

**T.C.
ISTANBUL GEDİK UNIVERSITY
INSTITUTE OF GRADUATE STUDIES**



**EVALUATION PRACTICES, BENEFITS AND
DISADVANTAGES TO CONSTRUCTION OF GREEN
BUILDING IN IRAQ**

MASTER THESIS

Hasanain Naji Mohammed ALBUOGHUNAIM

Civil Engineering Department

Master in Civil Engineering English Program

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ISTANBUL**

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Istanbul 2024



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Bu çalışma 15/03/2024 tarihinde aşağıdaki jüri tarafından İnşaat Mühendisliği Anabilim Dalı, İnşaat Mühendisliği (Tezli Yüksek Lisans) Programı Yüksek Lisans Tezi olarak kabul edilmiştir.

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DECLARATION

I, Hasanain Naji Mohammed ALBUOGHUNAIM, declare that this thesis titled “Evaluation Practices, Benefits and Disadvantages to Construction of Green Building in Iraq” is original work I completed this to receive my master's in civil engineering. I further declare that neither this thesis nor any part of it has ever been submitted to or presented for a research paper or other degree at any other university or institution.
(15 /03/2024)

Hasanain Naji Mohammed ALBUOGHUNAIM



DEDICATION

I offer my humble effort...

*To the Master of the Prophets and Messengers and the Messenger who sent to
guide all of creation. Mohammed*

*To the one who enlightened my mind with his knowledge and put me on the right
path. Dear admin*

To those who went through hardships to get to where I am... my mom and dad

To my family who supported me... my brothers and sisters

To those who helped me complete my scientific career

To my colleagues and teachers

I offer my humble effort...

PREFACE

Praise and thanks be to you, O our Lord, as befits the majesty of your face, the greatness of your authority and your glory, and prayers and peace be upon our Prophet Muhammad. May God's prayers and peace be upon him and his family and all his companions.

After God has granted me the grace to complete my humble dissertation, I am pleased and honoured to extend my sincere thanks, appreciation, and abundant gratitude to Dr. Hassan Bozkurt Nazilli for his kindness in supervising my dissertation and for the great effort he made. He did not skimp on me in providing advice and guidance, and he had a significant impact in making this dissertation appear to its fullest.

I extend my sincere thanks to my dear teachers, who were of great help in the preparatory year, as they did everything in their power and did not hesitate to provide us with scientific information.

To all of my journey companions, I extend my thanks and gratitude, wishing them good luck and lasting success.

I extend my thanks to the professors who provided their answers to the questionnaire form for my research.

Praise be to God, Lord of the Worlds, and prayers and peace be upon the Seal of the Prophets and upon him and his distinguished companions and those who follow their path until the Day of Judgment.

March 2024

Hasanain Naji Mohammed ALBUOGHUNAIM

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ABBREVIATIONS

GB	: Green Building
RII	: Relative Importance Index
α	: Cronbach's Alpha
SIG	: Significance Level
GHG	: Greenhouse Gases
GPM	: Green Project Management
SPM	: Sustainable Project Management
UNEP	: United Nations Environment Program
GBP	: Green Building Practices
GBM	: Green Building Management
GBC	: Green Building Construction
SPM	: Sustainable Project Management
SPSS	: Statistical Package Social Science
BIM	: Building Information Modeling

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EVALUATION PRACTICES, BENEFITS AND DISADVANTAGES TO CONSTRUCTION OF GREEN BUILDING IN IRAQ

ABSTRACT

These practices represent a comprehensive guide that enables stakeholders, including project managers, contractors, consultants, and engineers, to identify green construction practices. It also enables academics to take this guide as a reference to conduct future, more in-depth studies in green construction management. This study serves as evidence for awareness of the benefits of green construction for its adoption and encouragement for its use, in addition to the disadvantages of using green construction to overcome these disadvantages.

This thesis provides a comprehensive guide to green construction management that includes both green construction practices and the advantages and disadvantages of using these practices, with an in-depth analysis of the literature and accurate data analysis. This study examines the effectiveness of green construction practices from an environmental perspective, resource management, waste management, and health and safety management. Energy Efficiency This study also addresses the benefits resulting from green construction practices in terms of environmental, economic, social, health, and sustainability, in addition to revealing the disadvantages resulting from green construction practices, represented by disadvantages related to resources, technology, organization, and economics.

Among the most essential benefits that the study found in green construction management are reducing carbon emissions and resource consumption, improving economic development, reducing demand for fossil fuels, reducing carbon emissions, and improving air quality. This study confirmed that these benefits can be achieved through green construction management practices, represented by management's Effective use of resources and waste through recycling, reuse and handling processes, the use of renewable natural resources and water treatment, the adoption of environmentally friendly technology in the construction industry, work on integrating environmentally friendly technology to produce environmentally friendly materials, the use of renewable resources to improve energy efficiency, and the conduct of training workshops for workers to learn how to use green technology and equipment. This study also revealed the disadvantages related to green construction management through the lack of knowledge of stakeholders, including contractors and consultants, about green construction practices, in addition to the weakness of regulations and policies related to green construction practices and the lack of green suppliers. Moreover, there is a lack of knowledge about the specifications of green materials and the enormous economic costs resulting from green construction practices. This research not only identifies the significant practices for green construction management but also provides a comprehensive, implementable approach for construction companies, policy makers, and academics, in addition to raising awareness about the valuable benefits of green construction practices to adopt them and the disadvantages resulting from green construction practices to study them

in-depth and find future solutions to avoid them. This study recommends that the construction industry execute a comprehensive green construction management programme, provide innovation and employing technology, and provide financial incentives for green construction management. Also, this study recommends promoting green construction management through research into materials that are combined with building materials and reduce environmental impacts.

Keywords: *Sustainable Practices, Green Construction, Green Practices, Disadvantages-Benefits.*



IRAK'TA YEŞİL BİNA İNŞAATININ DEĞERLENDİRME UYGULAMALARI, FAYDALARI VE DEZAVANTAJLARI

ÖZET

Bu tez, yeşil inşaat uygulamaları ve bu uygulamaları kullanmanın avantajları ve dezavantajlarını kapsayan yeşil yapım yönetimi hakkında kapsamlı bir rehberlik sunar, bu uygulamanın derinlemesi nebiranalizi ve doğru verianaliziiile. Bu çalışma, yeşil inşaat uygulamalarının çevresel bakış açısıyla, kaynak yönetimi, atık yönetimi ve sağlık ve güvenlik yönetimi açısından etkililiğini inceliyor. Enerji Verimliliği Bu çalışma, yeşil inşaat uygulamalarının çevresel, ekonomik, sosyal, sağlık ve sürdürülebilirlik açısından yarattığı faydaları da elealarak, kaynaklar, teknoloji, organizasyon ve ekonomi açısından ortaya çıkandez avantajları ortaya çıkarıyor.

Çalışmanın yeşil inşaat yönetimi alanında bulduğu en önemli faydalar arasında karbon emisyonlarını azaltmak ve kaynak tüketimini azaltmak, ekonomik kalkınmayı iyileştirmek, fosil yakıtlara olan talebin azaltılması karbonsalınımını azaltma ve hava kalitesini artırmak yer alıyor. Bu çalışma, bu faydaların yönetim tarafından temsil edilen yeşil inşaat yönetimi uygulamaları yoluyla elde edilebileceğini doğruladı. Kaynakların ve atıkların geridönüşüm, yeniden kullanım ve yönetme süreçleri, yenilenebilir doğal kaynakların kullanımı ve suarıtımı, inşaat endüstrisinde çevre dostu teknolojinin uygulanması, çevre Dostu malzemeler üretmek için çevresel dostu teknoloji entegreetme çalışmaları, enerji ve rimliliğini artırmak ve işçilerin yeşil teknolojiler ve ekipmanların nasıl kullanılacağını öğrenmeleri için eğitim atöl yelerinin düzenlenmesi yoluyla etkili kullanımı. Bu çalışma, yeşil inşaat uygulamaları ile ilgili düzenlemelerin ve politikaların zayıflığına ve yeşil tedarikçilerine ksikliğine ekolarak, sözleşmecılar ve danışmanlar da dahil olmak üzere paydaşların yeşil yapım uygulamaları hakkında bilgi eksikliğin eden iyleyeşil yapı yönetimi ile ilgili dezavantajları da ortaya koydu. Dahası, yeşil malzemelerin özellikleri ve yeşil inşaat uygulamalarından kaynaklanan büyük ekonomik maliyetler hakkında bilgi eksikliğı. Bu araştırma sadece yeşil inşaat yönetimi için önemli uygulamaları tanımlamakla kalmıyor, aynı zamanda inşaat şirketleri, politikacılar ve akademi syenler için kapsamlı ve uygulanabilir bir yaklaşım sağlar, ayrıca onları kabuletmek için yeşil bina uygulamalarının değerli faydaları ve yeşil yapım uygulamalarından kaynaklanan dezavantajları hakkında farkındalık geliştirerek onları derinlemesine incelemek ve bunları önlemek için gelecekteki çözümler bulmak için.

Anahtar Kelimeler: *Sürdürülebilir uygulamalar, Yeşil inşaat, Yeşil uygulamaları, Dezavantajlar, Faydalar, Yeşil uygulamaları, Dezavantajlar, Faydalar*

1. INTRODUCTION

1.1 Introduction

The disposal of hazardous materials resulting from building practices in construction projects has become a cause for concern, as these materials and their waste can affect living organisms, including humans, animals, and plants, and thus cause harm as a result of an imbalance in the environment (Chevallier & Goutte, 2017). The environmental problems represented by greenhouse gas emissions, natural resource consumption, and energy consumption are due to the increase in construction activities as a result of the increasing demand for construction and urban expansion that the world is witnessing due to population inflation. UNEP, 2011 stated that about 40% of the energy is consumed in the construction industry, and in addition, construction practices are responsible for 30% of GHG emissions. The building sector heavily relies on construction materials, leading to a substantial depletion of resources and causing land and air pollution. Additionally, this activity contributes to soil degradation and a high level of energy consumption. Experts in the construction sector have created the notion of green building to meet the environmental needs and mitigate the effects of global warming by constructing eco-friendly infrastructure (Oguntona et al., 2019). Sustainable development is contingent upon three essential elements, namely environmental, economic, and social sustainability. Green building is a foundational strategy focused on minimizing adverse effects and enhancing the long-term sustainability of the construction sector (Shen et al., 2017). Green building practices can effectively reduce CO₂ emissions, energy depletion, water and air pollution, significant depletion of natural resources, and other diverse environmental impacts. Therefore, the construction sector must now prioritize the implementation of green building principles due to urbanization and increased energy consumption's impact on the environment. The recent focus on energy efficiency and environmental sustainability has made green building a fundamental consideration in infrastructure development.

