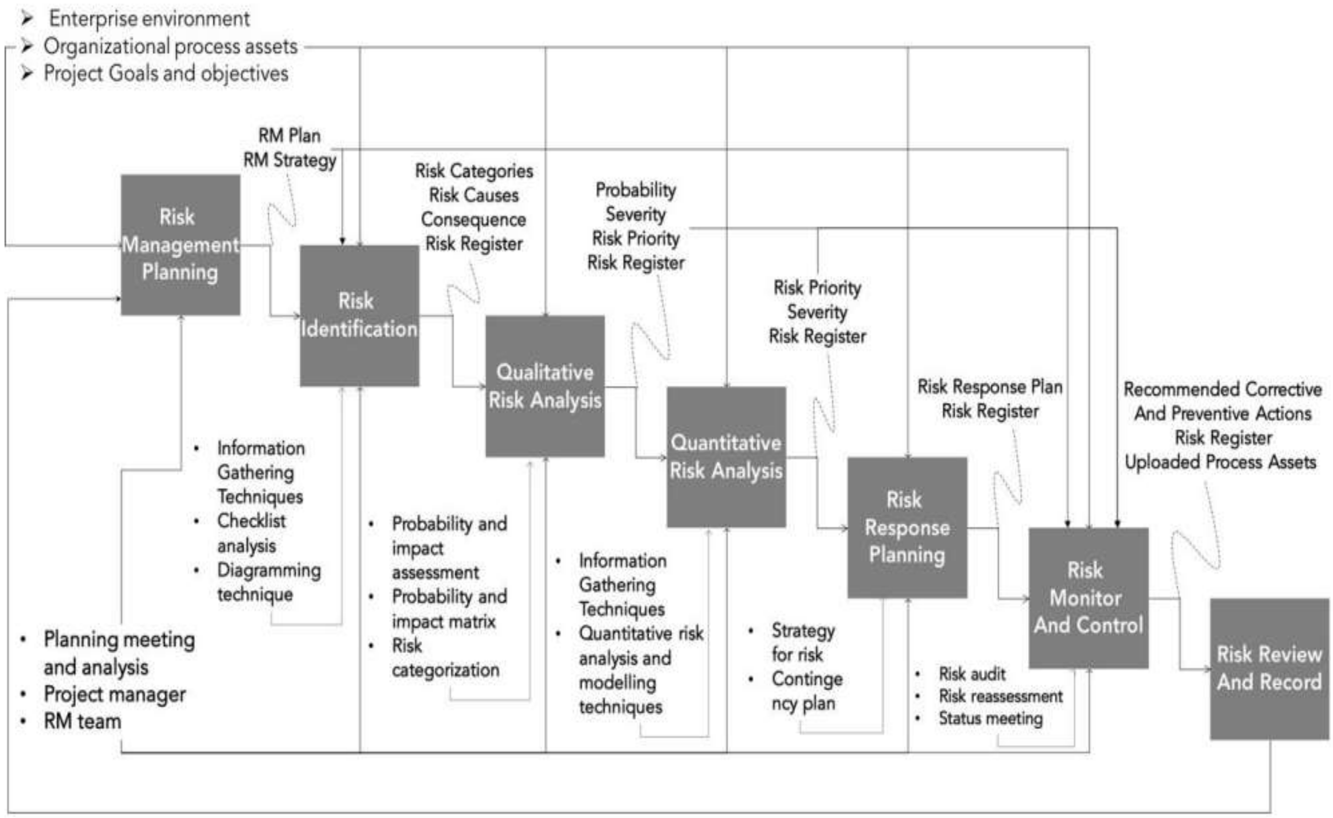


Fig. 2.3. Risk Management Process

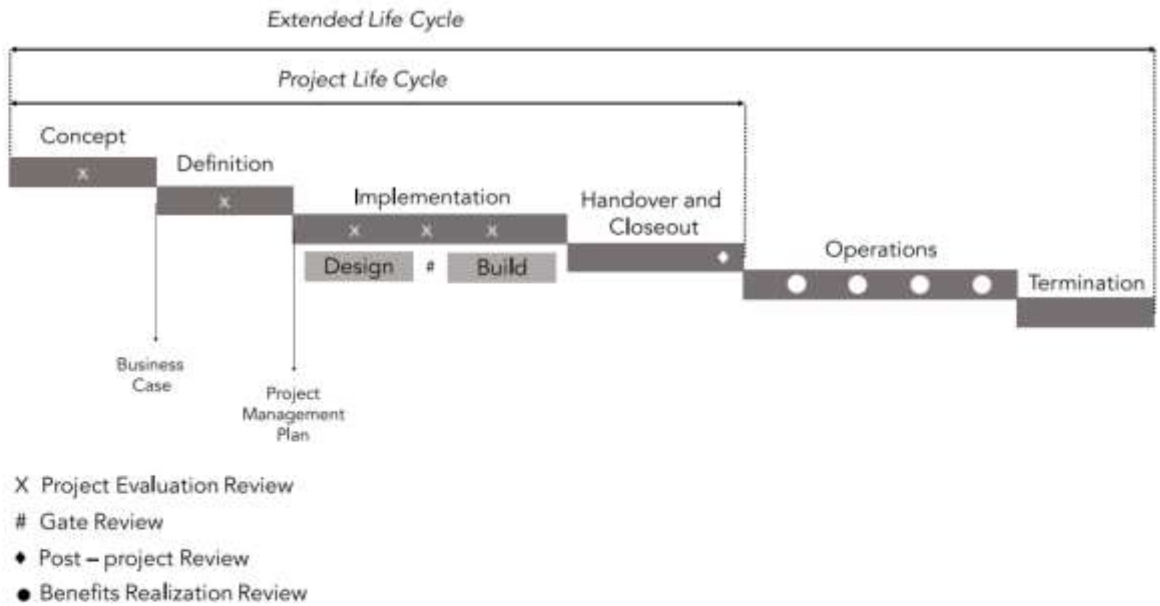
2.1.5.3. Project Risk Management Within the Project Life Cycle

a) Project Life Cycle and Project Extended Life Cycle

Projects are seen as a finite endeavor which end with the delivery of its final result or product to the owner, investor, marketer or user in accordance with the project contract or charter (Archibald D, 2012)

From this view, the project life cycle ends when the project closes out phase is complete. Later on, at the moment that the product begins to be used, sold or placed in operation producing benefits a product life cycle can be described. There can be an overlap between the standard project close out and the operation of the product extending this way the project life cycle (Archibald D, 2012).

Fig. 2.4. A second "standard" project and extended life cycle model. (Anon., 2006, p. 80)



b) Project Risk Management Loop of Control

According to (Elkjaer, 1999), it is suggested to perform a Project Risk Management (PRM) Loop of Control at the end of each project phase or when required by major change of circumstances. The beginning of a new phase of the project, for example, site mobilization, is a new round of risk identification, assessment and so on as described in the PRM Loop of Control. The PRM Loop of Control is a comprehensive model consisting of guidelines described within the project risk management. The PRM Loop of Control illustrates a dynamic and continuous process in which risks are continuously reassessed until they are prevented, reduced or accepted. The PRM Loop of Control can be divided into four different phases: identification, assessment, response, and monitoring.

The identification phase is the most critical to a successful risk management approach; risks that are not detected cannot be managed. For the next phase, risks can be quantified through an assessment of probability and impact (Caron, 2013) . “The standard perception of quantification is that probability multiplies impact result in the risk level” . The risk level can be measured in quantified or qualified units, meaning that either percentages or monetary units can be used. Further a response is needed; the purpose of the response phase is choosing a risk strategy, which can be acceptance, reduction, elimination or transfer. The last phase of the PRM Loop of Control is monitoring which encompasses documentation and reassessment of the risks in order to make sure that the right action has been taken to prevent these risks. Monitoring phase is aimed to ensure that risk register with potential risks is updated in all times and the responsibility is defined (Elkjaer, 1999).

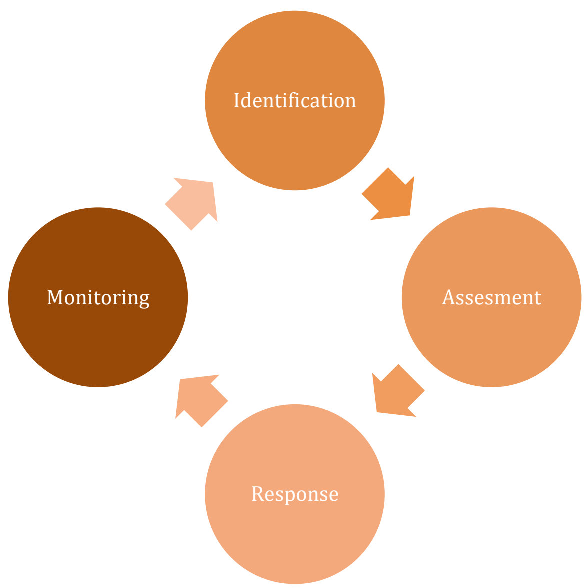


Fig. 2.5. Project Risk Management (PRM) Loop of Control (Elkjaer, 1999)

2.1.6. Sustainable Construction Projects

The term “sustainable construction” was first proposed to describe the responsibility of the construction industry in achieving sustainability. (Hill, 1997) “With the increasing necessity for resource efficiency and climate change adaptation, there is a need to implement sustainable principles and practices in construction projects” (Nnamdi MADUKA, 2016)This has driven the construction industry in the development of new technologies, from modern designs to revolutionary materials and new construction practices; that way, new concepts in the built environment have been introduced such as: sustainable construction, green buildings and high-performance buildings. It is necessary to make some distinctions in concepts commonly used in the built environment regarding sustainability. The terms: high-performance buildings, green buildings, and sustainable construction, are often used interchangeably and because of this, confusion among the terms occurs. Many authors in the sustainable construction area do not distinguish these terms, hence using them as one. makes this distinction; the term sustainable construction addresses the ecological, social and economic issues of a building in the context of its community (Kibert, 2016). In 1994 the Conseil International du Bâtiment (CIB), an international construction research networking organization, defined sustainable construction as “creating and operating a healthy built environment based on resource efficiency and ecological design”. The term green buildings refer to the quality and characteristics of the actual structure created using the principles and methodologies of sustainable construction. Green buildings can be defined as “healthy facilities designed and built in a resource-efficient manner, using ecologically based principles”. A high-performance commercial building “uses whole-building design to achieve energy, economic, and environmental performance that is substantially better than standard practice”. This requires full collaboration between design specialties from the project’s inception, thus, creating an integrated design. Wholebuilding, or integrated design considers site, energy, materials, indoor air quality, acoustics, and natural resources, as well as their interrelation with one another (Kibert, 2016)

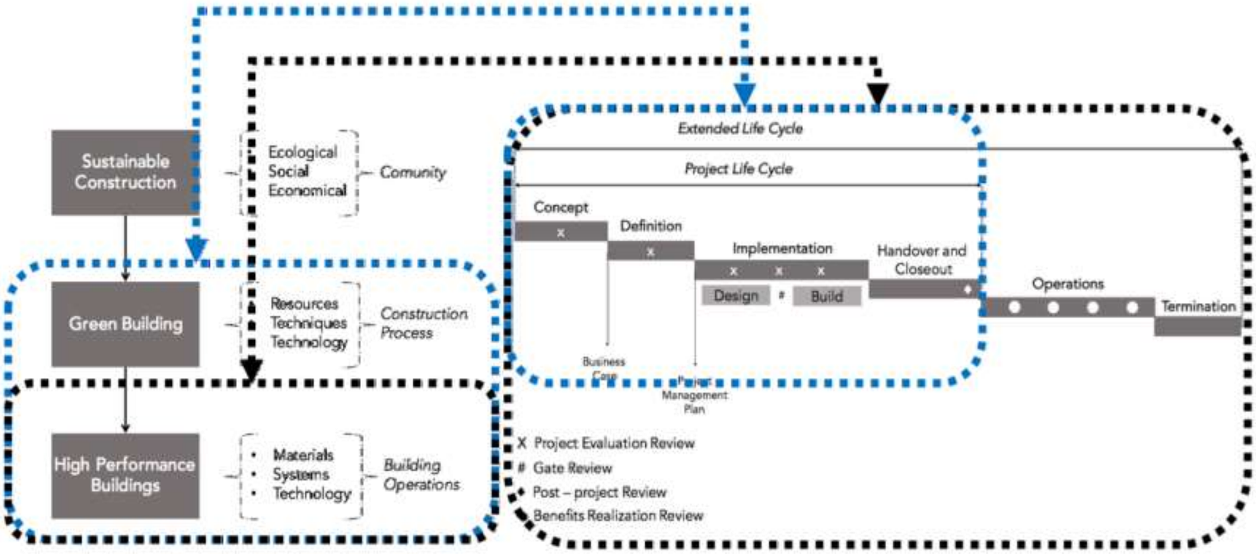


Fig. 2.6. Model for sustainable construction projects. (Apine, 2017)

2.1.6.1. An In-depth Exploration to Green Building

Green building, also known as sustainable design or high-performance building, embodies a significant shift within the construction industry. It comprises a set of principles and practices aimed at reducing negative environmental impacts, improving occupant health and wellbeing, fostering economic development, and promoting overall sustainability across the built environment.

The concept of green building has evolved over decades, influenced by increasing environmental awareness and a growing societal emphasis on sustainability. Beginning in the 1970s, heightened environmental consciousness laid the groundwork for rethinking building design and construction practices. This movement gained traction in the 1990s, reflecting a broader cultural shift towards more sustainable approaches to construction and development.

While there isn't a universally agreed-upon definition of green building, common themes emerge from various authoritative sources. Essentially, green building aims to minimize environmental harm while maximizing sustainability throughout the building's life cycle. This involves strategies such as energy efficiency, resource conservation, waste reduction, improving indoor air quality, and engaging with the local community.

(McLennan, 2004) stresses the importance of sustainable design in enhancing the built environment while mitigating its impact on nature. Similarly, the (U.S. Green Building Council, 2006) highlights the comprehensive improvement of environmental, economic, and health performance in green buildings compared to conventional structures.

(McGraw-Hill, 2006) and (Cassidy, 2003) emphasize the need for efficiency and sustainability across all stages of a building's life cycle, including design, construction, operation, and maintenance. This includes implementing energy-efficient designs, conserving water, sourcing materials responsibly, and prioritizing occupant health.

(The National Association of Homebuilders, , 2007) extends the concept of green building to residential construction, emphasizing energy and water efficiency, the use of sustainable materials, and indoor environmental quality.

(Kibert, 2005) further elaborates on the principles of sustainable construction, focusing on resource efficiency, ecological design, and core principles such as reducing, reusing, and recycling resources, and ensuring quality throughout the building's lifespan.

In essence, green building represents a holistic approach to sustainable development, integrating environmental, social, and economic considerations to create buildings that are environmentally friendly, resource-efficient, and conducive to occupant wellbeing.

2.1.6.2. Principles of sustainable construction

Sustainable construction principles serve as guiding principles for creating built environments that not only minimize environmental impact but also prioritize resource efficiency and enhance human health and wellbeing. These principles are underpinned by extensive research and practical applications within the construction industry. Let's delve deeper into each principle and provide additional details:

Resource Efficiency: This principle underscores the importance of utilizing resources efficiently throughout a building's life cycle, spanning from its inception to its eventual decommissioning. It involves strategies such as minimizing waste generation, optimizing material usage, and integrating renewable resources whenever feasible. For instance, efficient design techniques, such as modular construction and prefabrication, can reduce material wastage, while incorporating recycled or sustainable materials can further enhance resource efficiency (Sabnis, 2016)

Ecological Design: At the heart of sustainable construction lies ecological design, which aims to minimize the ecological footprint of buildings by integrating natural systems and processes into the built environment. This encompasses various strategies, including passive heating and cooling techniques, daylight harvesting, and the integration of green infrastructure such as green roofs and permeable pavements. By mimicking nature's processes, ecological design not only reduces environmental impact but also enhances biodiversity and ecosystem services within urban areas (Lombardía, A., & Gómez-Villarino, M. T., 2023)

Waste Reduction: Sustainable construction endeavors to minimize waste generation and maximize recycling and reuse of materials. By adopting practices such as construction waste management plans, on-site material sorting, and the use of reclaimed materials, construction projects can significantly reduce their environmental footprint while also lowering costs associated with material procurement and disposal (Sawhney, A., Riley, M., Irizarry, J., Eds., n.d.)

Energy Efficiency: Energy efficiency is a cornerstone of sustainable construction, focusing on reducing energy consumption and promoting the use of renewable energy sources. Strategies encompass efficient building envelope design, high-performance HVAC systems, and the integration of smart energy management technologies. By reducing energy demand and utilizing renewable energy sources such as solar and wind power, buildings can minimize their carbon footprint and contribute to mitigating climate change (Banihashemi, 2022)

Water Conservation: Sustainable construction prioritizes water conservation through the implementation of water-efficient fixtures, rainwater harvesting systems, and drought-resistant landscaping. By reducing water consumption and minimizing strain on local water resources, sustainable buildings contribute to water security and resilience in the face of changing environmental conditions (Zhu, D., & Chang, Y. J., 2020; Zhang, Y., Song, Y., & Luo, J. , 2023)

Indoor Environmental Quality (IEQ): Human health and wellbeing are paramount in sustainable construction, with a focus on creating indoor environments that are comfortable, healthy, and conducive to productivity. Strategies include proper ventilation, natural daylighting, low-emission materials, and indoor air quality monitoring. By prioritizing IEQ, sustainable buildings not only enhance occupant comfort but also reduce the risk of health issues associated with poor indoor air quality (Ogunkah, 2020).

Life Cycle Assessment (LCA): Sustainable construction adopts a life cycle approach, considering the environmental, social, and economic impacts of a building from cradle to grave. Life cycle assessment tools help assess and minimize the overall environmental footprint of buildings by evaluating their environmental performance across different life cycle stages, from raw material extraction to construction, operation, and end-of-life disposal (Ding, 2014)

2.1.6.3. Importance of sustainable buildings

Sustainable building practices have gained considerable attention due to their potential to mitigate environmental harm and promote efficient resource usage. These practices aim to reduce greenhouse gas emissions, minimize water consumption, and decrease energy usage (U.S. Green Building Council, 2006). Buildings play a significant role in resource consumption, accounting for a substantial portion of greenhouse gas emissions and energy consumption globally (U.S. Green Building Council, 2006) By adopting sustainable building methods, such as energy-efficient design and material selection, these environmental impacts can be mitigated (UNEP, 2007)

Moreover, sustainable buildings contribute to improving occupant health and well-being by providing healthier indoor environments. Features like natural lighting have been shown to enhance student performance and reduce absenteeism rates (U.S. Green Building Council, 2006) Additionally, green buildings have social and economic benefits, such as increased productivity rates among employees and improved student academic achievements (U.S. Green Building Council, 2006). This underscores the importance of sustainable building beyond its environmental impact.

Furthermore, the green building industry is experiencing significant growth, presenting opportunities for economic development and innovation. Projections indicate a substantial increase in green building projects in the coming years (McGraw-Hill, 2006). This growth not only fosters advancements in construction management but also promotes product development and knowledge exchange within the industry.

2.1.6.4. Traditional vs sustainable

Green construction initiatives signify a departure from conventional building methods, prioritizing sustainability through specialized materials and techniques. These projects often require comprehensive documentation and reporting to meet environmental certification standards. The unique nature of green construction necessitates adaptations to traditional project management methodologies to mitigate risks and ensure cost-effectiveness. Effective collaboration across disciplines is essential, particularly in areas such as site selection, construction techniques, and the early integration of building systems into the project life cycle.

Table 2.2. Comparison between Traditional and Sustainable Construction based on project aspect

Aspect	Traditional Construction	Sustainable Building Practices
Technical Perspective	Utilizes widely available materials like concrete and steel, focuses on cost-efficiency and structural integrity, but results in higher energy consumption and environmental impact. (UNEP, 2007)	Sustainable construction involves adjustments to traditional project management practices to minimize risks and ensure cost-effectiveness (U.S. Green Building Council, 2006)
Environmental Impact	Traditional construction methods typically prioritize immediate cost savings over long-term environmental sustainability (UNEP, 2007).	Sustainable building practices focus on eco-friendly materials and energy-efficient designs to mitigate environmental impact (U.S. Green Building Council, 2006)
Project Management	In traditional construction, budgets and schedules are prioritized over environmental considerations and long-term sustainability, which is characterized by cost control, timely completion, and adherence to established methods and materials. (UNEP, 2007)	Sustainable building practices require early integration of building systems and subsystems to streamline project delivery and ensure cost-effectiveness (U.S. Green Building Council, 2006)
Life Cycle Considerations	Traditional construction methods often overlook long-term environmental and economic impacts, focusing solely on initial construction (UNEP, 2007).	Sustainable building practices consider the entire life cycle of a building to minimize environmental impact and maximize sustainability (U.S. Green Building Council, 2006)

Table 3.3. Comparison between Traditional and Sustainable Construction based on project process

Project Process	Traditional Construction	Sustainable Construction
Phase 1: Feasibility	Initial project evaluation (Matthiessen, L., & Morris, P., 2004)	Identification of needs considering environmental objectives and LEED certification (Matthiessen, L., & Morris, P., 2004)
	Selection of project manager	Engagement of experienced green building consultant/manager (Pennsylvania State University., 2004)
	Preliminary site assessment and planning	Finalization of economic and environmental objectives through cost/benefit analysis (Matthiessen, L., & Morris, P., 2004)
	Collaborative design discussions	Involvement of diverse stakeholders in design discussions (Kibert, 2005)
	Finalization of site location	Site selection based on input from stakeholders (Kibert, 2005)
Phase 2: Design	Establishment of budget and schedule	Detailed cost estimates focusing on life cycle analysis (Griffin, 2005)
	Obtaining zoning approvals	Early engagement with regulatory bodies for smoother approval processes (Kibert, 2005)
	Formation of design team	Core design team selection with possible addition of technical experts (Kibert, 2005)
	Development of construction documents	Efficient development of construction documents with integrated team (Kibert, 2005)
	Regulatory review of project plans	Active involvement of regulatory agencies to ensure adherence to sustainability guidelines (Pennsylvania State University., 2004)

	Bidding process	Implementation of transparent bidding processes with open-book subcontracting (Reed, W., & Gordon, E. , 2000)
Phase 3: Implementation	Contract negotiation	Integration of sustainable practices into contracts with incentives (Pennsylvania State University., 2004)
	Construction phase	Commencement of construction with workforce education on sustainability (Pennsylvania State University., 2004)
	Inspection procedures	Reduction of field changes and rework through early government collaboration (Pennsylvania State University., 2004)
	LEED certification process	Streamlining of documentation process through collaborative team efforts (Pennsylvania State University., 2004)
Phase 4: Close out	Building occupancy and operations	Implementation of comprehensive building commissioning to ensure system functionality (Pennsylvania State University., 2004)

2.1.6.5. Risk Factor Assessment in Sustainable Buildings

In reviewing existing literature, it becomes apparent that evaluating and managing risks plays a crucial role in the success of construction projects, particularly those emphasizing sustainability (El-Sayegh, 2008; Hwang, B., & Ng, W. , 2013; Robichaud L, Anantatmula V., 2011).

Construction endeavors, especially those striving for sustainability, face a myriad of risks spanning management, technical aspects, stakeholder involvement, green materials and technology, as well as regulatory and economic factors (Zou, P., Zhang, G., & Wang, J., 2007; Hwang, B., Ng, W., & Shan, M., 2017)

Management-related challenges in sustainable construction projects often revolve around project feasibility, budgeting, and scheduling. Given the unique nature of sustainable projects, meticulous planning and execution are vital to navigate complexities such as the use of green materials and adherence to environmental standards (Mishmish, M., & El-Sayegh, S., 2018)

Technical hurdles during the construction phase encompass design alterations, inadequate sustainable design information, and productivity issues. These obstacles can result in delays and cost overruns, underscoring the importance of technical proficiency and thorough planning in sustainable construction endeavors (Al-Hajj, A., & Hamani, K., 2011)

Stakeholder-related risks entail resistance to adopting green practices, limited experience among consultants and contractors, and challenges in subcontractor and supplier selection. Overcoming these obstacles necessitates effective communication, collaboration, and stakeholder engagement throughout the project lifecycle (Hwang, B., & Ng, W. , 2013; Lam, P. T. I., Chan, E. H. W., Chau, C. K., Poon, C. S., & Chun, K. P., 2009).

The utilization of advanced green materials poses risks related to their availability, handling, and quality. Scarcity, inadequate research, and documentation can compromise project timelines and performance, underscoring the importance of careful consideration and planning when integrating green materials (Hwang, B., Ng, W., & Shan, M., 2017)

Regulatory and economic factors, such as delays in government approvals and fluctuations in material costs, also present significant risks to sustainable construction projects. Adapting to evolving regulations and economic conditions is crucial for maintaining project viability and sustainability (Nutter, 2012)

Efficient risk assessment methodologies, such as the Relative Importance Index (RII), empower stakeholders to prioritize and address critical risks. By quantifying the probability, impact, and severity of risks, stakeholders can allocate resources efficiently and implement targeted risk mitigation strategies (Zayed, T., Amer, M., & Pan, J. , 2008)

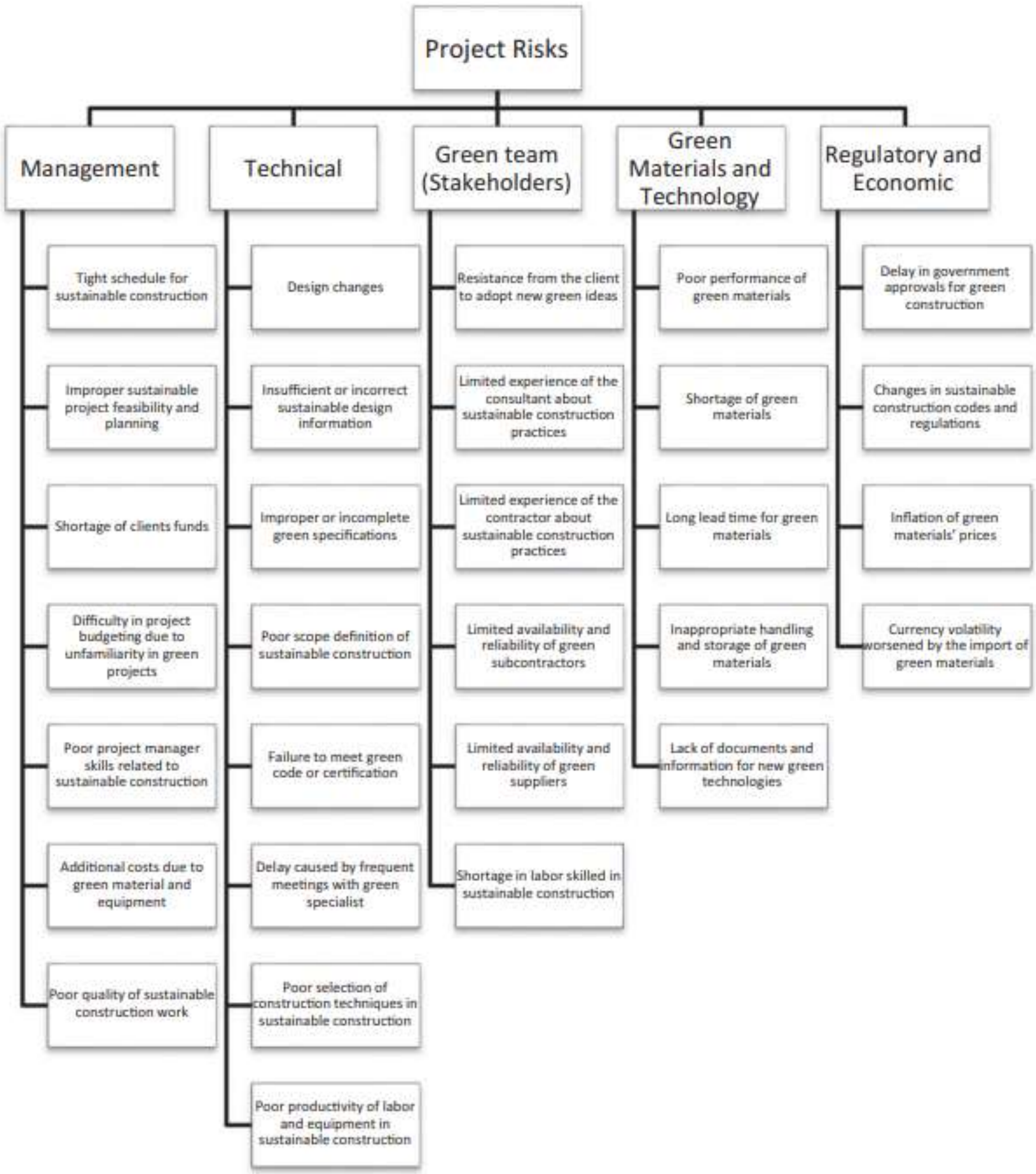


Fig. 2.7. Risk breakdown structure (RBS) for sustainable construction projects. (Sameh M. El-Sayegh, Solair Manjikian, Ahmed Ibrahim, Ahmed Abouelyousr & Raed Jabbour, 2018)

In addition to the fact that new materials and technologies are being developed for particular projects, there is still a lack of knowledge and expertise in green construction projects. All of this contributes to the risks mentioned above, which in turn affect the project's ultimate construction costs. Because there isn't a specialized risk management program to address these risks, construction companies remain stuck with their outdated models. There is a need for risk identification in the literature; it's interesting to note that authors in the legal field have done the majority of this "green" risk identification, as numerous claims have been filed regarding green construction errors that are connected to contracts and, thus, legally enforceable. (Apine, 2017)

Additionally, it's important to understand how to adapt the conventional models to meet the demands for current sustainable construction. A suggested model that outlines the project phases and risks connected to them was created to help visualize this issue. It is shown below, along with an explanation of how green building influences the model. This model is intended to highlight the necessity of viewing green buildings not just as a project cycle but also as an ongoing consideration, since major issues may surface after the project closes yet businesses may still be obligated to adhere to contract requirements. (Apine, 2017)

Construction firms' lack of site presence during commissioning phase results in risks not covered by current risk management models. Users typically manage projects, but legal obligations require companies to address issues, increasing construction costs.

The risk management process as outlined in the PMBOK (2008) is depicted in Figure below, along with its relevance to current theories about what has been done and what should be done. Additionally, it illustrates the link between project phases and the risks associated with sustainable construction techniques, highlighting the areas where those hazards are more likely to materialize and, thus, may be identified by current theory. ((Iqbal, 2015; Kibert C, 2016) highlights the ineffectiveness of risk management procedures due to time and knowledge constraints, increasing the likelihood of risk occurrence and improper risk identification, emphasizing the need for a balance between current theory and practice in the industry.

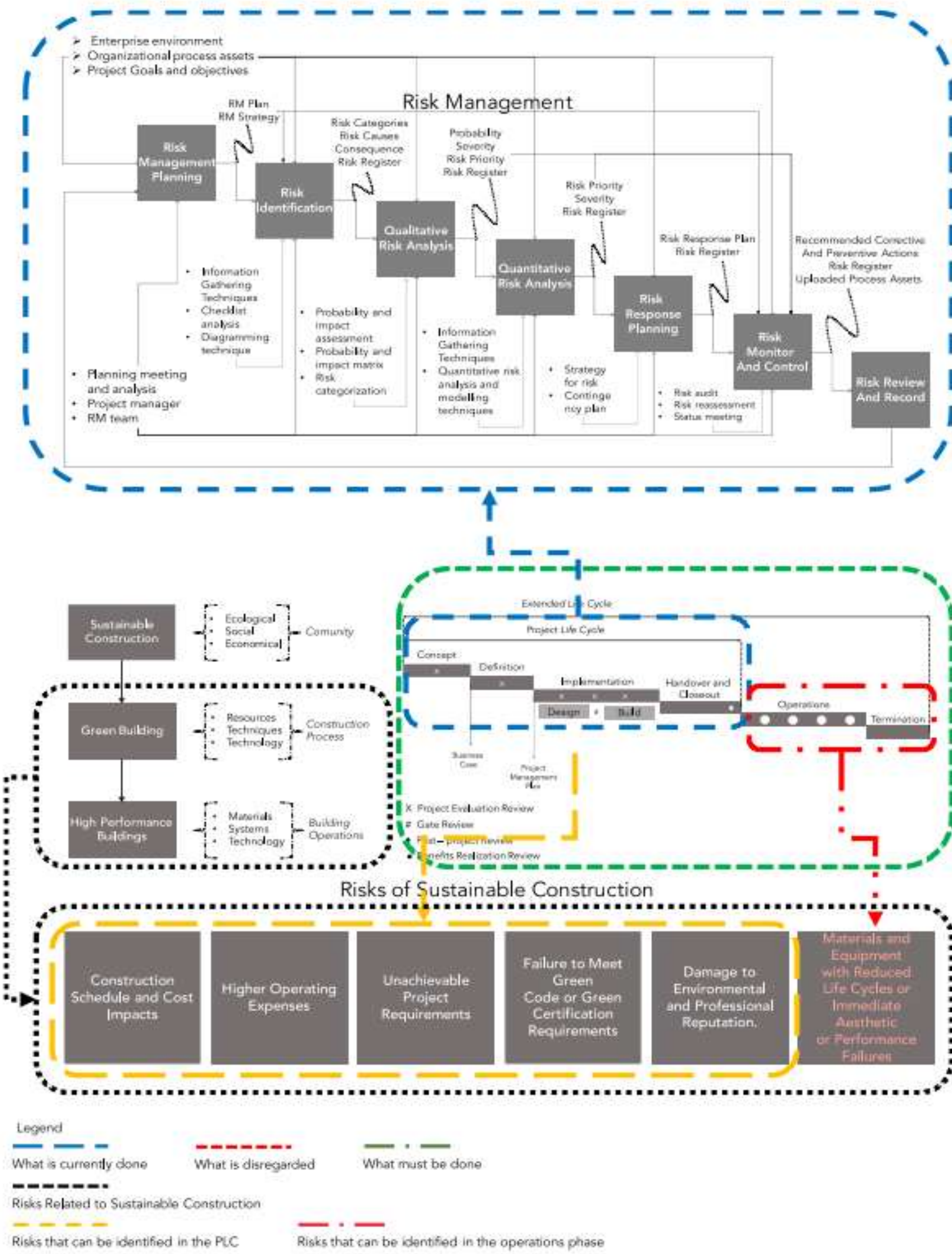


Fig. 2.8. Framework of Relationship between Risk Management, Sustainable Construction and Project Life Cycle (Apine, 2016)

2.1.7. Project performance

Within the context of a construction project, the success of a project may be judged differently by the construction organizations depending on their own objectives (Neyestani, 2016). What is viewed as a measure of success on one project may be perceived as an indication of abject failure on another project. In fact, it is difficult to measure whether the performance of a project is a success or a failure due to the fact that the concept of success remains vague among project participants (Alzahrani, 2013).

In addition, there is no commonly agreed framework for performance measurements on projects (Toor, 2010). Research on project success shows that it is impossible to generate a universal checklist of project success criteria that are suitable for all projects as the projects differ from each other in terms of size, location, uniqueness, and complexity (Westerveld, 2003). Time, cost, and quality or the so-called iron triangles are the commonly accepted performance indicator to measure the success of construction projects (Mane, 2015; Meredith, 2011). Over the years, the "iron triangle" criteria (time, cost, and quality) have been criticized because they seemed to be inadequate. (Toor, 2010) reported that the same old-fashioned performance criteria are no longer the sole dominant of project success due to the evolving project environments. The measurement of customer satisfaction and the overall satisfaction of stakeholders should be considered in performance evaluation criteria (Neyestani, 2016).

Due to the complexity of the process success concept and the lack of consensus among authors in the field, the traditional dimensions of the iron triangle, albeit criticized, are still considered central to the measurement of project success (Neyestani, 2016; Papke-Shields, 2010). This research uses the basic dimensions, denoted as project efficiency by (Shenhar, 2001). Project performance will be evaluated according to the planned budget, schedule, technical specifications (product/service requirements), and the ability to meet customer service requirements. So, in this research we will measure the project performance in terms of project efficiency (time, cost, and quality).

2.2. Empirical Review

Recent research has predominantly focused on the management of risks rather than pinpointing the critical risks inherent in construction projects specifically in sustainable construction projects.

According to (Andualem, 2019) the identification of major risks is crucial to project performance throughout its life cycle. In the context of sustainable construction projects worldwide, literature reviews have shed light on various risk factors. Previous studies have highlighted the significance of risk management in construction project management, emphasizing the need for the identification, assessment, and prioritization of risks to minimize the probability and impact of adverse events. The study aims to fill the gap by specifically identifying the major risks associated with construction projects in Ethiopia, focusing on factors such as unforeseen site conditions, incomplete contract documents, inflation, and political instability. By addressing these critical risks, the research seeks to contribute to the effective implementation of construction projects aligning with key project objectives.

(Shiferaw, 2023) The study identified that financial and economic risk, contractual and legal risk, resource risk, and design risk have a significant relationship with project performance in residential real estate development projects in Flintstone. These factors collectively impact project performance by 69.8 percent. The recommendation is for companies to minimize the occurrence of these risk factors and for developers to continuously identify and analyze risks to adapt to the dynamic nature of such projects.

(Bahiru Bewket Mitikie, 2017) The research studied the impact of risk on Ethiopian construction project performance. Key findings include the identification of high-impact risk factors such as equipment/material failure, labor poor productivity, and non-availability of equipment and material. The study also revealed the absence of formal risk management practices in Ethiopian construction projects, emphasizing the need for improved risk management based on Western practices to enhance project performance. Furthermore, the research highlighted the significant impact of certain risk factors on project objectives like time, cost, and quality. Overall, the findings underscore the importance of addressing risk factors and implementing effective risk management practices to improve construction project outcomes in Ethiopia.

(Melese, 2022) study aimed to evaluate the risk management practices of contractors in Addis Ababa's construction projects. The research identified 44 risk factors, categorized into nine main groups: Physical, Environmental, Design, Logistics, Financial, Legal, Construction, Political, and Management. The study found that 34.1% of these risks were high, significantly impacting project outcomes. The research also explored the risk management techniques employed by contractors, ranking the severity of each factor and assessing the importance of management practices. The findings provided valuable insights into how risks are identified, managed, and mitigated in the construction industry, contributing to a better understanding of risk identification, management, and mitigation.

(Asres, 2020) aimed to identify risk factors in real estate development projects in Addis Ababa. The research findings emphasize the importance of identifying and managing risk factors in private residential real estate projects in Addis Ababa. Major risk factors identified include technical, construction, and financial risks, which significantly impact project outcomes such as delays, cost overruns, and poor quality. The study highlights the crucial relationship between these risk factors and project performance, stressing the need for effective risk management to achieve project objectives. Recommendations include implementing formal risk management practices to mitigate risks and enhance project success by avoiding delays, cost overruns, and quality issues. Overall, the research underscores the critical role of risk identification and management in improving the performance of real estate development projects.

(Apine, 2017) The study highlighted the importance of implementing formal risk analysis tools in construction projects, especially in the context of sustainable construction where challenges arise due to the lack of experience and knowledge. The research emphasized the need for companies to identify and manage both positive and negative risks effectively, categorize risks based on various parameters, and adopt a project life cycle perspective in risk management.