The construction industry has set goals, and these goals have been defined as activities to address the deterioration resulting from construction activities. Green practices in construction project management have brought about a significant revolution in the field of project management because of their essential benefits and great importance in preserving the environment (Zhang et al., 2015). Wong & Zhou (2015) stated that adopting green management practices in construction projects should be a priority if the goal is to prevent and reduce the negative impact of construction activities in construction projects on the environment. The significant impact of the construction sector on the consumption of natural resources, as well as its contribution to climate change and pollution of air, water, and land, is the reason for this (Esen & Yuksel, 2013; Huisingh et al., 2015). Prior research on green construction management examines the impact of employing green construction site practices on the economic performance of projects. However, the results of these studies are contradictory. These previous studies provide evidence that implementing green construction site practices can help construction projects reduce their negative impact on the ecosystem while also improving economic performance. Examples of such studies include (Guy, 2017; Chang et al., 2018; Lucas and Noordewier, 2016).

However, other studies propose the adverse influence of adopting green practices in a construction project on economic performance (e.g. Jacobs et al., 2010; Zhang et al., 2015; Hwang, 2017), while no changing economic performance due to using green construction management (Watson et al., 2004).

A green building means building structures that are eco-responsible and that are efficient in using resources via the lifecycle of the building (Environmental Protection Agency 2016). It comprises components that feature high efficiency in using energy and water and are eco-friendly, introducing a high indoor air quality and having green characteristics for high performance of the building (BCA 2016). Due to the unique characteristics of green buildings, the construction methods and techniques used differ from those used in conventional construction (Dwaikat and Ali, 2016). Green building design differs from traditional building design as designers must employ an integrated design approach. Designers must possess knowledge of the interconnections among various building systems and the interactions between these systems and the environment. Comprehending this is vital for optimizing any system to match the particular environmental conditions (BCA

2010). To successfully deploy green buildings, it is essential to make precise alterations to conventional project management operations and methods (Robichaud and Anantatmula, 2011). The notion of green construction entails the judicious application of resources and the effective exploitation of the building (Dwaikat and Ali, 2016). Unlike traditional construction, green construction typically necessitates adhering to additional criteria in order to receive a green certification for a structure. Utilizing green construction principles can help a structure achieve high scores for green certification, hence promoting eco-protection (BCA 2013).

1.2 Problem Statement

Green construction execution is an actual practice of application the principle of scientific improvement in the construction sector, in addition to a significant procedure to achieve sustainable development. Therefore, the Green Construction Project became a requirement. Executing green construction practices not only enhances the green construction knowledge of industry staff but also promotes the improvement and development of the industry. Nevertheless, recently, the significance of the foundation green construction management assessment has not been updated. This issue has resulted in a slowdown in the development of green construction management. Therefore, there is a need to build a green construction assessment model to upgrade the development of green construction (Oguntona et al., 2019). Consequently, this study seeks to assess the practices, benefits, and disadvantages of green construction and introduce guidelines for its development. Also, most construction projects have not entirely adopted principles of green construction, and it is essential nowadays to verify the experts' perception awareness of green building and its valuable advantages in construction projects (Nduka & Ogunsanmi, 2015).

1.3 Research Objectives

Given the importance of green buildings and the resulting positive effects of reducing environmental pollution and achieving environmental sustainability, this study seeks to evaluate green building practices during the project implementation phase, which reduce the emission of greenhouse gases and achieve sustainability. This study also seeks to evaluate both the benefits and disadvantages resulting from the application of green building practices in order to enable green construction

management to make updates and developments on these practices in accordance with the current construction situation .Some minor objectives can be achieved:

- 1- To assess the most critical factors that can be applied to achieve efficient green construction management.
- 2- To determine the most significant benefits of the application of green construction management.
- 3- To identify the most challenges that limit applying green construction practices
- 4- To introduce guidelines that can assist the construction industry in applying efficient green construction management.

1.4 Research question

This study will answer the following questions:

- 1- What are the most efficient practices in green construction management?
- 2- What are the greenest construction benefits?
- 3- What are the greenest construction disadvantages?

1.5 Research Significance

The construction industry results in practices that lead to detrimental environmental impacts represented by pollution and GHG emissions. There is a lack of knowledge and application of green construction management.

This study contributes to enriching the academic and applied aspects by evaluating practices related to resource management, pollution management, health and safety management, etc. These evaluations help identify the most essential modern practices in green construction management and achieving sustainability in the construction sector. They also contribute to encouraging the adoption of green construction practices by highlighting the benefits that result from reducing pollution, reducing energy consumption, and achieving sustainability:

1. Practical Aspect:

The importance of this study comes from an applied perspective, which provides a guideline for the construction sector on the most critical and effective practices in green construction management. It also encourages the construction sector to adopt

green construction management through the benefits it has reached from adopting green construction. This study also contributes to warning the construction sector of the effects of negative aspects or challenges facing the construction sector in adopting sustainability practices to be avoided or solutions to be found.

2. Academic Aspect:

This study opens up horizons for future academics and researchers to research more into green building practices and develop them to achieve the best results. It also opens the way for them to search for solutions facing green construction management.

1.6 Research Structure

Chapter One: This chapter introduces the background of the dissertation, defining the problem statement, research objective and research significance

Chapter Two: This chapter provides a literature review comprising concepts about sustainability and green practices in the construction industry. It also includes practices of green construction management during project execution, benefits of green construction management, and challenges faced by adopting green construction management.

Chapter Three: This chapter describes the research design, research methods, sampling size, data collection, scale measurements, questionnaire design, and statistical tests.

Chapter Four: This chapter presents the results and findings obtained by analyzing questionnaire data using SPSS software. These findings will be presented in several groups comprising sections related to green construction practices, green construction benefits, and green construction challenges.

Chapter Five: This chapter presents the final remarks and offers suggestions for future endeavors.

2. LITERATURE REVIEW

2.1 Green Construction Management

Mochal and Krasnoff (2010) established green construction management. It combines project management with the organization's environmental features. GPM is important for its theoretical and practical elements (Maltzman & Shirley, 2012). In response to the rising scarcity of air, water, and food resources, as well as concerns about global warming, the eco-friendly movement has established protocols to conserve energy and protect the ecosystem. The primary criteria for evaluating the project in this principle are construction quality, safety, and environmental space. The emphasis on construction engineering and environmental development has become crucial in both emerging and developed countries, leading to a heightened focus on project management to safeguard the ecosystem and natural resources (Kurland & Zell, 2011). The field of project management encompasses five distinct procedures: initiation, planning, execution, monitoring and control, and closure. The scope of project management awareness has been broadened across ten fields. The Project Management Body of Knowledge (PMBOK) 2017 edition.

Dai & Xu (2011) argue that a project can be oriented towards environmental sustainability through various approaches. Greening refers to the evaluation of the environmental impact of manufactured products and the assessment of a project's adherence to green principles. This encompasses all areas of the project and aims to prioritize sustainability. Figure 2.1 depicts the methodologies employed in the project and environment as outlined in the study conducted by Dai & Xu (2011). The Environmental Protection Agency produced a model that showcases the standards for infrastructure projects and eco-management operations. The GPM model illustrates the environmental treatment criteria in project management, which are divided into two aspects: eco-preservation and assessment.

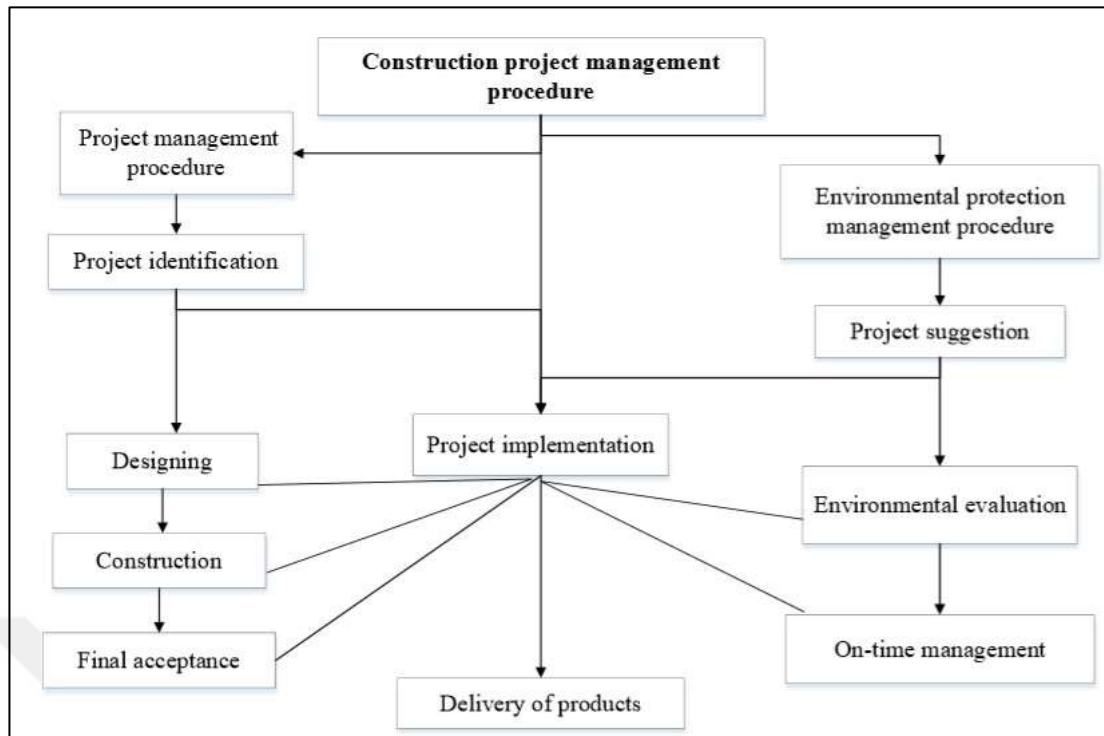


Figure 2.1: Project and Environment Processes
 Source: (Dai & Xu, 2011).