Furthermore, the study underscored the significance of sustainable construction in reducing long-term risks associated with resource depletion, energy consumption, and environmental impact. It also pointed out the challenges faced in implementing sustainability principles within the traditional construction industry, such as higher initial investment costs and risk aversion towards new green technologies.

In the context of green construction, the research findings highlighted potential risks such as unexpected operating expenses, delays and cost overruns due to conflicting standards, failure to meet green certification requirements, and issues with new materials and equipment. The study also emphasized the importance of maintaining a balance between the economic, environmental, and social dimensions of sustainability in construction projects.

Overall, the research findings support the research objective by providing insights into how risk management practices can be tailored to address the specific challenges and uncertainties faced in sustainable and green construction projects.

2.3. Conceptual framework

The conceptual framework for this study is derived from an extensive review of relevant literature and established risk management procedures. This framework examines the impact of various risk factors and their interrelationships, utilizing "project performance" as the dependent variable. According to the Institute of Risk Management (IRM), risk is defined by the combination of the likelihood of an event occurring and its subsequent consequences, which can be either positive or negative (Soroka-Potrzebna, 2018)In the context of this study, "project risk" is understood as the aggregate effect of uncertain events that may adversely affect the achievement of a project's objectives. Specifically, project risk encompasses the potential exposure to adverse events and the probability that these events will impact the project’s goals. These goals are typically measured in terms of quality, time, and cost (Staff, 2023). The framework serves as a tool to identify, assess, and prioritize risks, ultimately aiding in the development of effective risk mitigation strategies to enhance project outcomes.

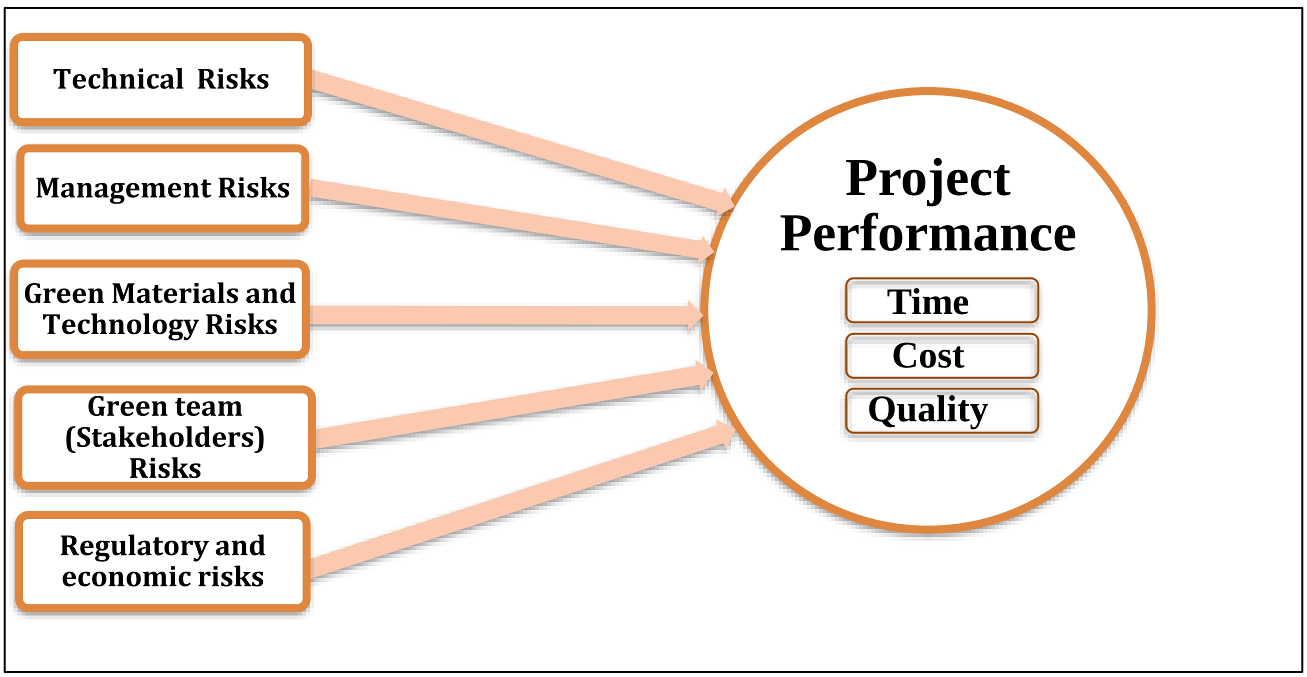


Fig. 2.9. Conceptual Framework

2.4. Research Hypothesis

Hypothesis Statements

H10: Management risk factors do not have a significant impact on project performance.

H1A: Management risk factors do have a significant impact on project performance.

H20: Technical risk factors do not have a significant impact on project performance.

H2A: Technical risk factors do have a significant impact on project performance.

H30: Green team (stakeholders) risk factors do not have a significant impact on project performance.

H3A: Green team (stakeholders) risk factors do have a significant impact on project performance.

H40: Green materials and technology risk factors do not have a significant impact on project performance.

H4A: Green materials and technology risk factors do have a significant impact on project performance.

H50: Regulatory and economic risk factors do not have a significant impact on project performance.

H5A: Regulatory and economic risk factors do have a significant impact on project performance.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Research Design and Research Approach

3.1.1 Research Design

The conceptual framework through which research has carried out is known as the research design. The research design acts as the foundation for this study, guiding the processes of data collection, measurement, and analysis. It involves several key phases, such as defining essential information, selecting measurement and scaling techniques, constructing questionnaires, determining sample procedures and sizes, and formulating a data analysis plan. The evaluation of risks in sustainable construction projects was shaped by an extensive review of relevant literature.

In the field of research methodologies, three main types of research purposes are commonly utilized: exploratory, descriptive, and explanatory (Mark N.K. Saunders, 2016). Consequently, this study employs both descriptive and explanatory research designs. Descriptive research aims to methodically portray a situation, issue, phenomenon, service, or program, or offer insights into attitudes regarding a particular topic. Conversely, explanatory research endeavors to clarify the underlying reasons for the relationship between two aspects of a situation or phenomenon.

By integrating both descriptive and explanatory research designs, this study is aligned with its research objectives. The descriptive component facilitates a systematic portrayal of risks in sustainable construction projects, while the explanatory aspect delves into comprehending the impact of construction risks on project performance. This dual approach enables a thorough exploration of the intricacies and dynamics within sustainable construction initiatives.

3.1.2. Research Approach

The study employs a mixed-methods research methodology, strategically chosen to comprehensively address the research questions at hand. This approach integrates both quantitative and qualitative methodologies within a single study, harnessing the synergies between these methods to provide a deeper understanding of the phenomenon under investigation. (Team, 2023) By combining quantitative data, which utilizes numerical data from methods like questionnaires or statistical analysis, with qualitative observations focused on describing events and behaviors, the study aims to capture the complexity and richness of the research context. (Mark N.K. Saunders, 2016)

Initially, the research aims to assess the adoption of sustainable techniques in projects by EASE, prompting the use of both quantitative and qualitative approaches to offer a nuanced understanding of the phenomenon. Similarly, in examining perceived risks associated with the application of sustainable practices, a mixed-methods approach is deemed appropriate to delve into the intricacies of the subject matter.

Moreover, the study's third research question seeks to determine the impact of perceived risks on project performance, particularly in terms of cost, time, and quality. Given the goal of establishing relationships between variables, a quantitative approach is preferred as it yields objective data that can be analyzed using statistical techniques. (William, 2021) Therefore, the utilization of quantitative methodologies is deemed suitable for effectively addressing this research question and deriving meaningful insights into the topic at hand.

3.2. Description of study Variables

The dependent and independent variables of the study, which is analysis of risk factors affecting sustainable construction project performance in the case.

Table 3.1. Dependent and Independent variables of the study

Variables	**Description**
	Independent Variable
Management risk	Refers to the potential challenges and uncertainties faced in managing construction projects, particularly sustainable ones. These risks lead to budgeting challenges, cost overruns, and compromised quality in construction.
Technical risk	Refers to potential challenges encountered during construction. These risks encompass issues such as improper selection of construction techniques due to contractor inexperience and reduced productivity of labor and equipment in sustainable construction settings.
Green team (stakeholders) risks	Refers to challenges unique to sustainable construction projects. These risks also extend to the limited expertise and resistance to change among the traditional construction labor force, hindering the adoption of sustainable practices.
Green materials and technology risks	Refers to challenges related to the shortage, handling, and quality of advanced green materials used in construction.
Regulatory and economic risks	Refers to challenges associated with government regulations, approvals, and economic factors affecting sustainable construction projects. These risks include delays in project start due to government approvals, complications arising from changes in sustainable construction codes and regulations.
	Dependent Variable
Project Performance	Refers to the evaluation of a construction project's success based on its adherence to planned budget, schedule, and technical specifications. This assessment considers the project's efficiency in managing resources (cost), meeting deadlines (time), and delivering outputs that meet predetermined standards (quality).

3.3. Description of Study Area and Target Population

3.3.1. Population

The study was conducted in East Africa Specialized Engineering PLC (EASE); Study participants were employees, and management of the selected organization who have the knowledge of the construction projects under consideration. The total number of population is 13 senior managers, 23 project manager, and 35 construction/ office engineers and 23 other such as Business development and operation managers, functional managers, Training managers, Design and Project Formulators, auditors and coordinators whom were working on projects in East Africa Specialized Engineering PLC (EASE).

3.3.2. Sample Size/ Census Inquiry

3.3.2.1. Qualitative Study

In the qualitative aspect of the case study conducted at East Africa Specialized Engineering PLC (EASE), interviews were utilized as the primary method of data collection. The study involved engaging with staff members of the construction company. Employing non-probability purposive sampling, participants were selected based on their relevance to the research topic. (Hassan, 2024). This method allowed for the deliberate selection of individuals who could provide valuable insights into the issue under investigation.

For the quantitative component of the study, determining an appropriate sample size was crucial to ensure the statistical validity and reliability of the findings (Umesh Kumar B Dubey, D P Kothari, 2022). Utilizing a census inquiry technique, the target population consisted of 94 participants based on the organizational structure. This population included individuals from various departments within the company, namely: Managing Directors, Business Development and Operation teams, Design and Project Formulation teams, Engineering teams, Resource

Management teams, Supply Chain and Logistics teams, Training Management, Finance Management, and Human Resource Management. The distribution of participants across these constituencies within the organization was as follows:Table 3.2. distribution of participants

Constituency	Target Population
Senior Managers	13
Project Managers	23
Construction/OfficeEngineers	35
Others	23
Total	94

This structured approach ensured that a diverse range of perspectives and expertise were captured, enhancing the comprehensiveness and validity of the study's quantitative findings.

3.4. Data Collection – Source, Types, Instruments

Secondary data was used for supporting the study and to get the findings of other researchers in the area of the study. Relevant Information was also gathered from different secondary sources such as library books, newspapers, and magazines different communication materials, internet sources, and other written documents and from related research materials. The primary data was gathered via semi-structured interviews and questionnaires from employees and management of the selected organization. The instruments of the quantitative research methodology used mainly include questionnaires for the project managers, senior managers, construction/office engineers, functional managers, and others. The questionnaire was designed to assess sustainable practice implementation, risks associated with sustainable building practice, and the impact on project performance. The questionnaire employed a Likert scale to examine the respondents' attitudes.

The researcher used google forms to distribute the questionnaire, this was helpful to ensure all questions are completed where one can not submit without completing all questions. Also, to ensure all questions are filled in correctly (e.g. no rating scale items have more than one entry per item, and no missed items) the researcher set different rules in the google form such as response validation was set to exactly one which ensures only one check box can be checked for a question at a time. It means that the questionnaires are completed rapidly and on one occasion, i.e. it can gather data from many respondents simultaneously. The questionnaire has two sections: section one collects the demographic characteristics of the target population, while section two is divided into seven parts based on the themes of study: the first measured the sustainable construction practices using nine items, the second part measured Management Risks using seven items, the third part measured the Technical risks using six items, the fourth part measured Green team (stakeholders) risks using six items, the fifth part measured the Green materials and technology risks using four items, the sixth part measured the Regulatory and economic risks using four items and the last part is project performance and its measured with six items. The questionnaire is presented in Annex I.

The measurement used for Sustainable Construction Risks (Management, Technical, Green team (stakeholders), Green materials and technology and Regulatory and economic risks) was adapted (Sameh M. El-Sayegh, Solair Manjikian, Ahmed Ibrahim, Ahmed Abouelyousr & Raed Jabbour, 2018).

3.5. Data Analysis – Software, Model, Techniques

The first thing that will happen after the data is collected is a processing operation. Data editing is the initial procedure. The process of editing data involves looking through the obtained raw data to identify mstakes and omissions and making the necessary corrections. Actually, editing involves closely examining the surveys that have been filled out. Editing is done to ensure that the data are accurate, consistent with other information obtained, submitted as thoroughly as possible, and organized in a way that facilitates coding and tabulation.

The process of assigning numbers or other symbols to responses so they may be categorized into a limited number of classes or categories is known as coding, and it is the second procedure.

These courses should be relevant to the current research question. They must also be exhaustive (each data item must have a class) and possess mutual exclusivity, which indicates that a particular response can only be recorded in one cell within a specific category group. Tabulation is the third and last operation. Condensing raw data for additional analysis and presenting it in an understandable format—such as statistics tables—is known as tabulation. In general, tabulation refers to the methodical arrangement of data into rows and columns. Version 26 of the Statistical Package for Social Sciences (SPSS) will be used to analyze the survey results.

The collected data was analyzed using quantitative data analysis techniques. The data collected from close-ended questions of the questionnaire is analyzed by descriptive data analysis methods using Statistical Package for Social Science (SPSS) software version 26. Statistical results like mean score, frequency of occurrence, and percentages were displayed in a tabular format followed by discussions.

Besides the above-mentioned data analysis methods the following questionnaire survey analysis methods for the major project risk identification and risk impact status assessment issues are practiced in this research:

3.5.1. Mean Score

Mean is the average of the given numbers and is calculated by dividing the sum of given number by the total number of numbers. The researcher applying descriptive statistics (specially mean and standard deviation) for the sake of better understanding and summarization, The researcher made use of the evaluation form as the data gathering tool and weighted mean as statistical treatment. A 5-point Likert scale was used to determine the level of acceptability of the material as shown in table 3.3.

Table 3.3. Five-point Likert Rating Scale Interpretation of Weighted Mean

Scale	Range	Value
5	4.50-5.00	Highly Acceptable
4	3.50-4.49	Acceptable
3	2.50-3.49	Moderately Acceptable
2	1.50-2.49	Fairly Acceptable
1	1.00-1.49	Not Acceptable

Source : (Terano, 2015)

3.5.2. Risk Ranking

A. Relative Importance Index (RII): is a method used to rank different factors in terms of their degree of importance. Therefore, in the questionnaire respondents are asked to rank the different types of risks according to their probability of occurrence and their impact on project cost, time, and quality. A scale of 1 to 5 to indicate the level of probability of occurrence of risks and to measure their impact for this study purpose used to choose from; where '1' is very low, '2' is low,3 is medium, '4' is high and '5' is very high. The relative importance index method (RII) was used herein to determine respondents' perceptions of the relative importance of the identified performance factors. The RII was computed as

$$RII = \sum PiUi /N (n) \text{ ..... (Equation 1)}$$

Where:

RII- Relative Importance Index

Pi- Respondent's rating of the risk

Ui- Number of respondents placing identical weighting on the risk

N- The total number of samples (Sample Size- which is 100 in this study)

n- The highest attainable score for each risk (which is 5 in this study)

B. Risk Ranking: based on the results obtained by RII, risks are ranked

3.5.3. Correlation Analysis

The correlation between the identified risk factors is tested to determine the strength and direction of the relationship between the risk factors. Correlation coefficients are calculated to measure the strength of a relationship.

The correlation analysis is conducted using the data on the impact of risk factors. The “project performance” is considered as a control ordinal variable in the analysis. This means it is between two ordinal values that the correlation is to be tested. It is suggested that Spearman’s rho or Kendall’stau and their associated significance tests are applied between ordinal variables. These coefficients will vary between −1 and +1. They provide information on the strength and direction of relationships (Rachma Anisa Ulya, Retnayu Pradanie, Aria Aulia Nastiti, 2020)

3.5.4. Multiple regression

Multiple regression, or MLR model, is a statistical method that use a number of explanatory factors to forecast the result of a response variable. Modeling the linear relationship between the explanatory (independent) factors and response (dependent) variables is the aim of multiple linear regression. Since multiple regression comprises more than one explanatory variable, it can be thought of as an extension of ordinary least-squares (OLS) regression. The formula for a multiple Linear Regression is;

$$Y = \beta 0 + \beta 1x1 + \beta 2x2 + ... + \beta nxn + \varepsilon$$

Then, the equation for the variables in this study will be:

$$Y = \beta 0 + \beta 1x1 + \beta 2x2 + \beta 3x3 + \beta 4x4 + \varepsilon$$

Y = dependent variable which in this study is (project performance)

- X1: represents the variable Management Risks
- X2: represents the variable Technical Risks
- X3: represents the variable Green team(stakeholder) Risks
- X4: represents the variable Green Material and Technology Risks
- X5: Regulatory and Economic Risks

B0 = the y-intercept (value of y when all other parameters are set to 0)

- Bn = regression coefficient that measures a unit change in the dependent variable when Xn changes.

3.6. Validity and Reliabiliy

3.6.1. Validity

Validity refers to both the extent to which a test measures and what it promises to measure (Umesh Kumar B Dubey, D P Kothari, 2022). This means that the degree to which variances detected by a measuring tool represent actual variations among the subjects of the test is known as validity. Construct validity is a validity test that describes how closely a measurement tool corresponds with and logically connects to the underlying theory. This sort of connection is described by a Pearson product moment correlation coefficient.

This study employs correlation analysis to examine the strength of relationships between the variables under investigation. According to (Hair, 2010), correlation measures the linear association between two metric variables, providing insights into both positive (where both variables increase together) and negative (where one variable increases while the other decreases) directions of relationships. Prior to conducting these analyses, rigorous steps were taken to ensure the validity of the study's measures. Content validity was assured by defining a clear theoretical framework and generating a comprehensive pool of items representing each variable of interest. Through expert review and pilot testing, a subset of these items was selected to ensure thorough coverage of the content domain. Concurrently, construct validity was maintained by aligning operational definitions with theoretical constructs and selecting appropriate measurement tools. These efforts were crucial in enhancing the reliability and validity of the correlation analyses, enabling a robust exploration of the relationships between independent (predictor) variables and the dependent variable.

The test also indicates the strength of a relationship between variables by a value that can range from -1.00 to 1.00; when 0 indicates no relationship, -1.00 indicates a negative correlation, and 1.00 indicates a perfect positive correlation (ibid). For the rest of the values is used the following guideline: small correlation for value 0.1 to 0.29; medium for 0.3 to 0.49; and large for 0.50 to 1.0 .The test is valid if the correlation value (Pearson correlation >r), on the other hand invalid if the correlation value (Pearson correlation<r).

The validity test result of the measuring instrument is shown in Table 4.11. Given a sample size of 80 respondents and α=0.05:

- Degrees of Freedom (df): 78
- Critical Correlation Value (rc): approximately 0.220

Table 3.4. Validity test result

Variable	Pearson correlation coefficient (r)	Coparison with Critical Correlation Value (rc)=0.220	Interpretation
MR	.331**	r>0.220	Valid
TR	.409**	r>0.220	Valid
SR	.483**	r>0.220	Valid
MTR	.436**	r>0.220	Valid
RR	.409**	r>0.220	Valid

3.6.2. Reliability

(Umesh Kumar B Dubey, D P Kothari, 2022) defined reliability and identified estimation measurements. They noted reliability as the degree to which the measurement or scale is consistent or dependable. It is considered that, when the outcome of a measuring process is reproducible, then the measuring instrument is reliable. It is also the degree to which the measurements of a particular instrument are free from errors and consistent results are produced. The author used the Cronbach's Alpha (α) to estimate reliability of the instrument. The Coefficient alpha may be thought of as the mean of all possible split-half coefficients. Coefficient alpha varies between 0.00 (no internal consistency) and 1.00 (complete consistency), as with all reliability estimates. As the estimate gets closer to 1.00 it indicates the instrument is highly reliable. Scales with coefficient alpha between 0.8 and 0.95 are considered to have very good quality, scales with coefficient alpha between 0.7 and 0.8 are considered to have good reliability, and coefficient alpha between 0.6 and 0.7 indicates fair reliability. Table 5 shows the coefficient alpha values of the variables measured by using SPSS 26.

Table 3.5. Coefficient alpha values

No	Variables	Cronbach's Alpha	Number of Items	Strength of Association
1	Management Risks	.707	14	Good
2	Technical Risks	.761	12	Good
3	Green team (stakeholders) risks	.758	12	Good
4	Green materials and technology risks	.688	8	Acceptable
5	Regulatory and economic risks	.688	8	Acceptable
6	Project Performance	.716	6	Good

Source: SPSS Version 26 Output, 2024

3.7. Ethical Consideration

Nearly all studies involving human participants carry some degree of risk. These dangers could range from mild embarrassment or discomfort caused by mildly provocative or intrusive queries to far more serious effects on the physical or mental well-being of participants. After reminding them that participation in the survey was completely voluntary and that declining to do so would not subject them to any type of discrimination, the researcher thus will make sure that everyone was treated with decency and respect.

The participants will benefit from complete anonymity. Identifying codes, as opposed to participant names, were assigned to completed surveys in order to ensure that the respondents received total confidentiality. The researcher allows respondents enough time for the data collection despite their hectic schedules when using the electronic format.

Before any data is collected, all respondents will be given the goal, objectives, and research questions of the study, so they knew exactly what was expected of them. Given that each of their contributions cannot be associated with a specific contributor, it was thought that taking these safety measures would help protect their reputation. Respondent data will be kept confidential and used solely to achieve the goals of the study. It will not be shared with other parties for any other purpose.

CHAPTER FOUR

4. DATA PRESENTATION, ANALYSIS, AND INTERPRETATION

The chapter is devoted to covering the data presentation and analysis, and lastly interpreting the findings of the study. The purpose of this study was to evaluate Risk Factors Impacting Sustainable Construction Project Performance: The Case of East Africa Specialized Engineering PLC (EASE) in Ethiopia**,** Besides, the study focused to study the cause and effect relation between management risks, technical risks, Stakeholder risks, material and technology risks, regulatory and economic risks, and Project Performance.

In the following sections of the chapter both descriptively and inferentially found results of the study are presented, examined, and interpreted using different statistical and judgmental procedures. Quantitative results are presented and discussed with the help of measurement tools such as; percentage, means, standard deviations and relative importance Index(RII). Interpretation of the demographic survey, quantitative analysis of the findings is presented in alignment with the findings of literature review and interview.

4.1. Data Presentation

4.1.1 Questionnaire Response Rate

Study show that a total of 94 questionnaires were distributed to the respondents. As presented in Table 4-1, Out of the total respondents 80 responses were obtained, accounting to 85 % response rate, a response of 70% and above is adequate according to (Fincham, 2008) hence 85 % response rate was satisfactory for data analysis. This response rate was good enough to make a comprehensive and in depth analysis of the research objective.

Table 4.1. Response Rate

Response	Total
No. of questionnaires distributed	94
No. of returned questionnaires	80
Response Rate	85%

Source: Survey

4.1.2. Demographic Characteristics of Respondents

Researchers can learn more about their subjects' backgrounds by including demographic questions in surveys. These inquiries give context to the survey data that have been gathered, enabling researchers to define their participants and do more accurate data analysis. In the survey conducted for this study respondents' gender, age, level of education, work experience in years, and their role in the organization was assessed. The result of the analysis of the demographic data is presented in Table 4.2 below.

Table 4.2. Demographic data of respondents.

Demographic Variable	Variable Category	Frequency	Percentage (%)
Gender	Male	52	65.0
	Female	28	35.0
	Total	80	100.0
Age	21 – 30 years	10	12.5
	31 – 40 years	39	48.8
	41 – 50 years	24	30.0
	Above 51 years	7	8.8

	Total	80	100.0
Level of Education	Certificate	1	1.3
	Diploma	10	12.5
	Bachelor Degree	63	78.8
	M.Sc./ MA	6	7.5
	Total	80	100.0
Role	Senior Manager	8	10.0
	Project Manager	18	22.5
	Construction/ Office Engineer	35	43.8
	Other	19	23.8
	Total	80	100.0
Experience	0-5 years	11	13.8
	6-10 years	32	40.0
	11-15 years	22	27.5
	Above 15	15	18.8
	Total	80	100.0

Source: SPSS Version 26 Output, 2024

4.1.2.1. Sex Distribution, age and work experience of Respondents

To ensure a fair and equal representation of respondents, the study considered sex as a key demographic factor. As shown in the table above, men constituted the majority of the respondents, accounting for 65%, while women made up only 35%. This indicates a lack of sex equity, highlighting poor representation of women in the study. Research has demonstrated that men and women often perceive and respond to risks differently due to various psychological, social, and cultural influences. These differences can significantly impact their risk perception, particularly in contexts like sustainable construction practices.

The survey also took into account the respondents' range in age and work experience. The age range was chosen in order to determine which age group made up the bulk of the construction team who are directly involved with the system of the organization and the work experience portrays how long they have come across the culture and policies of the company. Higher levels of work experience imply that employees are well-versed in the organization's project management processes and procedures. According to the survey, more than 86% of respondents have work experience spanning more than five years. This is an acceptable figure to make an observation over the company’s system. Table 4.3 portrays the findings of the two variables

Table 4.3. Work Experience of Respondents * Age of Respondents.

		Age of Respondents				Total
		21-30	31-40	41-50	Over 51	
Work Experience of Respondents	0-5	6	5	0	0	11
	5-10	4	20	8	0	32
	10-15	0	14	8	0	22
	Above 15	0	0	8	7	15
Total		10	39	24	7	80

Source: SPSS Version 26 Output, 2024

4.1.2.2. Level of Education of Respondents and Their Role in the Organization

The highest level of education attained by the respondents was another demographic aspect taken into account in the study. The respondents' education level was crucial in determining their proficiency in evaluating risks in their probability of occurrence and impact on project performance.

According to the results shown in table 4.2, 7% of respondents acquired master's degree, 78.8 % hold a bachelor's degree (BA/BSc). The result demonstrates that over 85% of the project team hold higher level of education related to the field of study implying that they know what they are answering. As presented in table 4.2, 10% and 22.5% of respondents described themselves as senior and project managers respectively . These findings confirm that more than 32% of respondents are managers who are actively participating in project risk management process. This underscores their inherent curiosity regarding the risks entailed in implementing sustainable practices and their eagerness to gauge the impact of the risks on project performance.

4.2 Data Analysis and Interpretation

Once the questionnaires were returned the gathered data was edited for invalid inputs, errors and omissions. The data was then corrected, uniformly input, and well-arranged to make coding and tabulation easier. The questionnaire was then coded / labeled into constructs with numbers and letters so that it can be classified into a finite number of categories or classes. Finally, the raw data was condensed for further analysis and presenting it in a concise format (i.e., in the form of statistical tables).

The aim of this study is to identify the main sustainable construction practices adopted by EASE, assess the perceived risks associated with these practices from the perspectives of project stakeholders (such as project managers, contractors, and senior managers), and analyze the impact of these risks on project performance in terms of time, cost, and quality.

It is generally agreed that employing quantitative and qualitative methodologies together rather than individually leads to a better understanding of study issues. Methodology triangulation, a hybrid methodology, aims to fill up any gaps and weak points between the quantitative and qualitative research. The employment of a variety of techniques shows an effort to comprehend and research the phenomenon in order to expand the breadth, depth, and consistency of methodological approaches. The descriptive and correlational analysis and a triangulated interpretation of the results in alignment with the research questions is presented as follows.

4.2.1. Descriptive Analysis of Variables

There are more exact ways of representing the form of the distribution of values for a particular variable, despite the fact that frequency tables and histograms give researchers a broad perspective of the distribution. These include metrics of dispersion and central tendency. By computing the mean value and standard deviation values of the responses, the statements studying the same variable were converted into a variable index. According to (Marczyk et al. 2005), the standard deviation is a measurement of the dispersion (variation) in values from a distribution's mean.

Also, information collected regarding the impact of different types of risks on project cost, time, and quality were analyzed and presented. Relative Importance Index (RII) for each type of risk is calculated to rank risks based on their probability, impact and severity. The Relative Importance Index (RII), for each risk, was calculated using Equation (1). Risk severity is calculated by multiplying the probability and impact for each of the identified risks.

4.2.1.1. Descriptive Analysis of Implementation of Sustainable Construction Practice

Table 4.4. Implementation of sustainable construction practice

	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
								Lower	Upper
EASE prioritizes energy efficiency in its construction projects.	80	3.66	0.83	7.18	79	0.000	0.66	0.48	0.85
EASE emphasizes water conservation in its construction projects.	80	3.28	0.57	4.29	79	0.000	0.28	0.15	0.4

EASE frequently uses sustainable materials in its construction projects.	80	3.80	1.13	6.34	79	0.000	0.80	0.55	1.05
EASE manages waste effectively to promote sustainability.	80	4.05	0.99	9.46	79	0.000	1.05	0.83	1.27
EASE often seeks green building certifications for its sustainable construction projects.	80	3.70	0.74	8.51	79	0.000	0.7	0.54	0.86
EASE incorporates renewable energy sources into its construction projects.	80	2.88	0.88	-1.16	79	0.252	-0.11	-0.31	0.08
EASE integrates sustainable design practices into its construction projects.	80	4.15	0.66	15.63	79	0.000	1.15	1	1.3
EASE engages with local communities to promote sustainability.	80	2.95	0.94	-0.36	79	0.720	-0.04	-0.25	0.17
EASE is willing to adopt new technologies to enhance sustainability.	80	3.95	1.15	7.41	79	0.000	0.95	0.69	1.21

Source: SPSS Version 26 Output, 2024

The one-sample t-test results presented in Table 4.4 provide a comprehensive analysis of the sustainability practices adopted by EASE in its construction projects, benchmarked against a hypothesized neutral mean value of 3. The factor "EASE prioritizes energy efficiency in its construction projects" exhibits a t-value of 7.175 (df = 79, $p < 0.001$), with a mean difference of 0.663 and a 95% confidence interval ranging from 0.48 to 0.85. This statistically significant result indicates that participants perceive EASE's emphasis on energy efficiency to be notably higher than the neutral mean. Similarly, "EASE emphasizes water conservation in its construction projects" yielded a t-value of 4.292 (df = 79, p < 0.001), a mean difference of 0.275, and a confidence interval of 0.15 to 0.40, further suggesting a significant positive deviation from the hypothesized mean.

The factor "EASE frequently uses sustainable materials in its construction projects" shows a t-value of 6.335 (df = 79, p < 0.001), a mean difference of 0.800, and a confidence interval between 0.55 and 1.05, reflecting a strong inclination towards the use of sustainable materials. For example, a study by (Banihashemi, 2022) emphasizes the importance of using sustainable materials to enhance building performance and reduce environmental impact. Additionally, "EASE manages waste effectively to promote sustainability" demonstrates a t-value of 9.464 (df = 79, p < 0.001), with a mean difference of 1.050 and a confidence interval from 0.83 to 1.27, indicating a significant positive perception of EASE's waste management practices. Research by (Sawhney, A., Riley, M., Irizarry, J., Eds., n.d.) discusses the benefits of implementing comprehensive waste management plans, which align with EASE's high emphasis on this aspect .

Conversely, the factor "EASE incorporates renewable energy sources into its construction projects" does not show a statistically significant difference from the neutral mean, with a t-value of -1.155 (df = 79, p = 0.252) and a mean difference of -0.112. The factors "EASE engages with local communities to promote sustainability" (t = -0.359, p = 0.720) and "EASE is willing to adopt new technologies to enhance sustainability" (t = 7.413, p < 0.001) also illustrate significant variations, with the latter showing a substantial positive deviation. This suggests that EASE is relatively open to embracing technological advancements for sustainability goals. Studies by (G/Egziabher, 2023) demonstrate that technologies such as Building Information Modeling (BIM), energy-efficient systems, and smart construction methods significantly contribute to sustainability goals. EASE's openness to new technologies is consistent with these findings .

The interviewee underscored a strong dedication to environmentally conscious building practices, stressing their significance for project accomplishment and ecological accountability. Among the strategies outlined to uphold EASE's commitment to sustainable construction practices are specific practices like using post-tensioning technology to minimize material consumption, incorporating environmentally friendly materials like locally sourced timber and recycled steel, using ERP system to enable precise tracking and allocation of costs to specific accounts, enhancing budget control and project profitability analysis and implementing energy-efficient systems like LED lighting. These initiatives seek to lessen their negative effects on the environment, promote environmentally friendly solutions, and support the organization's sustainability objectives.

Overall, the data analysis underscores EASE's significant commitment to various sustainability practices, particularly in energy efficiency, water conservation, sustainable material usage, and waste management, as perceived by the participants. The findings provide robust evidence of EASE's proactive stance in integrating sustainability into its construction projects.

4.2.1.2. Descriptive Analysis of Major Risks in Sustainable Construction Projects

This section of the study is to examine and summarize data gathered from the questionnaire, which aims to identify the main categories of risks associated with Sustainable Construction Projects under EASE. For every risk, the relative significance index (RII) was determined by taking into account the probability, impact, and severity. Risk severity is calculated by multiplying the probability and impact of each of the identified risks. These factors were then ranked according to their RII values.

i. Management Risk

Project management risks are potential obstacles and uncertainties that could impact the successful completion of a sustainable construction project. These risks are often related to resource management, stakeholders, schedules, budgets, and overall project execution. Respondents were asked to rate the probability of occurrence and impact of these risks using a Likert scale. The risks were then ranked based on the calculated RII. This was done for the probability, impact and severity. The descriptive statistics is shown in Table 4.5

Table 4.5. Management Risk in Sustainable Construction

Description	Probability			Impact			Severity	
	Mean Score	RII	Rank	Mean Score	RII	Rank	Mean Score	Rank
Tight schedule for sustainable construction	3.28	0.66	4	3.61	0.72	3	11.86	5
Improper sustainable project feasibility and planning	3.76	0.75	2	3.41	0.68	5	12.93	3
Shortage of clients funds	2.84	0.57	6	3.38	0.68	6	9.54	7
Difficulty in project budgeting due to unfamiliarity in green projects	3.89	0.78	1	3.34	0.67	7	13.01	2
Poor project manager skills related to sustainable construction	2.89	0.58	5	4.00	0.80	1	11.60	6
Additional costs due to green material and equipment	3.76	0.75	2	3.73	0.75	2	13.94	1
Poor quality of sustainable construction work	3.48	0.70	3	3.51	0.70	4	12.16	4

Source: SPSS Version 26 Output & MS Excel 16 Output, 2024

The results indicate that "Difficulty in project budgeting due to unfamiliarity in green projects" is a significant factor, scoring an average of 3.89 and ranking first in RII with a value of 0.78. This underscores the challenges faced in budgeting for green projects due to a lack of familiarity, aligning with findings from (Arifuzzaman, M., Gazder, U., Islam, M., & Skitmore, M, 2022) on the importance of realistic budgeting to control cost overruns in construction projects. "Shortage of clients' funds" has the lowest likelihood, with an average score of 2.84 and an RII of 0.57, placing it sixth, indicating it is a less common concern.

In terms of impact, "Poor project manager skills related to sustainable construction" ranks highest, with an average score of 4.00 and an RII of 0.80. This emphasizes the crucial role of skilled project management in sustainable construction, as supported by (Sang, P., Liu, J., Lin, Z., Zheng, L., Yao, H., & Wang, Y. , 2018), who highlight the importance of project management skills in construction practices. Conversely, "Difficulty in project budgeting due to unfamiliarity in green projects" has the least impact, ranking seventh with an average score of 3.34 and an RII of 0.67.

Regarding severity, the highest level of concern is attributed to "Additional costs due to green material and equipment," with a mean score of 13.94. This highlights the financial impact associated with green materials and equipment. In contrast, "Shortage of clients' funds" is the least severe, with a mean score of 9.54, suggesting it has a relatively lower impact on project outcomes.

Other significant constructs include "Tight schedule for sustainable construction" with a probability score of 3.28 (RII = 0.66), an impact score of 3.61 (RII = 0.72), and a severity score of 11.86, ranking it fourth in probability, third in impact, and fifth in severity. "Improper sustainable project feasibility and planning" has a probability score of 3.76 (RII = 0.75), an impact score of 3.41 (RII = 0.68), and a severity score of 12.93, ranking it second in probability, fifth in impact, and third in severity. "Poor quality of sustainable construction work" scores 3.48 in probability (RII = 0.70), 3.51 in impact (RII = 0.70), and 12.16 in severity, placing it third in probability, fourth in impact, and fourth in severity.

Overall, the analysis highlights the importance of addressing project management risks such as budgeting difficulties, project manager skills, additional costs due to green materials, and scheduling challenges to ensure the successful completion of sustainable construction projects.

ii. Technical risks

Technical risks in sustainable construction projects involve uncertainties and challenges related to design, construction methods, materials, and technology. Factors like design changes, insufficient or incorrect information, technical issues, and construction work quality contribute to these risks.

Respondents rate these risks using a Likert scale, ranking them based on probability of occurrence and impact, The risks were then ranked based on the calculated RII. The descriptive statistics is shown in Table 4.6

Table 4.6. Technical Risk in Sustainable Construction

	Probability			**Impact**			**Severity**	
	Mean Score	**RII**	**Rank**	**Mean Score**	**RII**	**Rank**	**Mean Score**	**Rank**
Design changes	3.78	0.76	4	3.48	0.70	1	13.19	2
Improper or incomplete green specifications	3.89	0.78	2	3.31	0.66	2	12.65	3
Poor scope definition of sustainable construction	3.76	0.75	5	3.23	0.65	3	12.19	4
Failure to meet green code or certification	4.26	0.85	1	3.14	0.63	4	13.40	1
Poor selection of construction techniques in sustainable construction	3.84	0.77	3	2.95	0.59	6	11.35	5
Poor productivity of labor and equipment in sustainable construction	3.36	0.67	6	2.98	0.60	5	9.86	6

Source: SPSS Version 26 Output & MS Excel 16 Output, 2024

The table shows an examination of factors that influence construction projects emphasizing their their probabilities, impacts and severity. These factors are ranked based on their scores and Relative Importance Index (RII).

The data reveals several significant insights into technical risks in sustainable construction. The highest likelihood is attributed to "Failure to meet green code or certification," ranking first with an average score of 4.26 and an RII of 0.85, highlighting the challenges in adhering to stringent green standards and certification processes. Conversely, "Poor productivity of labor and equipment in sustainable construction" is deemed the least likely issue, ranking sixth with an average of 3.36 and an RII of 0.67, indicating it is a less common concern compared to others.

In terms of impact, "Design changes" holds the highest position, ranking fourth with a mean score of 3.48 and an RII of 0.70. Frequent modifications to project designs can disrupt schedules and budgets. On the other hand, "Poor selection of construction techniques in sustainable construction" ranks sixth in impact, with an average rating of 2.95 and an RII of 0.59, indicating a relatively lower perceived impact.