2.2 Sustainable Management

Recently, lean management, which is considered a type of management philosophy, has experienced a fast development in the fabricating field, with a concentration on production on time, waste elimination, and continuous improvement. It seeks to enhance performance (Womack & Jones, 1996). Lean tools are not only a collection of tools or a routine but rather a set of concepts that rely on knowing individuals and their tendencies, enhancing leadership, fostering team development and communication, and implementing strategies (Alavi et al., 2014). Possessing expertise in sustainability and lean fields offers numerous benefits to firms, including enhancing product quality, lowering inventory, and minimizing payback periods (Zhan et al., 2018). Various instruments can be utilized to enhance and maintain sustainability (Zehtab et al., 2019).

These comprise value stream mapping, work teams, and analytical techniques. Kováčová (2013) asserts that sustainability in construction projects is an efficient and focused method that has been extended to include a broader purpose. Lean principles, techniques, and procedures can be employed in construction projects to attain sustainability by eliminating waste.

Previous studies proposed that sustainability should be a contributing element in project management, and project managers and authorities should consider sustainability in construction projects (Newman, 1999). Al-Qassab et al. (2019) affirmed that integrating sustainability into the procedure of project management can result in competitive benefits and economic advantages while minimizing risks to the ecosystem and community. Concentrating on the significance of sustainability has risen, and organisations have been subjected to high pressure in order to model their processes in a method via which their adverse influence on the environment can be minimized.

Project management can be sustainable by using national resources efficiently and reducing waste (Sears et al., 2015). An apparent sustainability perspective and methodology that powerfully highlights the business case should be the first step, followed by accessing the vision and teaching team management. Green project managers need skills and awareness, according to various research (Sears et al., 2015).

2.3 Key Properties of Sustainable Construction

Popular axes relate to construction and sustainability. Sustainable construction restores and protects natural and constructed ecosystems for a healthy economic ecosystem (CIB and UNEP-IETC, 2002). Sustainable building should increase living well-being, employment efficiency, and workplace health by integrating social and economic goals (Abd Jamil and Fathi, 2016). Sustainable construction reduces energy, materials, and waste (Ismail et al., 2017; Oke et al., 2017; Aghimien et al., 2019). Sustainable building was created to understand the construction sector's sustainability duty, according to Hill and Bowen (1997). Thus, sustainable practices examine the efficiency, safety, productivity, waste reduction, and environmental, economic, and social considerations of a building project (Abd Jamil and Fathi, 2016).

The sustainability principle in the construction project has developed over the years, from the initial concentration on how to address the challenges of insufficient resources, particularly energy, to technical challenges comprising materials, components of a building, construction technologies and energy that are based on the concepts of design named “eco-build” and “green build” (Balasubramanian and

Shukla, 2017). Moreover, most academics and researchers have confirmed that robust and successful construction projects have aided in attaining social, ecological, and economic success (Ndlangamandla and Combrinck, 2019). Sustainable construction has concentrated on how construction projects can maintain the ecology and affect the social and economic welfare of society.

2.4 Integration of Emerging Technologies

Trends and principles in designing buildings and construction are similar to those in intelligent cities (Apanaviciene et al., 2020), from smart to automation to sustainable intelligence, which has been receiving great concerns nowadays. Intelligent buildings concentrate on the requirement for automation but, in several conditions, guarantee sustainable characteristics (Apanaviciene et al., 2020). In order to achieve sustainability in buildings, they seek to satisfy the sustainable development of intelligent cities (Nawari; Ravindran, 2019), which demands the strengthening of technology (Perera et al., 2020). Then, the sustainable structure is an intelligent building that takes into account sustainability. Most of the present research on sustainable structures has concentrated on energy, water, and carbon efficiency. On the other hand, the next massive jump in sustainable building design could come from incorporating intelligent structural technologies (Wang and Adeli, 2017).

Building Information Modeling (BIM) is a technique to keep precise and interoperable records of building information to improve pre-planning, design construction, and rehabilitation via the life cycles of buildings (Volk et al., 2014; Tang et al., 2010); it is also utilized to deliver of incorporated projects in structures and infrastructure (Wen et al., 2021). research on BIM is still in a fast growth stage. BIM originated from the Building Description System (BDS) suggested by (Charles Eastman et al., 1974), which stores and processes building information regularly to prevent changes in design. The United States National BIM Standard determined BIM as “a digital presentation of physical and operational properties of a structure; a shared knowledge source to get information about a structure constituting a credible foundation for decisions during its life-cycle; described as existing from initial perception to demolition”. BIM is essential to simplify the employment of other technologies in the construction sector (Wang et al., 2020). One possible utilization of BIM is to enhance the present data capture technology for BIM model construction (Wong et al., 2018). The Internet of Things (IoT) is able to capture huge

numbers of data on structures in real time (Zhang et al., 2018). As an emerging technique, the term IoT is still not obvious, with several explanations. IoT in smart industrial IoT can be employed to control production operations, production environment monitoring, manufacturing supply chain tracking, product whole life cycle monitoring, enhance safe production and energy efficiency, and emission minimization (Shao et al., 2013), in which the created data are of a significant volume, varied, fast, and precise (Štefanič, M.; Stankovski, 2019).

2.5 Social Sustainability Considerations in Green Construction Management

Safety and durability are the most significant factors in green building social sustainability. Other major factors are health and welfare, as well as accessibility and convenience. This group of indexes simplifies decision-making operations for practitioners and introduces convenient practical guidance for different stakeholders to permit social sustainability to be attained (Tseng et al., 2023).

2.6 Application of Circular Economy Principles in Green Construction Management

Understanding the SDGs-circular economy linkages in construction waste management is integral to establishing long-term innovative solutions for developing multi-sectorial measures for waste prevention, eco-design, and re-use of materials. These linkages increase competitiveness, stimulate innovation, and boost economic growth. All stakeholders who generate waste should apply new innovative technologies, methods and strategies leading to transdisciplinary and transformative change (Ogunmakinde et al., 2022). By incorporating principles of durability, reusability, and recyclability into the design of materials, we are effectively mitigating our dependence on finite resources and mitigating the environmental impact of products. Alongside advancements in materials, the field of energy management has emerged as a prominent focus. The incorporation of renewable energy sources, energy-efficient technologies, and grid optimisation is revolutionising the methods by which energy is produced, distributed, and consumed. These technological advancements not only serve to mitigate the emission of greenhouse gases but also facilitate the achievement of energy self-sufficiency and enhance the ability to withstand and adapt to climate-related adversities. As we

explore these notable developments, we uncover the interconnections among materials, energy, and waste management. The convergence of these fields illustrates that a comprehensive approach to sustainability is not just attainable but necessary. Through the integration of these advancements, there is not only a mitigation of environmental consequences but also a promotion of economic growth, the creation of employment opportunities, and the enhancement of societal well-being (Bharadwaj et al., 2023).

2.7 Policy and Regulatory Analysis

Kar & Jha (2024) stated that Optimum use of resources and corporate social responsibility (CSR) initiatives; stakeholders' commitment; health, safety, and environment (HSE) initiatives; government directives; and organizational initiatives toward SMM were found to be the critical enabling factors for SMM engagement, whereas inadequate strategies, policies, and regulations on SMM; inadequate resources and managerial attributes; lack of organization's and other stakeholders' support; and unethical professional practices were found to be the critical barriers to SMM engagement. Ahmed et al. (2023) found that the top five most essential risk variables are as follows: Inadequate green construction codes and regulations, a lack of information and understanding about new techniques, difficulties gaining skills and expertise, and a lack of funding due to a lack of interest in the local market all contribute to a lack of investment. According to the study, the most severe obstacles are located in Qatar and a few other nations, including the UAE, Singapore, Ghana, the United States, Turkey, and Oman. This indicates that similar risk factors impacting green adoption exist not just in the Qatari construction sector but also in the building industries of many other nations. Furthermore, limited investment due to a lack of demand remains one of the top five recognized challenges to green adoption, particularly in the Gulf regions.

2.8 Sustainable and Green Construction Practices

Based on a review of the recent studies related to green and sustainable construction practices, this study suggests five primary practices to administer green building efficiency, which can be illustrated in Figure 2.2.



Figure 2.2: Green construction Practices
 Source: Prepared by the Researcher after Reviewing Previous Studies)

The Key Five Primary Practices Were Set Based on Several researchers and academics who addressed green construction practices in construction projects. Aghili et al., 2016) identified the green management practices in Malaysian construction projects. Several established international GB codes set the practice definition. The researcher stated that GB practices play an essential function in achieving sustainability, specifically in construction projects. The practices were identified as a result of the importance of GB in the environment to minimize influences on the environment, in addition to reducing building impacts on residents. The researcher reviewed global GB standards that define "management" requirements. The content analysis found five practices essential for optimal GB management in Malaysia. Sustainable tender, Operation, Resource Management, Maintenance Management, and Ecological Health are the groups. The findings revealed that the implementation of specific strategies contributed to the effective operation of green buildings, hence promoting sustainability and reducing operating costs, ultimately leading to higher investment returns.