Considering overall severity, "Failure to comply with standards or certification" emerges as the critical factor, ranking first with an average severity score of 13.40. This underscores the pivotal importance of adhering to eco-friendly regulations, as non-compliance can lead to severe penalties and reputational damage. In contrast, "Poor productivity of labor and equipment in sustainable construction" is deemed severe, ranking sixth with an average severity score of 9.86, indicating a relatively lower impact on project outcomes.

Other significant constructs include "Improper or incomplete green specifications" has a high likelihood, ranking second with a mean score of 3.89 and RII of 0.78. This element also ranks second in terms of impact, with a mean score of 3.31 and a RII of 0.66, showing that mistakes or shortcomings in green requirements can significantly affect project outcomes. Its overall severity, which ranks third with a mean score of 12.65, highlights the importance of exact and complete green criteria in sustainable building.

"Poor scope definition of sustainable construction" is another significant risk, ranking sixth in likelihood with a mean score of 3.76 and a RII of 0.75. This element has a significant influence, ranking third with a mean score of 3.23 and a RII of 0.65, indicating that ambiguous or poorly defined project scopes might result in misunderstandings, mismanagement, and inefficiencies. Its severity is also remarkable, placing fourth with a mean score of 12.19, emphasizing the importance of clear and detailed scope definitions to limit risks.

"Poor selection of construction techniques in sustainable construction" is particularly noteworthy, ranking third in probability (mean score of 3.84, RII of 0.77) and sixth in impact (mean score of 2.95, RII of 0.59). Regardless of its lower environmental impact, selecting the right construction techniques is critical for successfully implementing sustainable practices. Its severity score, placed fifth with an average of 11.35, underlines its significance in the larger context of sustainable construction. These findings highlight the multidimensional character of technical risks in sustainable building, where not only the most probable and impactful issues, but also those with high severity ratings, necessitate meticulous management to assure project success. According to (Al-Hajj, A., & Hamani, K., 2011), frequent design modifications can lead to cost overruns and project delays, directly impacting project performance. This finding is consistent with EASE's assessment of the high impact of design changes.

iii. Green team (stakeholders) risks

Stakeholder risks in sustainable construction projects involve uncertainties and challenges for stakeholders like clients, consultants, contractors, suppliers, and others. These risks can affect project success through factors like resistance to green practices, limited experience, challenges in obtaining green certifications, delays, and subcontractor selection issues. (Sameh M. El-Sayegh, Solair Manjikian, Ahmed Ibrahim, Ahmed Abouelyousr & Raed Jabbour, 2018) Respondents rate these risks using a Likert scale, ranking them based on probability of occurrence and impact, The risks were then ranked based on the calculated RII. The descriptive statistics is shown in Table 4.7

Table 4.7. Green team (stakeholders) risks in Sustainable Construction

Description	Probability			Impact			Severity	
	Mean Score	RII	Rank	Mean Score	RII	Rank	Mean Score	Rank
Resistance from the client to adopt new green ideas	3.33	0.67	4	3.51	0.70	1	11.83	4

Limited experience of the consultant about sustainable construction practices	3.80	0.76	2	3.51	0.70	1	13.44	1
Limited experience of the contractor about sustainable construction practices	2.86	0.57	5	3.41	0.68	3	9.78	5
Limited availability and reliability of green subcontractors	3.89	0.78	1	3.31	0.66	4	13.06	3
Limited availability and reliability of green suppliers	2.86	0.57	5	3.21	0.64	5	9.28	6
Shortage in labor skilled in sustainable construction	3.78	0.76	3	3.49	0.70	2	13.43	2

Source: SPSS Version 26 Output & MS Excel 16 Output, 2024

The data presented in the table examines the factors influencing construction projects focusing on their probabilities, impacts and severity. The analysis of stakeholder risks reveals several key insights. The highest likelihood is attributed to "Limited availability and reliability of green subcontractors," with a mean score of 3.89 and an RII of 0.78, ranking first. This underscores the challenge of securing subcontractors specialized in sustainable construction which highlight how shortages of subcontractors can lead to project delays and cost escalations. Conversely, both "Limited experience of the contractor about sustainable construction practices" and "Limited availability and reliability of green suppliers" have lower probabilities, each averaging a score of 2.86 and an RII of 0.57, placing them fifth. This suggests these issues are less frequent occurrences.

Regarding impact, "Resistance from the client to adopt new green ideas" and "Limited experience of the consultant about sustainable construction practices" rank highest, each with a mean score of 3.51 and an RII of 0.70. This emphasizes how client resistance and the lack of consultant experience significantly affect project outcomes. On the other hand, the factor "Limited availability and reliability of green suppliers" is ranked fifth in terms of impact, with an average score of 3.21 and an RII of 0.64.

In terms of severity, "Limited experience of the consultant about sustainable construction practices" stands out as the most critical factor, with an average score of 13.44. This highlights the essential role of consultant knowledge in sustainable construction practices. In contrast, "Limited availability and reliability of green suppliers" is deemed the least severe, with an average score of 9.28, indicating its relatively minor influence on project outcomes.

Other important components influence the technical hazards associated with sustainable construction projects. "Resistance from the client to adopt new green ideas" appears as a significant factor, ranking fourth in probability with a mean score of 3.33 and a RII of 0.67. This factor has the greatest impact, along with "Limited experience of the consultant about sustainable construction practices," which both have a mean of 3.51 and a RII of 0.70. Client resistance is also significant, ranking fourth with a mean score of 11.83, emphasizing the crucial importance of effective stakeholder involvement and education in overcoming hesitation toward green measures.

"Shortage of labor skilled in sustainable construction" is another significant danger, ranking third in probability with a mean score of 3.78 and a RII of 0.76. This factor ranks second in impact, with a mean score of 3.49 and a RII of 0.70, highlighting the significant impact that a skilled labor shortage can have on project deadlines and quality. Its severity score is also high, ranking second with a mean of 13.43, emphasizing the significance of investing in labor training and development programs for sustainable building. Research by (Hwang, B., & Ng, W. , 2013) underscores the scarcity of qualified green subcontractors and the challenges in sourcing sustainable materials. These findings corroborate the importance of availability and reliability highlighted in EASE's data.

"Limited experience of the contractor about sustainable construction practices" and "Limited availability and reliability of green suppliers" both had lower probabilities, with a mean score of 2.86 and a RII of 0.57, ranking sixth. Despite its low frequency, the impact of contractor experience is ranked third with a mean score of 3.41 and a RII of 0.68, demonstrating that even uncommon difficulties can have a major influence. In terms of severity, contractor experience ranks sixth with a mean score of 9.78, while the restricted availability and reliability of green suppliers, despite its lower impact and probability, ranks last with a mean score of 9. 28.

In summary, the evaluation of stakeholder risks in sustainable construction projects highlights the critical importance of securing reliable subcontractors, gaining client acceptance, and enhancing consultant expertise (Lam, P. T. I., Chan, E. H. W., Chau, C. K., Poon, C. S., & Chun, K. P., 2009). Addressing these key factors is essential for the successful implementation and completion of sustainable construction projects.

iv. Green Material and technology risks

Sustainable construction projects face material and technology risks related to green materials and technologies, affecting project success through shortages, long procurement lead times, inadequate handling, storage practices, and lack of documentation. Respondents rate these risks using a Likert scale, ranking them based on probability of occurrence and impact. Risk severity is calculated by multiplying probability and impact. The risks were then ranked based on the calculated RII, The descriptive statistics is shown in Table 4.8

Table 4.8. Green Material and technology risks in Sustainable Construction

	Probability			Impact			Severity	
	Mean Score	RII	Rank	Mean Score	RII	Rank	Mean Score	Rank
Shortage of green materials	3.00	0.60	2	3.44	0.69	2	10.55	4
Long lead time for green materials	2.89	0.58	3	3.65	0.73	1	10.68	3
Inappropriate handling and storage of green materials	3.49	0.70	1	3.44	0.69	2	12.20	1
Lack of documents and information for new green technologies	3.49	0.70	1	3.33	0.67	3	11.80	2

Source: SPSS Version 26 Output & MS Excel 16 Output, 2024

The data presented in the table examines the factors influencing construction projects focusing on their probabilities, impacts and severity. The highest probability of occurrence is shared by "Inappropriate handling and storage of green materials" and "Lack of documents and information for new green technologies," each with a mean score of 3.49 and an RII of 0.70, ranking first. This indicates that improper handling and insufficient documentation are common issues that can significantly affect project outcomes. The study by (Hwang, B., Ng, W., & Shan, M., 2017)underscores these concerns, noting that mishandling materials can lead to significant project setbacks and increased costs.

Regarding impact, "Long lead time for green materials" ranks highest with a mean score of 3.65 and an RII of 0.73, highlighting the challenge of delays in procuring necessary materials. This is followed by "Inappropriate handling and storage of green materials" and "Shortage of green materials," both with a mean score of 3.44 and an RII of 0.69, indicating that these factors also have a considerable impact on project success. "Lack of documents and information for new green technologies" has a slightly lower impact, with a mean score of 3.33 and an RII of 0.67, but still presents a significant risk.

In terms of severity, "Inappropriate handling and storage of green materials" emerges as the most critical factor, with a mean score of 12.20, emphasizing the importance of proper material management in sustainable construction. "Lack of documents and information for new green technologies" follows with a mean score of 11.80, underscoring the need for comprehensive documentation to ensure successful implementation of new technologies. "Long lead time for green materials" has a severity score of 10.68, reflecting the substantial impact of procurement delays. Finally, "Shortage of green materials" has the lowest severity, with a mean score of 10.55, suggesting it has a relatively lower, though still significant, impact on project outcomes.

"Shortage of green materials" has a relatively high likelihood, ranking second with a mean score of 3.00 and a RII of 0.60, indicating that the supply of sustainable materials is a common worry. Its impact is also noteworthy, placing second with a mean score of 3.44 and a RII of 0.69, indicating that material shortages might cause delays in project timelines and budgets. This component ranks fourth in severity, with a mean score of 10.55, indicating that it has a significant impact on project outcomes.

Similarly, "Long lead time for green materials" is a substantial danger, ranking third in probability (mean score of 2.89, RII of 0.58). This component had the biggest impact, with a mean score of 3.65 and a RII of 0.73, indicating how material procurement delays can have a significant influence on project timetables. Its severity score, rated third with an average of 10.68, stresses the need of prompt procurement processes.

In summary, According to (Hwang, B., Ng, W., & Shan, M., 2017) the evaluation of material and technology risks in sustainable construction projects highlights the critical importance of addressing issues related to handling, documentation, procurement lead times, and material shortages. These factors must be managed effectively to ensure the successful implementation and completion of sustainable construction projects.

v. Regulatory and economic risks

Regulatory and economic risks in sustainable construction projects include uncertainties and challenges related to government regulations, codes, policies, and economic factors. These risks can include delays in green construction approvals, changes in regulations, economic instability, currency volatility, and cost overruns due to inflation or green importation. (Sameh M. El-Sayegh, Solair Manjikian, Ahmed Ibrahim, Ahmed Abouelyousr & Raed Jabbour, 2018). The descriptive statistics is shown in Table 4.9

Table 4.9. Regulatory and economic risks in Sustainable Construction

Description	Probability			Impact			Severity	
	Mean Score	RII	Rank	Mean Score	RII	Rank	Mean Score	Rank
Delay in government approvals for green construction	3.71	0.74	1	3.48	0.70	2	13.24	1
Changes in sustainable construction codes and regulations	3.23	0.65	2	3.61	0.72	1	11.79	2
Inflation of green materials' prices	3.23	0.65	2	3.41	0.68	3	11.13	3
Currency Volatility worsened by the import of green materials	2.86	0.57	3	3.38	0.68	4	9.66	4

Source: SPSS Version 26 Output & MS Excel 16 Output, 2024

The data presented in the table examines the factors influencing construction projects focusing on their probabilities, impacts and severity. The highest probability is attributed to "Delay in government approvals for green construction," with a mean score of 3.71 and an RII of 0.74, ranking first. This underscores the challenge of navigating regulatory processes and the potential for delays in project timelines. "Changes in sustainable construction codes and regulations" and "Inflation of green materials' prices" share the second-highest probability, each with a mean score of 3.23 and an RII of 0.65. These factors highlight the dynamic nature of regulatory environments and the potential impact on project costs and timelines.

In terms of impact, "Delay in government approvals for green construction" and "Changes in sustainable construction codes and regulations" rank highest, with mean scores of 3.48 and 3.61, respectively, and both having an RII of 0.70. This emphasizes the significant influence that regulatory changes and approval delays can have on project outcomes. "Inflation of green materials' prices" follows closely behind, with a mean score of 3.41 and an RII of 0.68, indicating its considerable impact on project costs.

Regarding severity, "Delay in government approvals for green construction" stands out as the most critical factor, with a mean severity score of 13.24, underscoring the potential for significant disruptions to project schedules and budgets. "Changes in sustainable construction codes and regulations" follows closely behind, with a mean severity score of 11.79, highlighting the importance of staying abreast of regulatory changes to mitigate their impact on project execution. "Inflation of green materials' prices" ranks third in severity, with a mean severity score of 11.13, reflecting the potential for cost overruns associated with rising material costs.

"Currency volatility worsened by the import of green materials" is a significant risk, ranking third in probability with a mean score of 2.86 and a RII of 0.57. This component emphasizes the financial volatility that might result from exchange rate swings, particularly when green materials are sourced globally. Its fourth-place ranking (mean score of 3.38 and RII of 0.68) indicates that currency fluctuation can have a significant influence on project finances. In terms of severity, this factor ranks fourth with a mean score of 9.66, indicating a significant but relatively minor impact on project outcomes when compared to other factors.

Recent studies (Sameh M. El-Sayegh, Solair Manjikian, Ahmed Ibrahim, Ahmed Abouelyousr & Raed Jabbour, 2018) emphasize that navigating regulatory landscapes can indeed lead to significant delays and uncertainties in project execution. Strategies such as early engagement with regulatory bodies and proactive compliance monitoring are crucial to mitigate these risks.

In summary, the evaluation of regulatory and economic risks in sustainable construction projects emphasizes the importance of proactive risk management strategies to address challenges related to government regulations, economic fluctuations, and the procurement of green materials. By anticipating and mitigating these risks, project stakeholders can enhance the likelihood of successful project outcomes and promote sustainable construction practices effectively.

The risks that stakeholders perceive when implementing sustainable construction techniques were identified by the interviewees. These risks include probable project delays, greater initial investment costs, and technical difficulties. Concerns were also expressed concerning the necessity of adhering to changing environmental rules as well as the accessibility and dependability of resources that are environmentally friendly. Even while stakeholder knowledge of these risks is growing, there are still gaps in their comprehension, which makes proactive collaboration and communication necessary to reduce any potential negative effects. Perceived risks had a substantial impact on decision-making processes, frequently leading stakeholders to prefer traditional approaches. However, stakeholders can make well-informed decisions that strike a balance between project aims and environmental responsibility if they have access to good risk management tools and evidence of long-term benefits.

4.2.1.3 Descriptive Analysis of Project Performance (PP) in the company

To assess the overall Project Performance (PP) of projects under EASE, project staff were asked to evaluate performance in terms of cost, time, and quality using a five-point Likert scale (1=Strongly disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly agree). The descriptive statistics for these evaluations are presented in Table 4.10.

Table 4.10. Project Performance (PP)

	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Improper scheduling influences project performance	80	2.97	0.62	-0.363	79	0.717	-0.025	-0.16	0.11
Poor coordination and communication among project teams affect project performance	80	3	0.66	0.000	79	1.000	0.000	-0.15	0.15

Improper budget assignment contributes to the project performance risk	80	3.02	0.68	0.331	79	0.741	0.025	-0.13	0.18
Inaccurate cost estimation affects project performance	80	3.21	0.67	2.840	79	0.006	0.213	0.06	0.36
Inadequate quality control measures influence project performance	80	3.01	0.63	0.179	79	0.859	0.013	-0.13	0.15
Inadequate management in ensuring projects meet quality standards contributes to the project performance risk	80	3.54	0.87	5.522	79	0.000	0.538	0.34	0.73

Source: SPSS Version 26 Output, 2024

The one-sample t-test results provided in Table 4.10 reveal insightful information regarding the influence of various factors on project performance relative to the hypothesized mean value of 3. Specifically, the factor "Inaccurate cost estimation affects project performance" yielded a t-value of 2.840 (df = 79, p = 0.006), with a mean difference of 0.212 and a 95% confidence interval ranging from 0.06 to 0.36. This indicates a statistically significant deviation from the hypothesized mean, suggesting that participants perceive inaccurate cost estimation as having a notably adverse impact on project performance.

Similarly, the factor "Inadequate management in ensuring projects meet quality standards contributes to the project performance risk" produced a t-value of 5.522 (df = 79, p < 0.001), a mean difference of 0.538, and a 95% confidence interval from 0.34 to 0.73. This result is also statistically significant, implying a strong consensus among participants that inadequate management practices significantly elevate project performance risks.

In contrast, other factors such as "Improper scheduling influences project performance" (t = -0.363, p = 0.717), "Poor coordination and communication among project teams affect project performance" (t = 0.000, p = 1.000), "Improper budget assignment contributes to the project performance risk" (t = 0.331, p = 0.741), and "Inadequate quality control measures influence project performance" (t = 0.179, p = 0.859) did not exhibit statistically significant differences from the hypothesized mean. The mean differences for these factors were marginal, and the corresponding p-values exceeded the conventional alpha level of 0.05, indicating no significant departure from the hypothesized average perception.

In summary, while the perceptions from the table data provide valuable insights into how project staff view various performance factors, aligning these perceptions with recent research (Lewis, 2022) reinforces the importance of addressing scheduling, budgeting, quality control, and management practices to enhance project success in sustainable construction. Integrating best practices and continuous improvement efforts based on both empirical data and practitioner insights can lead to more resilient and successful project outcomes in sustainable construction contexts.

4.3. Correlation Analysis

A correlation is a number between -1 and +1 that measures the degree of association between two variables. A positive value for the correlation implies a positive and a negative value for the correlation implies a negative or inverse association. Correlations of .01 to .30 are considered weak, correlations of .30 to .50 are considered moderate, correlations of 0.50 to .90 is considered strong, and correlations of .90 to 1.00 are considered very large. As the correlation coefficient value goes towards zero, the relationship between the two variables will be weaker. The data presented on the Management Risks, Technical Risks, Stakeholder Risks, Material and technology

Risks and Regulatory and economic risks were computed as predictor variables. Then, Pearson's correlations analysis was conducted at a 99% confidence interval and 1% confidence level 2-tailed.

The table below indicates the correlation matrix between the Risk factors categories (Management, Technical, Stakeholder, Material and technology and Regulatory and economic risks), and Sustainable Construction Project Performance.

Table 4.11. Correlational Matrix of Management Risks, Technical Risks, Stakeholder Risks, Material and technology Risks and Regulatory and economic risks and Project Performance

Correlations							
		PP	MR	TR	SR	RR	MTR
PP	Pearson Correlation	1	.331**	.409**	.483**	.436**	.409**
	Sig. (2-tailed)		.003	.000	.000	.000	.000
	N	80	80	80	80	80	80
MR	Pearson Correlation	.331**	1	.535**	.230*	.200	.020
	Sig. (2-tailed)	.003		.000	.040	.075	.862
	N	80	80	80	80	80	80
TR	Pearson Correlation	.409**	.535**	1	.204	.119	.115
	Sig. (2-tailed)	.000	.000		.070	.293	.311
	N	80	80	80	80	80	80

SR	Pearson Correlation	.483**	.230*	.204	1	.570**	.530**
	Sig. (2-tailed)	.000	.040	.070		.000	.000
	N	80	80	80	80	80	80
RR	Pearson Correlation	.436**	.200	.119	.570**	1	.647**
	Sig. (2-tailed)	.000	.075	.293	.000		.000
	N	80	80	80	80	80	80
MTR	Pearson Correlation	.409**	.020	.115	.530**	.647**	1
	Sig. (2-tailed)	.000	.862	.311	.000	.000	
	N	80	80	80	80	80	80

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Source: SPSS Version 26 Output, 2024

The correlation matrix presented in Table 4.11 demonstrates the relationships between management risks (MR), technical risks (TR), stakeholder risks (SR), material and technology risks (MTR), regulatory and economic risks (RR), and project performance (PP). All correlations with PP are significant at the 0.01 level. Specifically, PP has a moderate positive correlation with MR ($r = 0.331$, $p = 0.003$), a moderate positive correlation with TR ($r = 0.409$, $p < 0.001$), a strong positive correlation with SR ($r = 0.483$, $p < 0.001$), a moderate positive correlation with RR ($r = 0.436$, $p < 0.001$), and a moderate positive correlation with MTR ($r = 0.409$, $p < 0.001$).