Aalavi & Janatyan (2020) showed that GPM includes management functions that identify, analyze, control, and ameliorate ecological impacts. Lean and sustainability improve ecology. This study ranks GPM-related tasks based on lean and sustainable concepts. The analysis revealed GPM lean and sustainability standards. Afterwards,

activities were sorted by importance to achieve a lean and sustainable GPM. The data was collected via two stages of distributing questionnaires between experts in green construction. The first stage is based on the Delphi technique utilization, lean and sustainability standards, and GPM activities that have been determined. After that, the next stage is ranking GPM activities utilizing the Analytic Hierarchy Process (AHP). Results pointed to three ecological, social, and operations and procedures criteria as the lean objectives—moreover, sustainability objectives comprised three social, economic, and environmental standards, as illustrated in Figure 2.3.

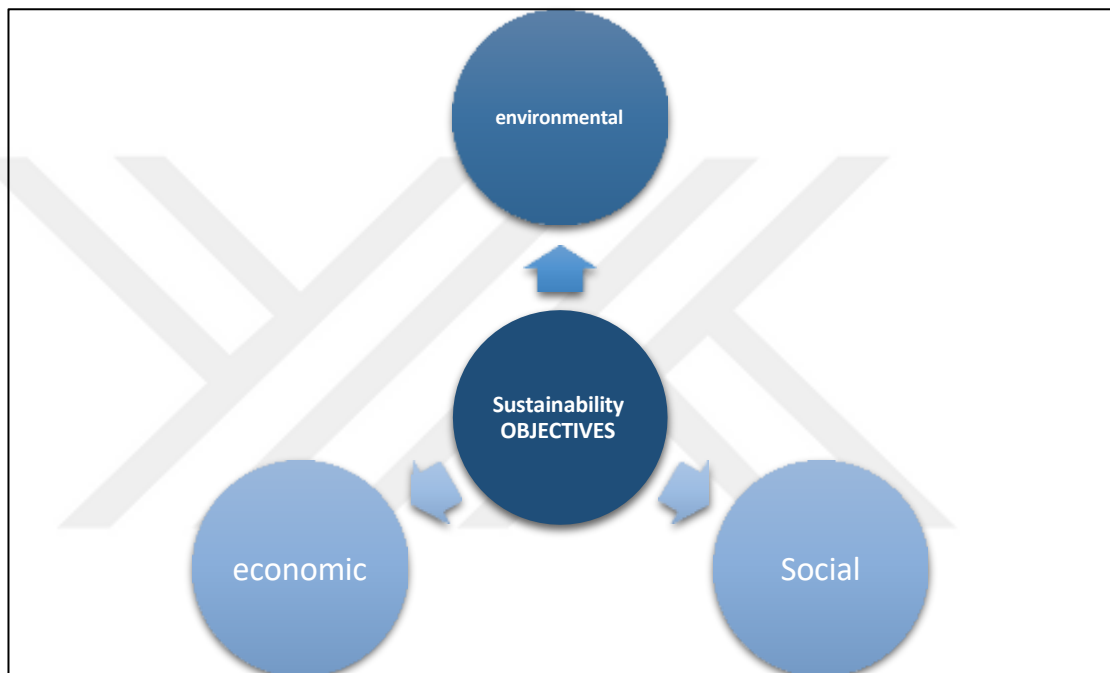


Figure 2.3: Sustainability Goals According to
Source: (Aalavi & Janatyan, 2020).

Phung (2020) concentrated on developing a methodology for sustainable project management. The research began with a conceptual framework for (SPM) with five major elements that were structured by classifying 35 project-management correlated to success factors for achieving sustainability in building projects. After that, five assumptions were suggested to test the inter-relationships among the five major elements of PM and their influences on the attainment of success of Sustainable projects. Data collected using a questionnaire were analyzed using the Structural equation modelling (SEM) method. The study outcomes support the importance and positive influence of sustainability evaluation and stakeholder management in successfully achieving sustainable projects. The findings shed light on the

improvement of the project team, the definition of sustainable purposes, and the implementation of sustainability planning in projects.

Verma et al. (2021) stated that by increasing knowledge of ecological issues and developing worries about climate fluctuation, green construction is being implemented all over the world. Nevertheless, GB construction in some locations still presents challenges as a result of a shortage of suitable frameworks for project management. Verma et al. (2021) results are as follows: a significant variation between traditional and green construction projects was found. The study recommended setting project management guidance in order to overcome barriers to GB construction and promote sustainable management practices for future green construction projects. Tu & Jhangr (2016) determined ecological concerns in their operational procedures for green construction projects. Their study determined how organizations can successfully use green procedures. The study is based on a review of studies, regulations and operational strategies. Then, the study was based on experts' views to complete a questionnaire, and then an analytic hierarchy process was utilized to gain the significant success factors of green practices. The findings related to major success factors introduce guidance for organizations that aim to execute green procedures and protect the ecology.

Ferrarez et al. (2023) polled 919 Brazilian construction project managers about sustainable project management. The study links 37 sustainability strategies using factor analysis. The findings categorized sustainability practices as ecological efficiency, compliance, social responsibility, continuous improvement and lessons learned, and project success. The findings helped building project managers and specialists integrate sustainability into project management.

Hwang & Ng (2013) conducted a study in order to explore the limitations that project leaders face in managing green construction projects and to identify awareness of the scope and skills that can solve the difficulties. Via literature review and questionnaire interviews with project managers, and interviews with three project managers, the study determined and ranked the challenges “the more duration demanded during the pre-construction stage”, “limitation to select subcontractors who introduce green construction procedures ”, “green materials and equipment is unreliable ”, “the high cost required to supply green materials and equipment”, and “more meetings and organization required with green project stakeholders.”

Willar et al. (2020) conducted a study to assess the tools used to implement sustainable concepts in Indonesian infrastructure projects executed by primary construction service introducers.

The technique utilized is surveyed with construction experts in construction projects. The findings affirmed that executing the sustainable concepts by construction service introducers is necessary to implement sustainable infrastructure project execution. Also, the study introduced the practices to improve sustainable infrastructure projects.

Al-Qassab et al. analyzed project managers' green practices competence in 2019. The literature reveals that green project managers have good schedule management, project party communication, and HRM skills. The study uses a questionnaire of 33 Dubai project managers and interviews to analyze the replies. GPM awareness is young; budget compliance is the focus. Stakeholder management and management skills related to communications are not taken into account as significantly as trouble-solving or scheduling. Changes in the prices of materials and challenges related to providing sub-contractors prevent green project management. The study affirmed that some enterprises train and improve project managers to assist them in attaining skills related to GPM. In contrast, others do not, and a scarcity of manufacturing criteria increases challenges related to green project management.

2.8.1 Green practices related to environment

In the field of environmental practices, several researchers and academics have identified practices related to environmental management in construction projects. (Aghili et al., 2016) recommended preparing an emergency plan to respond quickly to natural disasters such as earthquakes, hurricanes, and fires .

Aalavi & Janatyan (2020) affirmed that green construction practices should depend on analyzing the project's influence on the ecology and determination of possible project hazards related to the environment. (Phung, 2020; Verma et al., 2021; Tu & Jhangr, 2016) affirmed that green construction practices can minimize GHG emissions to a minimum. Also, it was recommended that eco-friendly technology be used.

Table 2.1: Environmental Practices

No	Environmental Practice	Authors
1	Preparing an emergency plan for rapid response to natural disasters	(Aghili et al., 2016)
2	Determining a skilled staff with ecological policies	(Aalavi & Janatyan, 2020)
3	Controlling pollution to the minimum	(Phung, 2020; Verma et al, 2021; Tu & Jhangr, 2016)
4	Using eco-friendly technology	(Phung, 2020; Verma et al, 2021; Hawang & Tan, 2012; Tu & Jhangr, 2016)
5	Selecting suppliers uses natural resources	(Ferrarez et al, 2023)

2.8.2 Green practices related to resources

Aghili et al. (2016) mentioned that resources should be managed in a manner that results in a minimum negative impact on the environment by using natural or artificial resources, which are characterized by low environmental influences. Also, the researcher mentioned the significance of managing water resources by regularly monitoring leaked water, utilizing treated and recycled water, collecting both rainwater and wastewater and water preserving control system utilization. Phung (2020) mentioned that using eco-friendly materials can significantly reduce CO₂ emissions. Al-Qassab et al. (2019) shows that green practices related to resources include providing eco-friendly equipment and eco-friendly technologies in addition to achieving efficient human resource management. Al-Qassab et al. (2019); Hwang & Ng (2013); Tu & Jhangr (2016) mentioned that using materials, technology, and equipment that are eco-friendly for the environment are the most critical success factors in implementing practical green construction.

Table 2.2: Resource Practices

No	Resource practice	Authors
1	Usage of eco-friendly materials	(Aghili et al, 2016; Phung, 2020; Ferrarez et al, 2023; Verma et al, 2021; Fathalizadeh et al., 2019; Hawang & Tan, 2012; Hwang & Ng, 2013)
2	A regular program of leak inspections at the building	(Aghili et al., 2016)
3	The use of treated and recycled water	(Aghili et al., 2016; Ferrarez et al, 2023)
4	Efficient human resource management	(Al-Qassab et al., 2019)

Table 2.2: (Cont.) Resource Practices

No	Resource practice	Authors
5	Using eco-friendly equipment	(Al-Qassab et al., 2019; Hwang & Ng, 2013)
6	Using eco-friendly technologies	(Al-Qassab et al., 2019; Hwang & Ng, 2013; Tu & Jhangr, 2016)
7	Dealing with suppliers and contractors who support green practices	(Willar et al., 2020)
8	Provide skilled labour in sustainable and green construction	(Willar et al., 2020; Hwang & Ng, 2013)

2.8.3 Green practices related to energy efficiency

Aghili et al. (2016); Tu & Jhangr (2016) stated that it is necessary to assess the energy cost of building construction projects in order to evaluate energy efficiency. Also, following (Aghili et al., 2016), energy efficiency should be protected by using emergency plans in case of energy systems failure. Ferrarez et al. (2023) recommended selecting materials that consume less energy during the fabrication process, adopting equipment that consumes less energy and using green transport means with less adverse environmental impacts.

Table 2.3: Energy Efficiency practices

No	Energy efficiency practice	Authors
1	Energy cost assessment of building	(Aghili et al., 2016; Tu & Jhangr, 2016)
2	Prepare an emergency plan for the failure of energy systems	(Aghili et al., 2016)
3	Selecting materials consumes less energy during the fabrication process	(Ferrarez et al., 2023; Tu & Jhangr, 2016)
4	Adopting equipment consumes less energy	(Ferrarez et al, 2023)
5	Using green transport means with less adverse environmental impacts	(Ferrarez et al, 2023)
6	Using renewable energy resources	(Tu & Jhangr, 2016)
7	High utilization of natural lighting and cooling systems	(Onubi et al., 2020)

2.8.4 Green practices related to health and safety management

Phung (2020) confirmed that ensuring the safety of the site and maintaining its health is one of the most important practices related to sustainability in the field of health and safety, as it ensures the safety of the project team members. Ferrarez et al. (2023); Onubi et al. (2020) indicated that the most effective practices in the field of Health and safety management in green construction projects are following health

and safety policies and regulations, training labour and project members on green health and safety regulations and preparing emergency plan related to health and safety risks.

Table 2.4: Health and Safety Practices

No	Health and safety practice	Authors
1	Ensuring that the Construction site is healthy and safe for all project members and labourers	(Phung, 2020; Onubi et al., 2020)
2	Follow health and safety policies and regulations	(Ferrarez et al., 2023; Onubi et al., 2020)
3	Training labour and project members on green health and safety regulations	(Ferrarez et al., 2023; Onubi et al., 2020)
4	Prepare emergency plans related to health and safety risks	(Ferrarez et al., 2023; Onubi et al., 2020)
5	Training labour on green technologies	(Long, 2022; Wang et al, 2021)
6	Training labour on green equipment	(Long, 2022; Hwang et al., 2018)

2.8.5 Green practices related to waste reduction

Aghili et al. (2016); Phung (2020) recommended implementing several procedures related to waste reduction that can significantly reduce the adverse impact on the environment, and these practices present collecting, processing, carriage, storage, recycling, and reusing.

Table 2.5: Waste Reduction Practices

No	Waste Reduction Practices	Authors
1	Collecting, transporting and processing.	(Aghili et al., 2016; Phung, 2020; Ferrarez et al., 2023; GARCIA, 2023; Fathalizadeh et al., 2019)
2	Storage of waste	(Aghili et al., 2016; Phung, 2020; Ferrarez et al., 2023)
3	Reuse waste	(Aghili et al., 2016; Phung, 2020; Ferrarez et al., 2023; Fathalizadeh et al., 2019)
4	Recycling waste	(Aghili et al., 2016; Phung, 2020; Ferrarez et al., 2023; Fathalizadeh et al., 2019; Tu & Jhangr, 2016)
5	Disposal of waste	(Aghili et al., 2016; Phung, 2020; Ferrarez et al., 2023)
6	Selecting material results in low-waste	(Willar et al., 2020)

2.9 Beneficial Contribution of Sustainable and Green Construction Practices

Due to the importance of green construction methods in construction projects and their positive impact on the environment and sustainability, various researchers and academics have highlighted their benefits. These advantages can motivate and encourage the construction industry to adopt green construction practices. The benefits can be classified into four groups: environmental benefits, sustainable benefits, economic benefits, and health benefits.

Okoye et al. (2021) used a questionnaire to assess construction stakeholders' understanding of sustainable construction benefits. According to the Mann–Whitney U Test, construction experts and non-professionals have different understandings of the benefits of sustainable construction approaches. The relative significance indicator (RII) demonstrated that 12 knowledge promotion strategies could reduce these variations.

Danso (2018) affirmed that Sustainable construction practices are introduced to minimize resource consumption and eliminate ecological degradation results in construction practices. Danso (2018) aims to research broad and important green construction material metrics. The study concludes the central sustainability assessment premise. It also reviews the benefits of sustainable construction by classifying these benefits into three groups: ecological, social factors and economic factors. Moreover, it sheds light on the analytical hierarchical process of assessing sustainable construction materials. The study shows that it is significant to determine the relevant, sustainable indicators for construction materials.

Tokbolat et al. (2020) examine the pros and downsides of sustainability in Kazakhstan's building industry. Surveys and interviews with construction specialists confirmed the benefits and obstacles to ensure their relevance to local conditions, and they were then arranged by influence degree by Kazakhstani industry experts. The Delphi method was the last step before list integration. Combining stakeholder opinions improved a Decision Support System. The results showed that addressing environmental issues is essential to increase sustainability and improve building resource use. Several social sides have also been revealed to be motivating factors for adopting the sustainable construction principle. However, a significant fraction of sustainable construction challenges is correlated to economic factors. The outcomes

can also be beneficial for construction participators who are searching for techniques to enhance the sustainability performance of construction projects.

Iravani (2017) explained that the principle of green practices and technologies considers eco-friendly practices and technologies, which are improved and utilized in techniques that don't deteriorate the environment and preserve natural resources. The study focuses on the benefits and barriers of green technology utilization. Some experts indicate green technology as ecological technology and clean technology. The benefits of green technologies are that they meet the requirements of the community without wasting or deteriorating natural resources on the land. The principle is to manufacture products that can be reclaimed entirely or re-utilized. Moreover, by changing patterns of production and consumption, procedures can be considered to minimize waste and pollution, which is one of the most necessary goals of green technologies.

Ren et al. (2022) stated that green investment became a key motivating force for attaining green and sustainable growth. The study utilized a dynamic threshold model to analyze the influence of green investment and institutional quality on ecological pollution. The study findings illustrate that China's ecological pollution is extensively featured by spatial dependence. Local ecological pollution is negatively influenced by green investment. Green investment can minimize ecological pollution by enhancing and maintaining energy efficiency and emission minimization, extending technological innovation abilities and boosting the industrial structure.

A study will be conducted to detect the concepts of sustainability in construction projects via a review of relevant literature (Isa et al., 2014). Content analysis is utilized to determine the concepts in the sustainability literature regarding construction projects. The results of the study adopted the formulation of a theoretical framework of sustainability concepts in construction projects. The final guideline comprises 29 sustainability concepts that should be considered via the project progress operation.

Tunji-Olayeni et al. (2018) conducted a study with the objective of evaluating the benefits, techniques, and recommendations for incorporating sustainable construction practices in Nigeria. The study utilizes a qualitative methodology, employing interviews with professionals in the field of sustainable construction. The researchers utilized a purposive sample strategy to select the persons who would be questioned. Thematic analysis is employed to do the interview analysis. The data was examined

and interpreted using descriptive statistics, which encompassed frequencies, percentages, and rankings. The research has found five main benefits of sustainable construction: client demand, global pressure, corporate social responsibility, competitiveness, and cost-effectiveness. The study provides empirical facts that can inform the formulation and execution of policies intended to promote knowledge of sustainable construction.

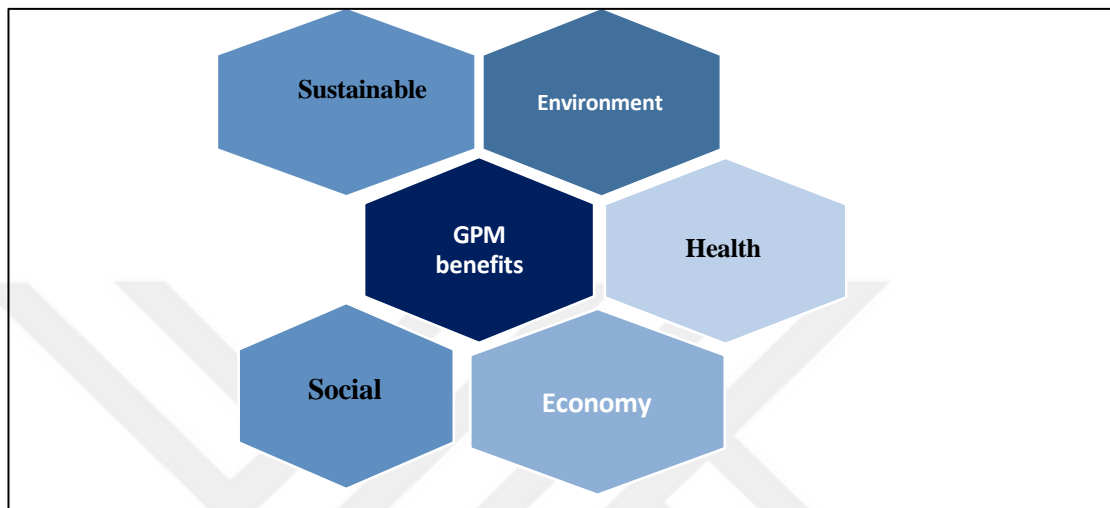


Figure 2.4: Benefits of Using Green and Sustainable Construction Practices

Source: Prepared by the researcher after reviewing previous studies).

Table 2.6 illustrates a literature review of the environmental benefits of adopting green construction management in construction projects. Most studies have shown that green construction contributes to preserving natural resources, saving the environment, mitigating global warming, and reducing pollution.

Table 2.6: Environmental Benefits.