These results indicate that while each of the risk factors significantly correlates with project performance, the strongest predictor is stakeholder risks (SR). The moderate correlations of the other risk factors with project performance highlight the importance of a comprehensive approach in managing various risks to improve sustainable construction project performance.

The interviewees pointed out that project performance in terms of schedule, budget, and quality might be strongly impacted by perceived risks related to sustainable construction methods. Challenges including delays acquiring materials, technical difficulties, and problems with regulatory compliance can cause schedule delays, budget overruns, and deteriorated workmanship quality. Maintaining project efficiency requires addressing these risks, and proactive risk mitigation strategies like careful planning, frequent monitoring, and backup plans were suggested. Project performance can be negatively impacted by failing to manage these risks, however resilience can be strengthened and project performance can be improved by adopting techniques including encouraging stakeholder engagement, carrying out in-depth risk assessments, and funding research and development.

4.4. Regression Analysis

4.4.1. Regression test assumptions

Regression analysis requires assumptions that has to be made to prove the data collected was valid and reliable. These includes linearity, multicollinearity, independence of residuals, homoscedasticity, normality of residuals, and outliers.

Normal Probability Plot (P-P) of the regression standardized residual and a scatter plot of the standardized residuals examined to test regression assumption. There were no major violations of assumptions in this study. A detailed discussion of assumption testing follows prior to a description of the regression results.

4.4.1.1. Linearity

To run the multiple regression analysis, the first regression assumption test was to check the independent variables (Management Risks, Technical Risks, Stakeholder Risks, Material and technology Risks and Regulatory and economic risks) against the dependent variable (project performance). Variables should be linear and it is a problem if the dispersion of points indicates otherwise (Burns & Burns 2008)

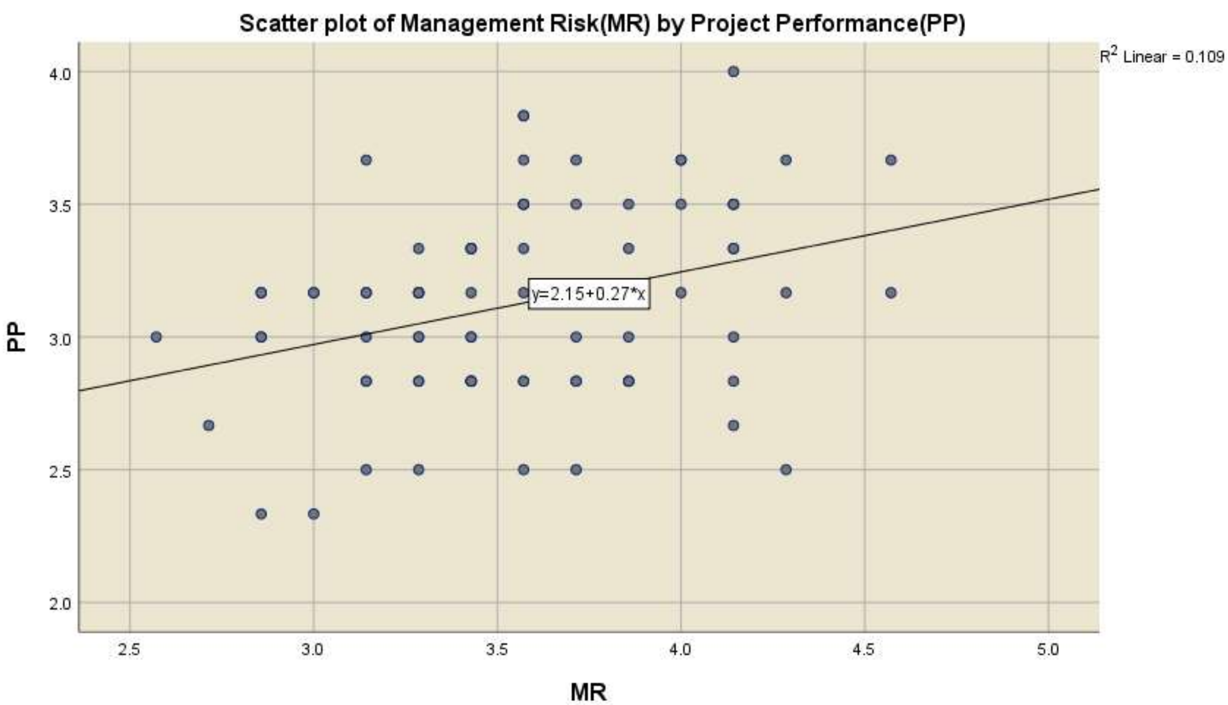


Figure 4.1. Linearity test of Management Risks and Project Performance

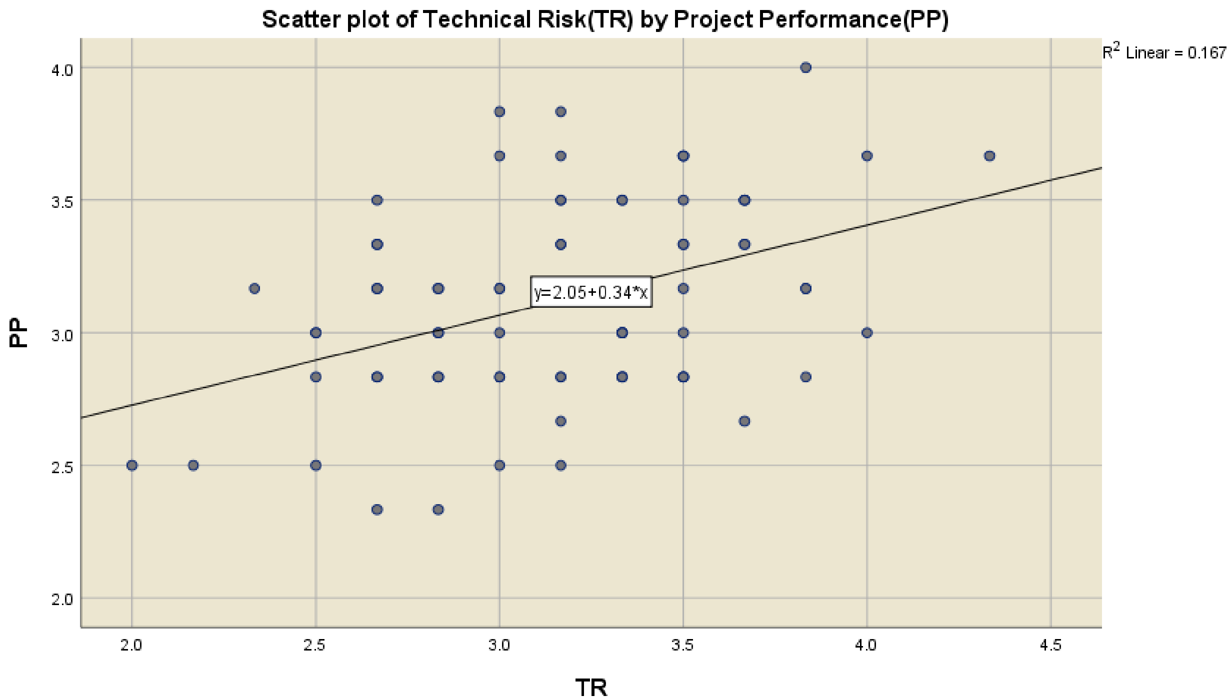


Figure 4.2 Linearity test of Technical Risks and Project Performance

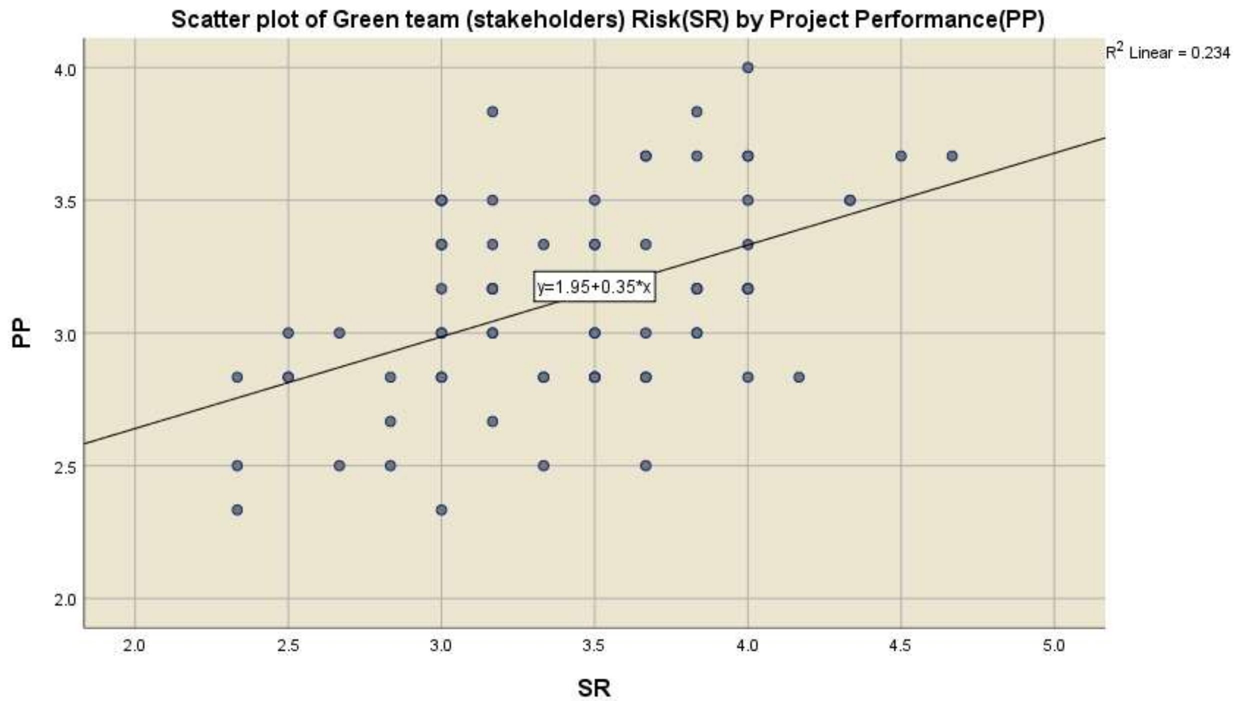


Figure 4.3 Linearity test of Green team(Stakeholder) Risks and Project Performance

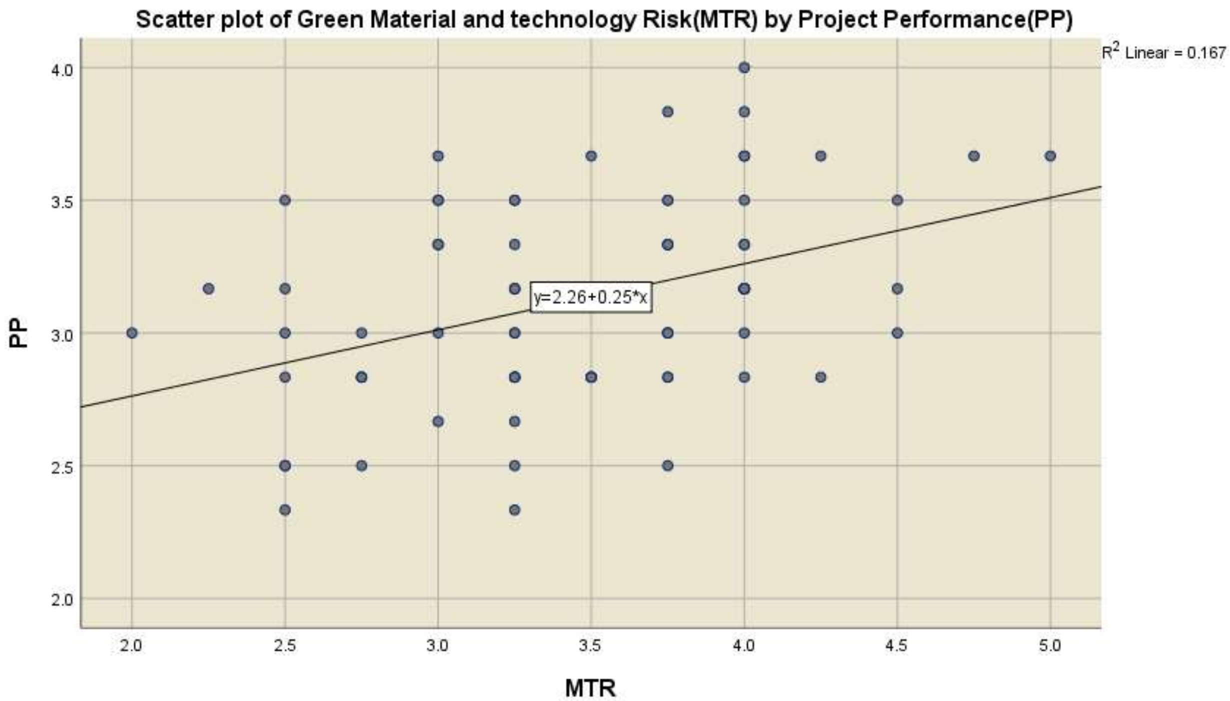


Figure 4.4 Linearity test of Green material and Technology Risks and Project Performance

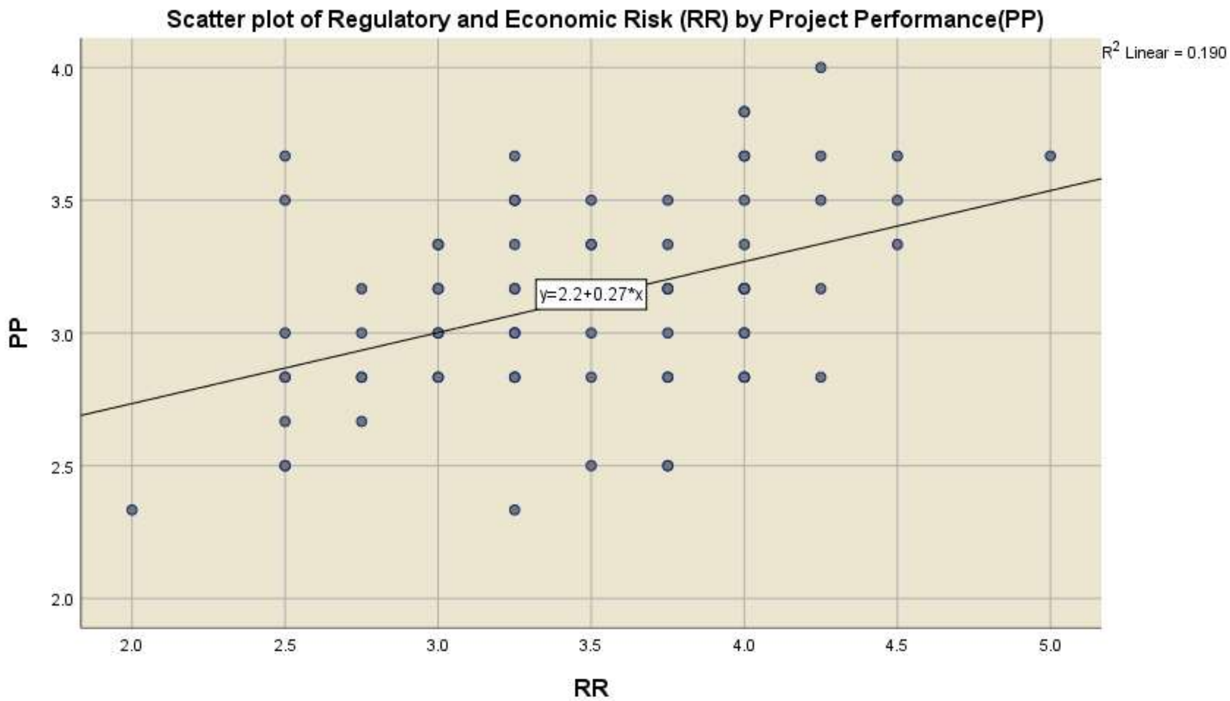


Figure 4.5 Linearity test of Regulatory and Economic Risks and Project Performance

4.1.1.2. Residual independence

The second test of the regression analysis assumption was to determine whether the residuals are independent (or uncorrelated). This was determined by looking at the variance inflation factor (VIF) and using the Durbin Watson test for autocorrelation coefficients. The Durbin Watson statistic will always have a value ranging between 0 to 4, so if the value is in the range of 1.5 to 2.5, it means that no autocorrelation was found in the sample. The test resulted in a value of 1.522, which is a good indication that there is no multicollinearity between the predictors and dependent variables.

Table 4.12. Durbin Watson test of auto correlation

Model Summary [b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
	.622[a]	.387	.345	.297	1.522

a. Predictors: (Constant), MTR, MR, TR, SR, RR

b. Dependent Variable: PP

Source: SPSS Version 26 Output, 2024

4.1.1.3. Multicollinearity

The second assumption checks if there are high correlations between the five independent variables dimensions. The most common approach to evaluating multicollinearity is by examining the correlation coefficients and the variance inflation factor (VIF).) stated that a small correlation is less than 10 and tolerance scores to be above 0.2. Analysis of collinearity statistics show this assumption has been met, as all VIF scores were below 10, and tolerance scores above 0.2.

Table 4.13. VIF: test of autocorrelation

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	.900	.349		2.578	.012		
	MR	.079	.093	.096	.855	.395	.655	1.526
	TR	.227	.091	.273	2.500	.015	.694	1.441
	SR	.172	.084	.240	2.049	.044	.605	1.654
	RR	.092	.080	.150	1.154	.252	.490	2.042

MTR	.092	.077	.151	1.192	.237	.515	1.943

Source: SPSS Version 26 Output, 2024

4.1.1.4. Homoscedasticity

The other assumption made was assumption of homoscedasticity, which is the assumption that the variation in the residuals (or amount of error in the model) is similar at each point of the model. The graph plotted below showed the standardized values of the model would predict, against the standardized residuals obtained. As the predicted values increase (along the X-axis), the variation in the residuals should be roughly similar. If everything is good, the dot scatter graph looks like a random array of dots. If the graph looks like a funnel shape, then it is likely that this assumption has been violated.