No	Environmental Benefits	Authors
1	Preserving natural resources	(Nduka & Ogunsanmi, 2015; Danso, 2018; Tokbolat et al., 2020; Iravani et al., 2017)
2	Eliminating global warming	(Nduka & Ogunsanmi, 2015; Okoye et al., 2021)
3	Preserving the safety of the environment	(Nduka & Ogunsanmi, 2015; Tokbolat et al., 2020; Iravani et al., 2017)
4	Preserving air, water and land ecosystem	(Nduka & Ogunsanmi, 2015; Danso, 2018; Okoye et al., 2021; Tokbolat et al., 2020)
5	Reducing producing waste and elimination	(Nduka & Ogunsanmi, 2015; Okoye et al., 2021; Tokbolat et al., 2020; Iravani et al., 2017)
6	Reducing pollution	(Okoye et al, 2021; Tokbolat et al, 2020; Ren et al, 2022)

As for economic Benefits, as depicted in Table 2.7, several studies mentioned that green construction practices could minimize environmental deterioration costs, increase the adoption of renewable resources, and reduce health costs and the cost of energy depletion.

Table 2.7: Economic Benefits.

No	Economic benefits	Authors
1	Minimizing ecological damage cost	(Nduka & Ogunsanmi, 2015)
2	Utilizing renewable natural resources	(Nduka & Ogunsanmi, 2015)
3	Minimizing energy depletion and cost	(Nduka & Ogunsanmi, 2015; Danso, 2018; Tokbolat et al., 2020)
4	Minimizing health cost	(Nduka & Ogunsanmi, 2015)
5	Enhancing economic development	(Nduka & Ogunsanmi, 2015)
6	Minimizing water depletion and cost	(Nduka & Ogunsanmi, 2015; Danso, 2018)
7	Reducing infrastructural cost	(Nduka & Ogunsanmi, 2015)
8	Enhancing return on investment	(Nduka & Ogunsanmi, 2015; Okoye et al., 2021; Iravani et al., 2017)
9	Increase economic value	(Isa et al., 2014; Kibert, 2016; Tunji-Olayeni et al., 2018)

By reviewing sustainable benefits illustrated in Table 2.8, It can be found green construction practices enhance productivity, enhance indoor air quality, reduce financial crisis, reduce long-term subject to ecological or health issues and build sustainable future

Table 2.8: Sustainable Benefits

No	Sustainable benefits	Authors
1	Improving productivity	(Nduka & Ogunsanmi, 2015; Okoye et al., 2021; Iravani et al., 2017)
2	Lower long-term subjected to ecological or health issues	(Isa et al., 2014; Okoye et al., 2021)
3	Reduce financial crisis	(Okoye et al., 2021)
4	Improves indoor environmental quality	(Kibert, 2016; Tokbolat et al., 2020; Iravani et al., 2017)
5	Prevent ecological degradation	(Okoye et al., 2021)
8	Building a sustainable future	(utilities one, 2023)

Health and safety benefits, as illustrated in Figure 2.9, can be as follows, according to the literature review: reducing environmental toxins, reducing illnesses and diseases, and minimizing GHG emissions.

Table 2.9: Healthy Benefits

No	Healthy	Authors
1	Enhancing health, comfort and well-fare	(Nduka & Ogunsanmi, 2015; Tokbolat et al., 2020)
2	Reducing environmental toxins	(utilities one, 2023)
3	Indoor air quality	(utilities one, 2023)
4	GHG emission reduction	(Sandanayake et al., 2020)
5	Reducing illnesses and diseases	(Onubi et al., 2020)

Table 2.10 Social advantages resulting from adopting green construction management in construction projects that present: enhancing life quality, introducing favourable natural and social environments, satisfying human demands, Collaborative working environment and maintaining culture/heritage.

Table 2.10: Social Benefits.

No	Social	Authors
1	Enhancing life quality for people and the community as a whole	(Nduka & Ogunsanmi, 2015; Omopariola et al., 2019; Iravani et al., 2017)
2	Satisfying human demands	(Nduka & Ogunsanmi, 2015)
3	Raising awareness the multi-disciplinary societies	(Nduka & Ogunsanmi, 2015)
4	Increases profitable and competitive advantage	(Giannoni et al., 2018; Okoye et al., 2021; Tokbolat et al., 2020)
5	Introduces favourable natural and social environments	(Omopariola et al., 2019; Okoye et al., 2021)
6	Enhance client satisfaction, comfort, and well-fare	(Omopariola et al., 2019; Yahuza & Erçin, 2020; Okoye et al., 2021)
7	Collaborative working environment	(Tokbolat et al., 2020)
8	Maintaining culture/heritage	(Tokbolat et al., 2020)

2.10 Disadvantages of Adopt Green and Sustainable Construction Projects

Despite the considerable advantages of implementing sustainable and green construction methods, there are restrictions, hurdles, and downsides associated with adopting such approaches in construction projects. Various academic research, experts, and professionals in the field of green construction have recognized the following advantages for the purpose of promoting green construction and mitigating any restrictions associated with sustainable development. Disadvantages related to implementing green construction practices were grouped into four categories:

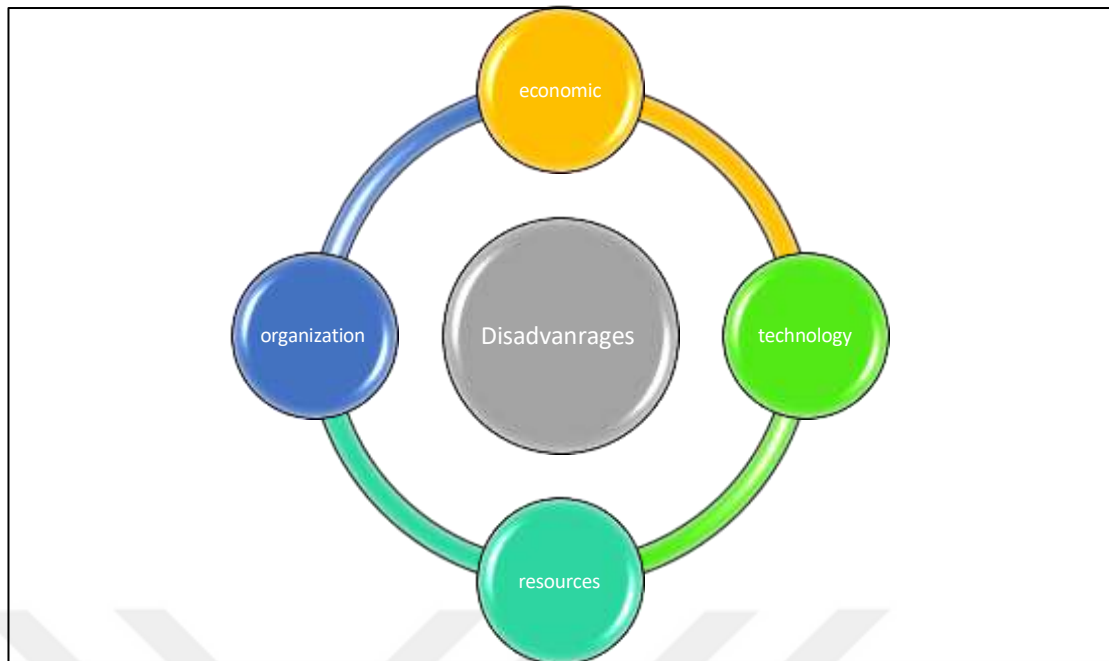


Figure 2.5: Green Construction Disadvantages

Source: (Prepared by the researcher after reviewing previous studies).

The objective of Omopariola et al. (2019) is to identify the obstacles and potential advantages of implementing sustainable construction techniques at construction sites. The study utilized a survey that specifically targeted professionals in the construction industry, gathering data from a total of 50 construction sites. The study demonstrates that the improper usage of natural and human resources is the most crucial challenge encountered in construction projects. The findings also demonstrated that the use of conventional construction methods poses a significant obstacle to the implementation of sustainable construction practices. The study identified training, a sustainability evaluation system, and the provision of the National Building Code as appropriate measures for promoting sustainable construction.

Aghaegbuna et al. (2020) focused on the implementation of sustainability in project management, specifically addressing the issues that affect the goal of achieving sustainable outcomes in project management. The research identified the nature and frequency of challenges in integrating sustainability concepts into project management practice. The study used a questionnaire survey targeting all professional project leaders as a sample of the study community. The outcomes indicate that project managers are exposed to great difficulties when executing sustainability in their practice. Results indicate that the most critical difficulty can be information shortage among project parties and other stakeholders, as well as

awareness shortage in the subject field. The literature review conducted addressed several aspects of green construction management, sustainable construction projects, and practices related to several categories, such as environment, resources, energy efficiency, health and safety and waste reduction. Also, the benefits were grouped into five categories: economic, social, health, environmental, and sustainable. In contrast, the disadvantages were classified into four groups: organization, economics, technology, and resources. A conceptual framework was created from the literature collected.

El-Sayegh et al. (2020) identified and assessed the drawbacks associated with green construction projects in the UAE. They compiled a comprehensive list of 30 drawbacks based on a thorough evaluation of the existing research. The drawbacks were categorized into five distinct groups: managerial, technical, green team-related, green materials-related, and regulatory/economic. The list was formatted as a questionnaire and thereafter dispatched to professionals hailing from the UAE. The participants evaluated each drawback based on its likelihood of happening and potential impact. Subsequently, the thirty problems were prioritized according to their level of risk severity. The primary drawbacks include insufficient money from clients, limited availability of green design information, design modifications, and insufficient time allocation for sustainable construction.

Table 2.11: Technology Disadvantages.

NO.	Technology disadvantages	Author
1	Information shortage	(Iravani et al., 2017; Aghaegbuna et al., 2020; El-sayegh et al., 2020; Fathalizadeh et al., 2019)
2	Lack of awareness of alternative process technology	(Iravani et al., 2017; El-Sayegh et al., 2020)
3	Taking a long period to approve a process for new green technologies	(Aghaegbuna et al., 2020; Hwang & Ng, 2013)
4	Lack of equipment productivity in sustainable construction	(El-Sayegh et al., 2020)
5	Experience shortage of contractors for green construction practices	(El-Sayegh et al., 2020)

Table 2.12 shows the Resources and disadvantages of adopting green construction practices. Most disadvantages related to resources include a lack of adoption of green materials to comply with regulations, a lack of skilled labour in green construction, and a lack of green suppliers and equipment.