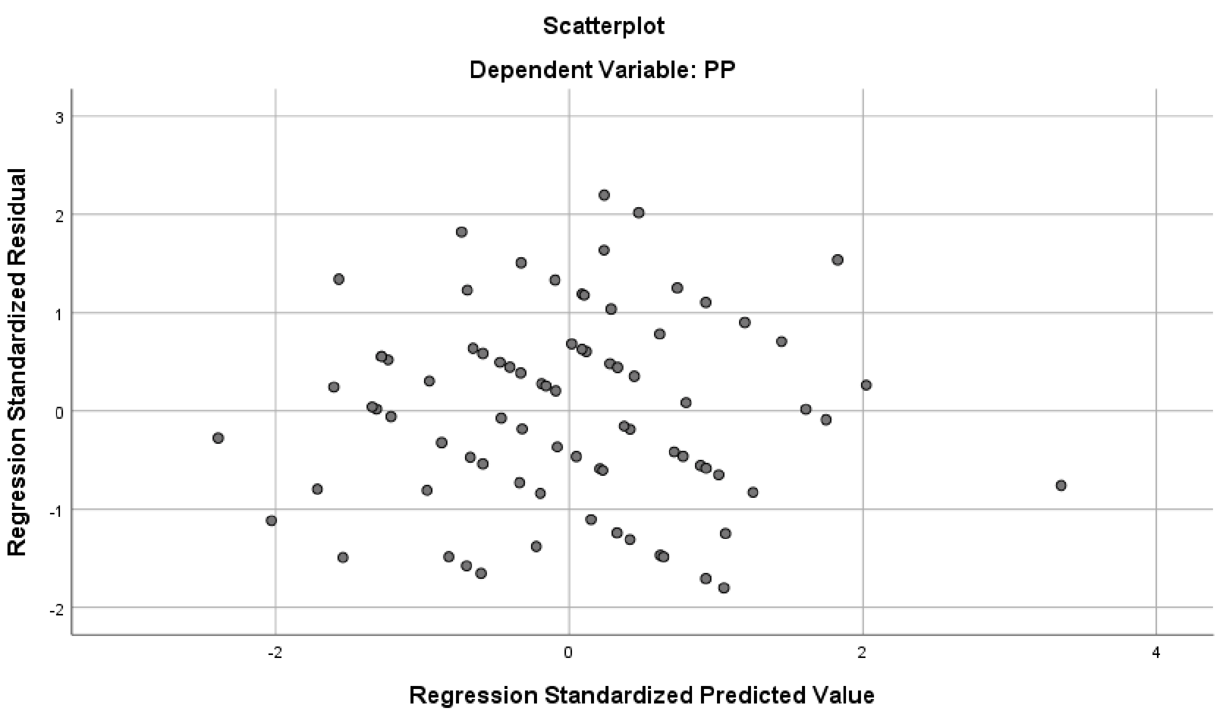


Figure 4.6 Homoscedasticity test

4.1.1.5. Normality of residuals

The other values that have to be tested to check regression is whether the value of the residuals is normally distributed. This assumption can be tested by looking at the P-P plot for the model. The closer the dots lie to the diagonal line, the closer to normal the residuals are distributed. In the case of the study data conducted, the provided P-P plot, the points closely follow the diagonal line, indicating that the residuals are approximately normally distributed. This suggests that the normality assumption is reasonably met. Additionally, the histogram of the regression standardized residuals depicts a bell-shaped curve, further supporting the normality of the residuals. Furthermore, a p-value of 0.354 and a statistic of 0.983 are obtained from the Shapiro-Wilk test indicating that the residuals do not significantly deviate from a normal distribution.

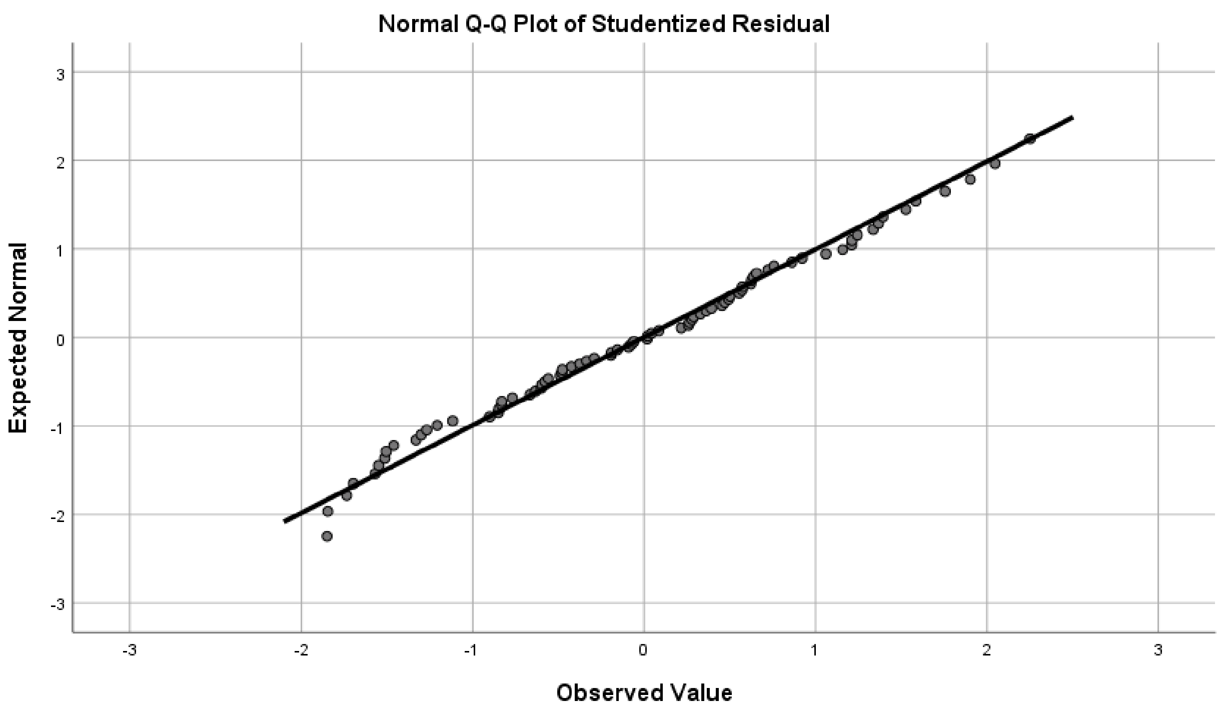


Figure 4.7 P-P plot for the model

Table 4.14.Test of Normality

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Studentized Residual	.053	80	.200*	.983	80	.354

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

Lilliefors Significance Correction

Source: SPSS Version 26 Output, 2024

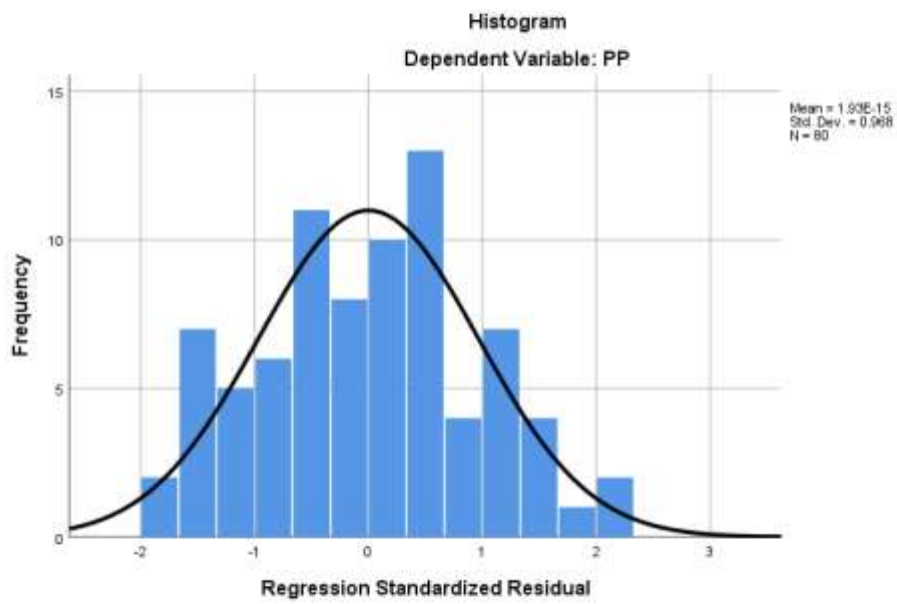


Figure 4.8. Histogram plot for the model

4.1.1.6. Outlier

The last assumption to be tested in regression analysis involves checking for outliers using Cook's distance statistics for each participant. Significant outliers, defined as those with Cook's distance values greater than 1, can exert undue influence on the model and should be removed before rerunning the analysis. The Cook's distance test in this study revealed that all values were below 1, indicating no significant outliers affecting the model. The box plot of the studentized deleted residuals further supports this finding; the absence of circles or asterisks at either end of the plot confirms that no outliers are present. Consequently, all preconditions for conducting regression analysis, including multicollinearity, outlier identification, normality, and heteroscedasticity, have been met. This ensures that the regression analysis is valid and reliable.

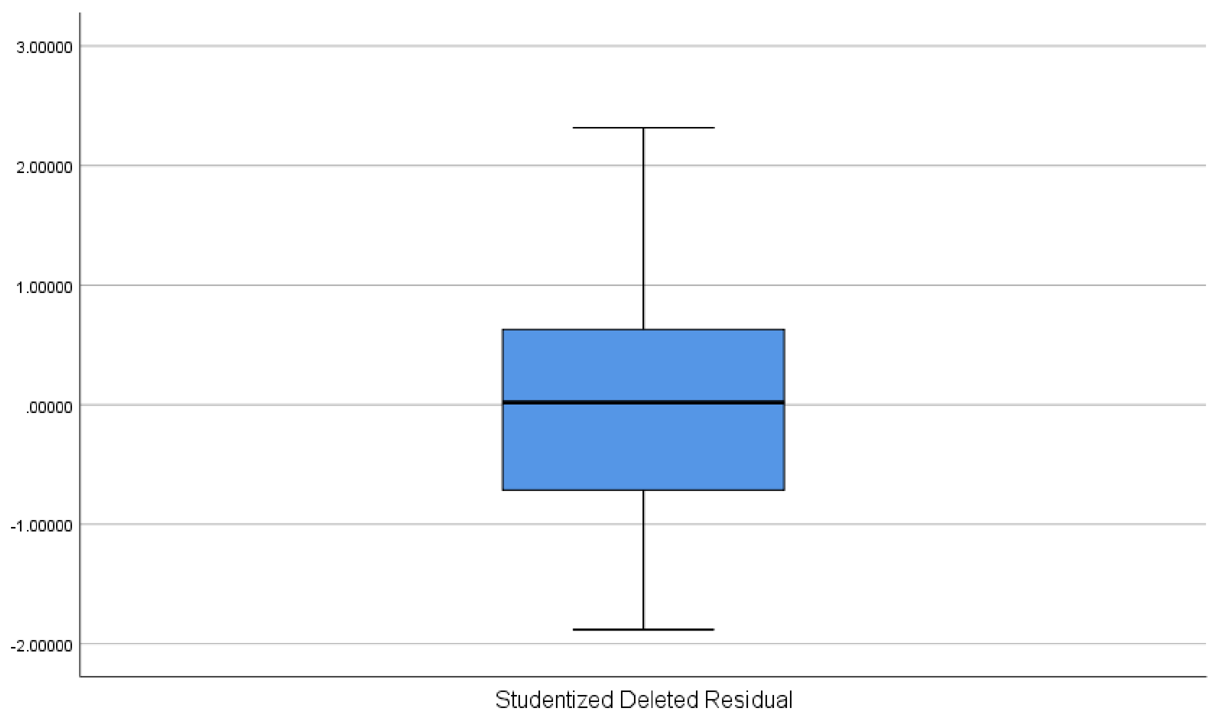


Figure 4.9. Outlier plot for the model

4.4.2. Multiple Regression analysis

The regression model in the table below illustrates the predictions of PP(Project Performance) with the known values of the five variables. R square shows the proportion of the variance for a project variable that's explained by the variables in a regression model.

Table 4.15. Regression Model

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.622[a]	.387	.345	.297	1.522

a. Predictors: (Constant), MTR, MR, TR, SR, RR

b. Dependent Variable: PP

Source: SPSS Version 26 Output, 2024

The model summary (Table 4.15) shows the coefficient of determination which revealed the model explanatory power. The R-value of 0.622 shows that there is a strong and positive correlation among the five variables (shows a good prediction level). The model summary demonstrates that the regression model has a coefficient of determination (R^2) of 0.387 indicating that 38.7% of the variability in PP can be explained by these five predictors(Management Risks, Technical Risks, Green team(stakeholder) Risks, Green Material and Technology Risks and Regulatory and Economic Risks). This implies a substantial explanatory power of the model, although it also suggests that 61.3% of the variability in PP is due to factors not included in the model.

ANOVA

The ANOVA reveals whether the model's overall performance significantly improves the outcome variable's prediction. (Field, 2005). As can be seen in Table 4.16, the regression analysis yielded a strong degree of prediction with a significant result on the ANOVA table of 0.001, or p 0.05.

Table 4.16. ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.110	5	.822	9.336	000[b]
	Residual	6.515	74	.088		
	Total	10.625	79			

a. Dependent Variable: PP

b. Predictors: (Constant), MTR, MR, TR, SR, RR

Source: SPSS Version 26 Output, 2024

The ANOVA table evaluates the overall fit of the regression model and its ability to predict the dependent variable, project performance (PP). The F-ratio in the ANOVA table indicates that the independent variables, comprising Management Risks (MR), Technical Risks (TR), Green team (stakeholder) Risks (SR), Green Material and Technology Risks (MTR), and Regulatory and Economic Risks (RR), collectively have a statistically significant predictive capability for PP. The results demonstrate that the model's F-ratio is 9.336, with a significance level of $p < 0.0005$, confirming that the regression model is a good fit for the data. The Sum of Squares for the regression is 4.110, with 5 degrees of freedom (df), leading to a Mean Square of 0.822. The Residual Sum of Squares is 6.515 with 74 degrees of freedom, resulting in a Mean Square of 0.088.

The total Sum of Squares is 10.625, with 79 degrees of freedom. Given that the significance value (p = 0.000) is less than 0.05, the results indicate a high degree of prediction, signifying that the independent variables significantly contribute to explaining the variance in PP. Therefore, the regression model is robust and effective in predicting project performance within the context of sustainable construction projects.

Table 4.17. Standardized coefficient Beta

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.900	.349		2.578	.012
	MR(X1)	.079	.093	.096	.855	.395
	TR(X2)	.227	.091	.273	2.500	.015
	SR(X3)	.172	.084	.240	2.049	.044
	RR(X4)	.092	.080	.150	1.154	.252
	MTR(X5)	.092	.077	.151	1.192	.237

Source: SPSS Version 26 Output, 2024

A unit of change in the independent variable causes an average change of one in the dependent variable, which is explained by the regression coefficient. An independent variable is more strongly supported as the more significant predictor of the dependent variable when it has a bigger value of beta coefficient. The Standardized coefficient Beta can be used to investigate which of the variables contributed the most to the prediction of the dependent variable. The standardized coefficients signify that the values for each of the several variables have been scaled to be comparable. The nature of the relationship of the constructs, Management Risks, Technical Risks, Green team(stakeholder) Risks, Green Material and Technology Risks and Regulatory and Economic Risks was positive with Beta equal to .079, .227, .172, .092 and .092 respectively. The positive slope indicates that practice of PP increases as each construct increases at their Beta value.

$$Y= 0.079X1+0.227X2 +0.172X3 + 0.092X4 + 0.092X5+ 0.900$$

Where:

Y: PP(Project Performance)

X1: Management Risks

X2: Technical Risks

X3: Green team(stakeholder) Risks

X4: Green Material and Technology Risks

X5: Regulatory and Economic Risks

Notably, only the effects of TR ($t = 2.500$, $p = 0.015$) and SR ($t = 2.049$, $p = 0.044$) are statistically significant, as their p-values are less than 0.05. The standardized coefficients (Beta) further illustrate that TR (0.273) is the strongest predictor of PP, followed by SR (0.240), with MR (0.096) being the weakest predictor. Although the coefficients for MTR and RR are the same (0.092 unstandardized, 0.151 Beta), neither is statistically significant ($p > 0.05$). The model's constant (intercept) is 0.900, which is statistically significant ($t = 2.578$, $p = 0.012$). The positive coefficients across all variables suggest that increases in these risk factors are associated with increases in PP, though the magnitude and significance of these effects vary. The findings underscore that while TR and SR significantly enhance PP, MR has the least impact and lacks statistical significance. Overall, the model offers valuable insights into the differential influence of risk factors on PP, guiding stakeholders to prioritize the most impactful areas to improve project outcomes in sustainable construction.

4.5 Hypothesis Testing

Hypothesis testing is a formal procedure for investigating our ideas about the world using statistics. It is most often used by scientists to test specific predictions, called hypotheses, which arise from theories. Hypothesis testing is based on standardized coefficients (beta) and P-values to determine whether the hypotheses are rejected or not. Based on the testing results, the researcher tested each proposed hypothesis as follows:

Hypothesis 1

H10: Management risk factors do not have a significant impact on project performance.

H1A: Management risk factors do have a significant impact on project performance.

The results of regressions revealed that management risk factors do not have a significant impact on project performance with a beta value (beta = 0.096), at a 95% confidence interval (p = 0.395). Consequently, the null hypothesis (H10) is not rejected, indicating that management risk factors do not significantly impact project performance.

Hypothesis 2

H20: Technical risk factors do not have a significant impact on project performance.

H2A: Technical risk factors do have a significant impact on project performance.

The regression results showed that technical risk factors have a strong significant impact on project performance with a beta value (beta = 0.273), at a 95% confidence interval (p = 0.015). Therefore, the null hypothesis (H20) is rejected, and the alternative hypothesis (H2A) is accepted, indicating that technical risk factors have a significant impact on project performance.

Hypothesis 3

H30: Green team (stakeholders) risk factors do not have a significant impact on project performance.

H3A: Green team (stakeholders) risk factors do have a significant impact on project performance.

The regression results indicated that green team (stakeholders) risk factors have a significant impact on project performance with a beta value (beta = 0.240), at a 95% confidence interval (p = 0.044). Consequently, the null hypothesis (H30) is rejected, and the alternative hypothesis (H3A) is accepted, indicating that green team (stakeholders) risk factors have a significant impact on project performance.

Hypothesis 4

H40: Green materials and technology risk factors do not have a significant impact on project performance.

H4A: Green materials and technology risk factors do have a significant impact on project performance.

According to the regression coefficient results, green materials and technology risk factors do not have a significant impact on project performance with a beta value (beta = 0.151), at a 95% confidence interval (p = 0.237). Therefore, the null hypothesis (H40) is not rejected, indicating that green materials and technology risk factors do not significantly impact project performance.

Hypothesis 5

H50: Regulatory and economic risk factors do not have a significant impact on project performance.

H5A: Regulatory and economic risk factors do have a significant impact on project performance.

The regression results showed that regulatory and economic risk factors do not have a significant impact on project performance with a beta value (beta = 0.150), at a 95% confidence interval (p = 0.252). Consequently, the null hypothesis (H50) is not rejected, indicating that regulatory and economic risk factors do not significantly impact project performance.

In social science studies, the decision to reject the null hypothesis and accept the alternative hypothesis depends on the specific research question, study design, and statistical analysis employed. The criteria for making this decision typically involve statistical significance and effect size. Statistical significance refers to the probability that the observed results are not due to random chance. Researchers use statistical tests, such as t-tests, chi-square tests, or analysis of variance (ANOVA), to determine if the observed differences or relationships between variables are statistically significant. If the P-value associated with the statistical test is below a predetermined threshold (commonly set at 0.05), researchers reject the null hypothesis and accept the alternative hypothesis. Effect size, on the other hand, measures the magnitude or strength of the observed impact or relationship. It provides an indication of the practical significance of the findings. While statistical significance determines if the results are unlikely to occur by chance, effect size helps researchers understand the magnitude of the observed impact and its practical implications.

In summary, social science studies determine the acceptance of the alternative hypothesis through a combination of statistical significance and effect size. This decision is made based on the results of statistical tests and the assessment of the practical significance of the observed impacts or relationships.

CHAPTER FIVE

5. SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATION

This chapter summarizes the findings and results based on the data collected from respondents. This study looks at the risk factors that influence sustainable construction project performance. Following that, the discussion had attempted to achieve all of the study's objectives. As a result, recommendations has made to the target company in order to address the issue at hand.

5.1. Summary of Major findings

The primary objective of this study was to describe and rank the various categories of risks associated with the implementation of sustainable practices in construction projects from the perspectives of individuals involved in EASE's projects, including senior managers, project managers, and engineers at East Africa Specialized Engineering PLC. The study also aimed to determine how these risks impacted project performance in terms of time, cost, and quality. This section highlights the analysis's primary results and findings.

The first specific objective was to identify the main sustainable construction practices being adopted by the company. EASE emphasizes nine major constraints in its sustainable construction practices: sustainable materials, efficient waste management, green building certifications, renewable energy integration, sustainable design practices, community involvement, and adoption of new technologies. The interviewees highlighted the importance of environmentally conscious building practices for both project success and ecological responsibility. Strategies for upholding EASE's commitment include the use of post-tensioning technology, the incorporation of ecologically friendly materials, the use of ERP systems for cost tracking and budget control, and the implementation of energy-efficient systems such as LED lighting. These efforts strive to reduce environmental impact, promote sustainable solutions, and help the company achieve its sustainability goals.

The second particular objective was to examine the perceived risks associated with these sustainable practices from the viewpoints of people participating in EASE initiatives, such as senior managers, project managers, and engineers. The study used a five-dimensional instrument that included management, technical, stakeholders, green materials and technology, and regulatory and economic risks.

In terms of management risks, the factor with the highest likelihood is the difficulty in project budgeting due to unfamiliarity with green projects (mean score of 3.89, RII of 0.78). Poor project manager skills related to sustainable construction had the highest impact, with a mean score of 4.00 and a RII of 0.08.The most significant level of concern is the additional costs due to green material and equipment, with a mean score of 13.94. Other important factors include tight schedules for sustainable construction, improper sustainable project feasibility and planning, and poor quality of sustainable construction work. Addressing these risks is critical to the successful execution of sustainable construction projects.

In terms of technical risks, the most likely is a failure to meet green codes or certification (mean score of 4.26, RII of 0.85), underscoring the difficulties in adhering to demanding green standards and certification processes. Design changes have the greatest impact (mean score of 3.48, RII of 0.70), upsetting timelines and finances. The key factor is a failure to comply with standards or certification (mean score of 13.40). Other key constructs include improper or incomplete green specifications, poor scope definition of sustainable construction, and poor selection of construction techniques. These findings emphasize the multifaceted nature of technical risks in sustainable building, underlining the importance of meticulous project management to assure success.

In terms of Green Team (Stakeholder) Risks: The largest likelihood is linked to the restricted availability and reliability of green subcontractors (mean score of 3.89, RII of 0.78), resulting in project delays and cost increases. Risk factors associated with the impact are client resistance to adopting new green ideas (mean score of 3.51, RII of 0.70). and limited consultant experience with a mean score of 3.51, RII of 0.70). The severity with the highest value is limited experience of consultants about sustainable construction practices (mean score of 33.44). A skilled labor scarcity in sustainable construction can have a substantial influence on project schedules and quality, stressing the significance of investing in labor training and development programs. Contractor experience is also an important element, with a mean score of 3.41 and a RII of 0.68. Addressing these essential aspects is critical to the successful implementation and completion of sustainable construction projects.

Risks associated with green materials and technology, the most probable factors of occurrence are improper handling and storage of green materials (mean score of 3.49, RII of 0.70) and a lack of papers and knowledge for new green technologies (mean score of 3.49, RII of 0.70). These concerns have a substantial impact on project performance, resulting in setbacks and increased costs. The long lead time for green materials (mean score of 3.65, RII = 0.73) is the most impactful, illustrating inappropriate handling and storage of green materials is the most severe with a mean score of 12.20. Other major concerns include a lack of green materials.

Regulatory and Economic Risks: The greatest likelihood is attributable to delays in government clearances for green development. Inappropriate handling and storage of green materials resulted in a mean score of 3.71 and a RII of 0.74, emphasizing the difficulty of navigating regulatory systems and potential project delays. Changes in sustainable construction norms and regulations, as well as inflation in green material prices, can have a substantial influence on project performance due to inappropriate handling and storage of green materials (mean score of 3.61, RII of 0.72). The severity of these risks is highest for delays in government approvals, with a mean score of 13.24. Currency volatility worsened by the import of green materials is a significant risk, ranking third in probability with an RII of 0.57. This aspect highlights the financial instability caused by exchange rate variations, especially when green materials are sourced abroad.

The third specific objective was to analyze the potential impact of these risks on project performance inside EASE. The study used a five-dimensional instrument that included management, technical, stakeholders, green materials and technology, and regulatory and economic risks. The data revealed that these factors significantly influence project performance, with an adjusted R2 value of 38.7%, indicating that 38.7% of the variance in project performance can be explained by these factors. Pearson's correlation results indicated a positive and significant relationship between all affecting factors and project performance. Green team (stakeholder) risks had the strongest connection with project performance, whereas management, green materials and technology, and regulatory and economic risks all had a moderate correlation.

In conclusion, the data indicate that management, technical, green team (stakeholders), green materials and technology, and regulatory and economic risks are variables impacting project performance. Addressing these risks through comprehensive risk management techniques is critical for improving project efficiency in terms of time, cost, and quality, thereby ensuring the successful completion of EASE's sustainable construction projects.

5.2. Conclusion of the study

The primary objective of any construction project is to achieve the project's goals while adhering to the budget, schedule, and quality standards set by the client. However, risks are potential situations that could impede these objectives. Through an extensive review of the literature, this study has identified and categorized the most significant risk factors impacting the performance of sustainable construction projects. A questionnaire survey was conducted as part of a quantitative study to gather information about these identified risk factors based on the experiences of industry professionals.

The study revealed several key insights into the risk categories affecting sustainable construction project performance at EASE. Management risks, particularly difficulties in project budgeting due to unfamiliarity with green projects and poor project manager skills related to sustainable construction, were highlighted as significant concerns. These factors have a notable impact on project timelines and costs. Technical risks, including failure to meet green codes or certification and design changes, also pose substantial challenges, often leading to delays and financial overruns. The emphasis on precise project management to address these risks is crucial for successful sustainable construction.

Stakeholder-related risks, such as the limited availability of reliable green subcontractors and client resistance to adopting new green ideas, were identified as substantial threats to project performance. The study underscored the importance of investing in training and development programs to address skilled labor shortages in sustainable construction. Furthermore, risks associated with green materials and technology, like improper handling and long lead times for green materials, significantly impact project outcomes. Regulatory and economic risks, particularly delays in government approvals and inflation in green material prices, were also found to affect project performance critically. Overall, addressing these multifaceted risks through comprehensive risk management strategies is essential to improve project efficiency and ensure the successful completion of EASE's sustainable construction projects.

The findings will serve as the foundation for a framework demonstrating that sound investment decisions require more than mere risk analysis; they also necessitate addressing issues related to time, cost, and performance, as well as ensuring accountability for decisions. Preliminary interview results suggest a lack of understanding among developers regarding the management of inherent risks in their work, despite the necessity of such understanding for the ongoing professionalization of the sector. Risk analysis enables project managers to prioritize tasks, allocate resources, and implement processes and actions that reduce the likelihood of failing to meet project goals. Risk analysis enhances company and project outcomes by providing insights, knowledge, and confidence for improved decision-making. Specifically, it promotes smarter choices about planning and design procedures to mitigate or eliminate risks and to seize opportunities. It also improves contingency planning for addressing risks and their impacts, supports better resource allocation and budget alignment to risks, and facilitates decisions regarding optimal risk allocation among project stakeholders. Collectively, these factors will increase certainty and reduce overall risk exposure, as outlined in the Project Management Institute's (PMI) guide (PMI, 2004).

Effective management of stakeholder risks, particularly ensuring the availability and reliability of green subcontractors, is essential. Proper handling and storage of green materials, coupled with comprehensive documentation, are crucial for mitigating material and technology risks. Regulatory and economic risks require proactive strategies to manage government approvals, regulatory changes, and material cost inflation. Skilled project management and realistic budgeting are imperative for addressing project management risks. Lastly, technical risks necessitate detailed planning and adherence to green standards to ensure successful project outcomes.

5.3. Recommendations of the study

The following recommendations are presented in concordance with the key findings:

- Enhance Industry Education and Training Programs: Improving the industry's education and training programs is essential to promoting a broader comprehension and acceptance of sustainable construction. Offer workshops and certification courses focused on the latest sustainable construction techniques and materials.
- Customer Education : Enlightening customers about the many advantages of sustainable practices will greatly diminish opposition, and providing consultants and project managers with specific training will improve their knowledge and effectiveness in this area of implementation.
- Improve Supply Chain Management : supply chain management must be improved; building trustworthy networks of environmentally conscious suppliers and subcontractors will reduce the risks related to the availability of sustainable resources. Lead times can be further shortened by putting in place effective procurement procedures, guaranteeing project completion on schedule.

- Proactive Regulatory Engagement: Staying up to date with rules requires proactive involvement with regulatory authorities; creating regular channels of communication with government agencies can help with this, and creating plans to expedite government approvals will guarantee compliance and smooth project progression.

5.4. Research Limitations and Areas for Further Study

5.4.1. Limitations of the study

The scope of this study is confined to a specific geographical region, potentially limiting its representation of global sustainable construction practices. The research primarily focuses on the initial stages of construction projects, with limited consideration given to long-term sustainability outcomes. Data limitations are evident, as the study relies on self-reported measures, which may introduce biases or inaccuracies. Additionally, the sample size may restrict the generalizability of the findings to all sustainable construction projects. Moreover, sustainable construction practices and technologies are rapidly evolving, and this research may not fully capture the latest developments or future trends in the field.

5.4.2. Areas for Future Study

As this study had bounded itself with a single company and limited with geographical boundary, future research into the risks associated with the implementation of sustainable practices in construction projects and their relationship to project performance could be conducted in other directions.

- Conduct a longitudinal research to investigate the long-term implications of risk factors on sustainable construction project performance, which will provide significant insights into how these risks evolve over time.
- Perform a comparative examination of risk management techniques across regions or industries to find best practices and opportunities for improvement.

- Investigate the perspectives and experiences of various stakeholders, such as clients, contractors, and regulators, about risk considerations in sustainable building projects to gain a thorough understanding of these challenges.

- To understand how the regulatory environment affects sustainable construction, assess the impact of government policies and regulations on risk factors and project performance.
- Conduct in-depth case studies of different construction companies or projects to better understand the dynamics. These areas of future study can contribute significantly to advancing knowledge in sustainable construction project management.

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Annex I

QUESTIONNAIRE FOR SENIOR MANAGERS, PROJECT MANAGERS AND OFFICE ENGINEER

Bezawit Tesfaye

Email: - bezawittesfaye13@gmail.com

Addis Ababa

RE: Request for Participation in a Research Study

Dear Sir/Madam,

I am attending a postgraduate program in Project Management at Addis Ababa University School of Commerce (AAUSC). As part of my degree requirements, I am conducting a research study titled " Risk Factors Impacting Sustainable Construction Project Performance: The Case of East Africa Specialized Engineering PLC (EASE) in Ethiopia."

The objective of this study is to evaluate various risk factors that impact the success of sustainable construction projects, with a particular focus on the work and projects undertaken by EASE. I aim to identify key risks, understand their potential impact, and explore effective strategies to mitigate them.

Your insights and experiences are invaluable to this research. I would greatly appreciate it if you could take a few minutes to answer the following questions. Your responses will contribute significantly to understanding the risk landscape in sustainable construction and help develop better risk management practices.

All responses will be kept confidential, and the data will be used solely for academic purposes. Thank you for your time and assistance in advancing this important research.

Bezawit Tesfaye, Addis Ababa University, 0922827210

INSTRUCTION:

i. Do not write your name on the questionnaire.
ii. Please read each question carefully.
iii. Kindly answer all the questions by ticking or filling in the spaces provided.

SECTION ONE: **Background Information**

1. **Sex:**

- ☐ Male
- ☐ Female

2. **Age:**

- ☐ 21-30 years
- ☐ 31-40 years
- ☐ 41-50 years
- ☐ Over 51 years

3. **Level of Education:**

- ☐ Certificate
- ☐ Diploma
- ☐ Bachelor's Degree
- ☐ M.Sc./M.A.
- ☐ Doctorate/Ph.D.

4. **Work Experience in the Organization:**

- ☐ 0-5 years
- ☐ 6-10 years
- ☐ 11-15 years
- ☐ Over 15 years

5. **Role in the Organization:**

- ☐ Senior Manager
- ☐ Project Manager
- ☐ Construction/Office Engineer
- ☐ Other (specify): ________________________

SECTION TWO: **Assessing Risk Factors in Sustainable Construction Projects in the Organization.**

1. **Sustainable Construction Practices**

To what extent have sustainable techniques been adapted in projects carried out by your organization? Please tick 1= Strongly Disagree, 2= Disagree 3= Neutral 4= Agree 5= Strongly Agree)

Sustainable Construction Practices		1	2	3	4	5
SCP1	EASE prioritizes energy efficiency in its construction projects.					
SCP2	EASE emphasizes water conservation in its construction projects.					
SCP3	EASE frequently uses sustainable materials in its construction projects.					
SCP4	EASE manages waste effectively to promote sustainability.					
SCP5	EASE often seeks green building certifications for its sustainable construction projects.					
SCP6	EASE incorporates renewable energy sources into its construction projects.					
SCP7	EASE integrates sustainable design practices into its construction projects.					
SCP8	EASE engages with local communities to promote sustainability.					
SCP9	EASE is willing to adopt new technologies to enhance sustainability.					

2. Risks Associated with Sustainable Construction Practices

How do you perceive risks related to the application of sustainable practices in projects in the organization? Please tick (For **Probability of Occurrence**:1: Very Low Probability, 2: Low Probability, 3: Moderate Probability, 4: High Probability, 5: Very High Probability; For **Impact on Construction Projects:**1: Very Low Impact, 2: Low Impact, 3: Moderate Impact, 4: High Impact and 5: Very High Impact)

A. Management Risks

- **Assessment of Probability of Occurrence**

	Risk Category	**Probability of Occurrence**				
	Management Risks	**1**	**2**	**3**	**4**	**5**
MR1	Tight schedule for sustainable construction					
MR2	Improper sustainable project feasibility and planning					
MR3	Shortage of clients funds					
MR4	Difficulty in project budgeting due to unfamiliarity in green projects					
MR5	Poor project manager skills related to sustainable construction					
MR6	Additional costs due to green material and equipment					
MR7	Poor quality of sustainable construction work					

- **Assessment of Impact on Construction Projects**

	Risk Category	**Impact on Construction Projects**				
	Management Risks	**1**	**2**	**3**	**4**	**5**
MR8	Tight schedule for sustainable construction					
MR9	Improper sustainable project feasibility and planning					
MR10	Shortage of clients funds					
MR11	Difficulty in project budgeting due to unfamiliarity in green projects					
MR12	Poor project manager skills related to sustainable construction					
MR13	Additional costs due to green material and equipment					
MR14	Poor quality of sustainable construction work					

B. Technical Risks

- **Assessment of Probability of Occurrence**

	Risk Category	**Probability of Occurrence**				
	Technical Risks	**1**	**2**	**3**	**4**	**5**
TR1	Design changes					
TR2	Improper or incomplete green specifications					
TR3	Poor scope definition of sustainable construction					
TR4	Failure to meet green code or certification					
TR5	Poor selection of construction techniques in sustainable construction					
TR6	Poor productivity of labor and equipment in sustainable construction					

- **Assessment of Impact on Construction Projects**

	Risk Category	**Impact on Construction Projects**				
	Technical Risks	**1**	**2**	**3**	**4**	**5**
TR7	Design changes					
TR8	Improper or incomplete green specifications					
TR9	Poor scope definition of sustainable construction					
TR10	Failure to meet green code or certification					
TR11	Poor selection of construction techniques in sustainable construction					
TR12	Poor productivity of labor and equipment in sustainable construction					

C. **Green team (stakeholders) risks**

- **Assessment of Probability of Occurrence**

	Risk Category	Probability of Occurrence				
	Green team (Stakeholders) Risks	**1**	**2**	**3**	**4**	**5**
SR1	Resistance from the client to adopt new green ideas					
SR2	Limited experience of the consultant about sustainable construction practices					
SR3	Limited experience of the contractor about sustainable construction practices					
SR4	Limited availability and reliability of green subcontractors					
SR5	Limited availability and reliability of green suppliers					
SR6	Shortage in labor skilled in sustainable construction					

- **Assessment of Impact on Construction Projects**

	Risk Category	Impact on Construction Projects				
	Green team (Stakeholders) Risks	**1**	**2**	**3**	**4**	**5**
SR7	Resistance from the client to adopt new green ideas					
SR8	Limited experience of the consultant about sustainable construction practices					
SR9	Limited experience of the contractor about sustainable construction practices					
SR10	Limited availability and reliability of green subcontractors					
SR11	Limited availability and reliability of green suppliers					
SR12	Shortage in labor skilled in sustainable construction					

D. Green materials and technology risks

- **Assessment of Probability of Occurrence**

	Risk Category	Probability of Occurrence				
	Green Materials and Technology Risks	**1**	**2**	**3**	**4**	**5**
MTR1	Shortage of green materials					
MTR2	Long lead time for green materials					
MTR3	Inappropriate handling and storage of green materials					
MTR4	Lack of documents and information for new green technologies					

- **Assessment of Impact on Construction Projects**

	Risk Category	Impact on Construction Projects				
	Green Materials and Technology Risks	**1**	**2**	**3**	**4**	**5**
MTR5	Shortage of green materials					
MTR6	Long lead time for green materials					
MTR7	Inappropriate handling and storage of green materials					
MTR8	Lack of documents and information for new green technologies					

E. Regulatory and economic risks

- **Assessment of Probability of Occurrence**

	Risk Category	Probability of Occurrence				
	Regulatory and Economic Risks	**1**	**2**	**3**	**4**	**5**
RR1	Delay in government approvals for green construction					
RR2	Changes in sustainable construction codes and regulations					
RR3	Inflation of green materials' prices					
RR4	Currency Volatility worsened by the import of green materials					

- **Assessment of Impact on Construction Projects**

	Risk Category	**Impact on Construction Projects**				
	Regulatory and Economic Risks	**1**	**2**	**3**	**4**	**5**
RR5	Delay in government approvals for green construction					
RR6	Changes in sustainable construction codes and regulations					
RR7	Inflation of green materials' prices					
RR8	Currency Volatility worsened by the import of green materials					

3. **Project Performance**

How would you rate the organization's project performance in the following areas? Please tick (1=Very Low, 2=Low, 3=Moderate, 4=High, and 5=Very High)

Project Performance		**1**	**2**	**3**	**4**	**5**
PP1	Improper scheduling influences project performance					
PP2	Poor coordination and communication among project teams affect project performance					
PP3	Improper budget assignment contributes to the project performance risk					
PP4	Inaccurate cost estimation affects project performance					
PP5	Inadequate quality control measures influence project performance					
PP6	Inadequate management in ensuring projects meet quality standards contributes to the project performance risk					

Annex II

INTERVIEW QUESTIONS FOR SENIOR MANAGERS

1. Can you provide examples of specific sustainable practices that have been integrated into recent projects?
2. How do you prioritize sustainable construction practices in project planning and execution?
3. Have you observed any challenges or successes in implementing sustainable practices in construction projects?
4. What are the main concerns or obstacles you foresee when considering sustainable construction practices?
5. Do you believe there is sufficient awareness and understanding of the risks related to sustainable construction practices among stakeholders?
6. How do you think these perceived risks impact decision-making processes in construction projects?
7. How do these risks influence project efficiency in terms of time management, cost control, and quality assurance?
8. Can you provide examples of how addressing or neglecting these risks has affected project outcomes in the past?
9. What strategies or measures do you believe can mitigate the negative impact of perceived risks on project performance?