Table 2.12: Resources Disadvantages

NO.	Resources disadvantages	Author
1	Lack of awareness of alternative chemical	(Iravani et al., 2017; Fathalizadeh et al., 2019)
2	Lack of awareness of raw material inputs	(Iravani et al., 2017; Aghaegbuna et al., 2020; Fathalizadeh et al., 2019)
3	Human resources shortage and skills	(Iravani et al., 2017; Fathalizadeh et al., 2019; Hwang & Ng, 2013)
4	Difficulty in comprehending the green specifications in the contract details.	(Aghaegbuna et al., 2020; El-Sayegh et al., 2020)
5	Uncertainty with green material and equipment	(Aghaegbuna et al., 2020; El-sayegh et al., 2020; Hwang & Ng, 2013)
6	Lack of local green material or equipment.	(Aghaegbuna et al., 2020; Hwang & Ng, 2013)
7	Lack of technical skill regarding green technologies and techniques	(Aghaegbuna et al., 2020)
8	Labour awareness shortage of the proper techniques and procedures.	(Aghaegbuna et al., 2020)
9	Inappropriate selection of subcontractors to introduce green construction services.	(Aghaegbuna et al., 2020; El-Sayegh et al., 2020; Hwang & Ng, 2013)
10	Lack of standards and regulations.	(Aghaegbuna et al., 2020)
11	Lack of experience in skills of project manager regarding green construction	(El-Sayegh, 2020)
12	Lack of green suppliers	(El-Sayegh et al., 2020; Hwang & Ng, 2013)
13	Lack of documents and information for new green technologies	(El-Sayegh et al., 2020; Hwang & Ng, 2013)

Disadvantages related to cost are illustrated in Table 2.13, which indicates a high initial budget, high execution cost, high green material prices, fluctuation prices in green material and inaccurate budget assessment.

Table 2.13: Economic Disadvantages

NO.	Economic disadvantages	Author
1	High initial budget	(Iravani et al, 2017)
2	Their economic viability is compromised as they fail to recoup the initial expenditure in a timely manner.	(Iravani et al, 2017)
3	Lack of experience with green initiatives leads to inaccuracies in project budgeting.	(El-Sayegh et al., 2021; Hwang & Ng, 2013)
4	Extra expenses result from the use of environmentally friendly materials and equipment.	(El-Sayegh, 2020; Hwang & Ng, 2013)
5	Inflation of green materials' prices	(El-Sayegh, 2020; Hwang & Ng, 2013)

Table 2.13 shows Organization disadvantages that present a long schedule process in the pre-construction stage, challenges to assess progress in implementation, changes in design during construction and lack of communication between project stakeholders.

Table 2.14: Organization Disadvantages

NO.	Organization disadvantages	Author
1	Extended duration is necessary for the pre-construction phase.	(Aghaegbuna et al., 2020; El-Sayegh et al., 2021); (Hwang, & Ng, 2013)
2	Challenges in evaluating the level of completion in sustainable construction	(Aghaegbuna et al., 2020; Hwang & Ng, 2013)
3	Design modifications occur throughout the construction phase.	(Aghaegbuna et al., 2020; El-Sayegh et al., 2021; El-Sayegh et al., 2020; Hwang & Ng, 2013)
4	Lack of a systematic approach to planning and acting for the fulfilment of sustainability	(Aghaegbuna et al., 2020; Fathalizadeh et al., 2019; Hwang & Ng, 2013)
5	Communication and interest among project team members;	(Aghaegbuna et al., 2020; Hwang & Ng, 2013)
6	Frequent meetings with green specialists	(Aghaegbuna et al., 2020; El-Sayegh et al., 2020)
7	Green consultant delay in providing information	(Aghaegbuna et al., 2020; Hwang & Ng, 2013)
8	Governmental authorization for eco-friendly buildings is being delayed.	(El-Sayegh et al., 2020; Fathalizadeh et al., 2019; Hwang & Ng, 2013)
9	Changes in sustainable construction codes and regulations	(El-Sayegh et al., 2020)

2.11 Literature Review Summary

The literature related to green construction practices was reviewed, as well as the benefits and disadvantages resulting from the application of green construction practices. Through the review, it was revealed that there is a research gap, as some studies examined practices related to managing green building projects from certain aspects, such as practices related to technology or the environment, and did not address other aspects. Therefore, this study provides a comprehensive assessment of the aspects related to green construction practices. It was also noted that there is a deficiency in evaluating the benefits and disadvantages resulting from green construction practices in construction projects and addressing them from all aspects. Therefore, this study is concerned with conducting a comprehensive assessment of

green construction practices and the disadvantages and benefits resulting from evaluating these. Practices.



3. STUDY METHODOLOGY

3.1 Introduction

This chapter provides a clear explanation of the study methodology, which includes the chosen study technique, the population targeted for sampling, and the specific analysis methodologies used in this study. Moreover, this chapter clarifies the research workflow by providing examples of the protocols for activities and equipment. Multiple data analysis strategies were discussed.

3.2 Study Methodology

Quantitative approaches can be employed through either experimental or non-experimental designs, utilizing questionnaires to gather data and subsequently subjecting it to statistical analysis (Nerija, 2012). A nonexperimental quantitative approach was applied to inform the study's research design. This study's research design was intended to identify green-building management. Johnson and Christensen's (2004) definition of nonexperimental quantitative research was applied to justify the use of this research design to address the study's research questions. The quantitative method was used to measure the effectiveness of the proposed practices and the benefits of adopting green construction practices, in addition to measuring the extent of the difficulties and challenges that limit the adoption of green construction practices. This approach is suitable when the study objective is to confirm a hypothesis or theory. The study utilized a quantitative method to evaluate green construction management. This involved assessing various dimensions such as green construction practices, advantages, and disadvantages. The aim was to develop a framework that can improve green construction management and lead to the successful creation of green buildings. The outcome of this study methodology is the development of a green construction management model to help project managers, engineers, contractors, and all stakeholders enhance their work process via having awareness about green construction execution and knowing its benefits and disadvantages on the statistical analysis.

The study methodology is a quantitative research approach. A research approach directs plans and operations to execute the study from the general hypothesis to the detailed way to collect and interpret data (Nurdiana, 2017). The research approach comprises a quantitative approach. The quantitative approach investigates the reliability of data collected utilizing statistical analysis. The quantitative approach required a greater sample size and took a longer period to collect data (Johnson, 2008). The limitations of the quantitative approach lie in the difficulties associated with structuring the study framework. Errors occurring during the configuration of the model lead to inaccuracies in the data analysis. The study employed a quantitative approach as it allowed for the efficient collection of data from a large sample size within a short timeframe.

The quantitative method adopted in this study included three key phases. Firstly, the study problem was formulated while executing a literature review in the second phase. The final phase was comprised of collecting data, verification and analysis. Depending on the mentioned phases, Figure 3.1 shows the flow chart of a quantitative method used in this research.

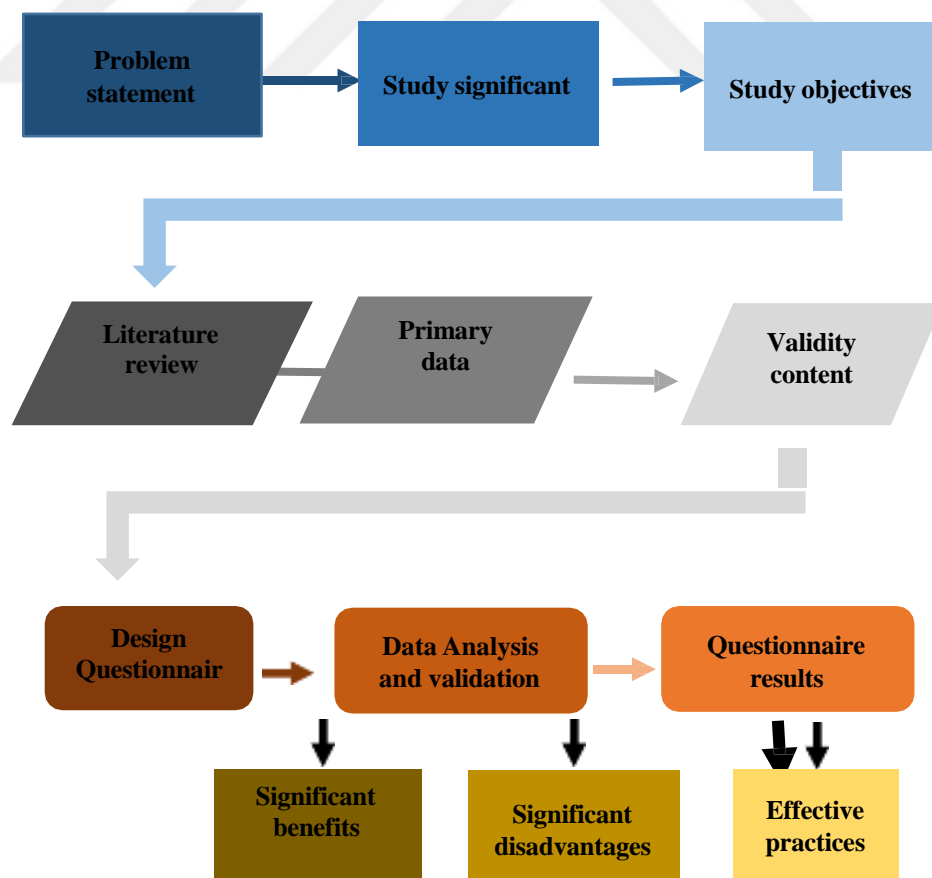


Figure 3.1: Research Flow Chart

Step 1: This stop is comprised of the formulation of study problems depending on proof from websites, papers, and academic research that sheds light on the challenges and issues facing construction management in green construction projects. After that, the research gap was identified. Multiple academic research focused on identifying obstacles in green building projects have been disclosed. However, there is a lack of study in identifying complete strategies for green management and determining the advantages of these activities. Furthermore, there is a deficiency in proposing effective measures to tackle the issues faced in managing green building. This leads to the formulation of the research aim and study objectives that were previously discussed in chapter one.

Step 2: The activities flow went on by conducting an in-depth review of recent academic research, articles, papers, dissertations, and studies correlated to identifying green construction practices, benefits of using these practices and disadvantages of using these advantages via online platforms and web sites as Google Scholar, research gate and Science Direct and other scientific web sites. The searching stage adopted using Keywords such as “green construction practices”, “green construction benefits”, and "disadvantages" to search for relevant studies.

Step 3: The Questionnaire was set based on the outcomes of the literature review chapter two and then valid content based on experts and professionals to give their views and opinions about questionnaire contents to delete, add and modify its content according to their experience. This procedure is based on a pilot test executed on ten respondents from professionals in green construction projects. Following the pilot test, the professionals' perspectives were included, and the questionnaire was subsequently changed. The results of the questionnaire were analyzed using the Statistical Package for the Social Sciences (SPSS). The green construction techniques, together with their benefits and downsides, were evaluated using statistical tests such as Pearson correlation, reliability test, and Relative Important Index. In addition, means and standard deviations were computed.

3.3 Study Tool

A study tool is utilized to design a research plan (Nurdiana. 2017). The tool of this study is comprised only of a questionnaire. The questionnaire includes several selection questions in closed-ended or open-ended constitution. Two key reasons

should be taken into account when selecting a suitable study tool: the duration of data collection and the kind of analysis of data. The questionnaire in this study adopted closed-ended questions. Green construction management specialists involved in GB projects received the questionnaire. Questionnaires were employed for the study due to their trustworthiness and ease of data collection from multiple respondents.

Additionally, it is a rapid and effective way to collect data for large and complex projects like construction (Javed, 2019). In addition, the questionnaire's closed-ended questions made it easy to compare project management success variables. Respondents answered closed-ended questions using rating scales.

3.4 Data Collection

3.4.1 Instrument design

The first draft of the questionnaire was developed on the basis of a review of the literature and questionnaire regarding green building investigation and promotion. Some questions were also quoted from this questionnaire. Modifications and new questions were then added to suit the local construction industry in Iraq; the content of the draft questionnaire was also discussed with the experts.

The data was obtained through a survey conducted using a questionnaire. The survey was administered using Google Forms. The questionnaire was divided into four main components. The main goal of the initial segment was to determine the demographic details of the participants, such as their professional background, engagement in GB projects, and occupational role. This information is essential to verify that the respondents have satisfied the conditions for carrying out this survey. In Section Two, the emphasis was placed on prioritizing green construction techniques in green construction management according to their relative significance. A pilot test was done to evaluate and validate the suitability of the questionnaire for implementation in the domain of green building project developers. The survey was disseminated to four participants who were chosen from the precise target population. The team comprised a project leader specializing in environmental initiatives, a supervisor responsible for overseeing the construction site, an engineer with expertise in sustainable practices, and a contractor specializing in environmentally friendly

construction methods. The questionnaire was ultimately modified, incorporating all the feedback obtained during the pilot testing.

3.4.2 Population and sampling

A population is defined as the entirety of persons who possess specific traits (Amitav, 2010). The study population is often determined based on characteristics such as region, industry, and age. Sampling refers to a group of persons that is chosen from the overall population being studied (Amitav, 2010). The study specifically targeted construction experts who possessed specialized knowledge in green construction projects in Iraq and had previous involvement in projects adhering to GB standards. The specialists were chosen among key players in green construction, including contractors, project managers, site supervisors, and site engineers. The respondents who were active in GB projects were selected.

The process of sample selection is considered a crucial stage because of its importance in maximizing efficiency and minimizing effort. The research sample for this study consists of engineers, project managers, contractors, and site supervisors employed in the construction business. There are roughly 100 professionals in this field, and this sample was selected from the study population comprised of construction agencies and construction firms that have experience in green construction management.

The Stephen Thomson equation, which was depicted visually, was employed to identify a statistically representative subset of the population.

$$n = \frac{N \times p \times (1-p)}{(N-1) \times \frac{d^2}{Z^2} + p \times (1-p)} \quad (3.1)$$

Where:

n= sample size

N= population size

d= standard error of the sampling distribution (0.05)

p: population proportion

Z= Standard score corresponding to the significance level (0.95), which is equal to (1.96)

The recommendation's value (p) is 0.5 in cases where the p-value is unknown, as indicated by McClave et al. (2014). A sufficient sample size is acquired as required.

The researcher employed a confidence level of 95% and a significance level of 5% in this investigation.

The sample size of the population was calculated as follows:

Population (N) are engineers of various disciplines, contractors and workers in the construction sector, N =100

$$n = \frac{100 \times 0.5 \times (1 - 0.5)}{100 \times \frac{0.05^2}{1.96^2} + 0.5 \times (1 - 0.5)} \approx 80$$

(SPSS) software was utilized for data analysis gained from the questionnaires. SPSS introduces statistical analysis characteristics to assist the researchers in understanding and verifying the data. The statistical analysis was comprised of several procedures, such as determining, ranking and assigning a numeric value to the data.

3.4.3 Measurement development

The scale was set to be utilized to identify the variables' value and identify the degree of significance. This study employed an ordinal scale, utilizing integers to assess values and the degree of significance. Additionally, a Likert scale was used for measurement purposes (Babatunde, 2021):

$$\text{Statistical significance levels} = \frac{\text{Max value} - \text{Min.value}}{\text{Max.value}}$$

$$\text{Statistical significance levels} = \frac{5-1}{5} = 0.8$$

Table (3.1) displays the significance level that the researcher used.

Table 3.1: Significance Levels

Level	Interval of Mean	Description
1	1-1.8	Strongly disagree
2	1.81-2.6	Disagree
3	2.61-3.4	Neutral
4	3.41-4.2	Agree
5	4.21-5	Strongly agree

3.5 Statistical Analysis

3.5.1 Demographic analysis

Demographic analysis is widely recognized as a highly effective method for depicting the characteristics and background of a survey participant (Karim et al., 2020). Demographic analysis is utilized to collect data on the characteristics of respondents and ensure that they meet specified requirements for completing a questionnaire (Tahmina, 2018). The personal information of respondents will be analyzed by calculating frequencies and percentages of respondents' answers regarding their scientific qualifications, years of experience, and involvement in GB initiatives.

3.5.2 Relative importance index (RII)

RII determines the relative relevance of variables in an inquiry (Karim et al., 2020). RII analysis identifies the most influential criteria or factors based on participant replies. Based on the rated Likert scale, RII values rank variables, statements, behaviours, and criteria (Rooshdi, 2018). To indicate usage frequency, research participants ranked green construction approaches from 1 to 5. Furthermore, the level of importance and consensus about the pros and drawbacks are also assessed. The relative significance index (RII) method was employed to prioritize green construction methods in each proposed domain. It was employed as it assessed and organized the advantages and difficulties of sustainable construction. The RII values are ranked on a scale from zero to one (Karim et al., 2020). An RII value is considered high when it meets the significance criteria outlined in Table 3.2 (Akadiri, 2011). The replies to the question were assigned a Likert scale ranging from 1 to 5.

Table 3.2: RII Value

RII values	Importance Level	
$0.8 \leq RII \leq 1$	High	H
$0.6 \leq RII < 0.8$	High-Medium	H-M
$0.4 \leq RII < 0.6$	Medium	M
$0.2 \leq RII \leq 0.4$	Medium-Low	M-L
$0 \leq RII \leq 0.2$	Low	L

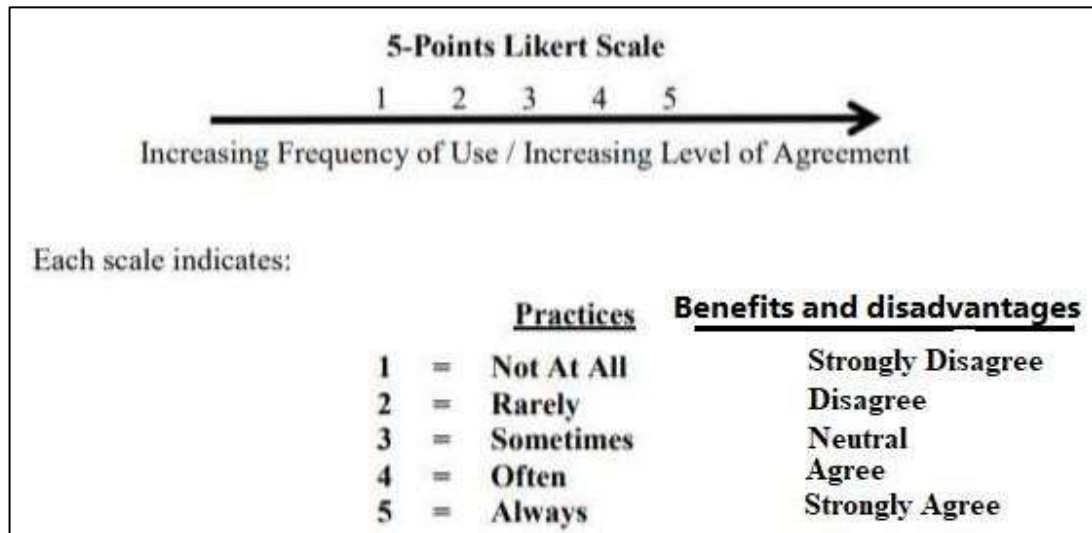


Figure 3.2: 5-Point Likert Scale

The relative importance index was calculated as follows:

$$RII = \frac{\sum W}{A \times N} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5 * N}$$

Where:

W = the weight regarded to each item by the respondents

A = the largest weight

N = the total respondent's number

n_i = frequency

3.5.3 Cronbach's coefficient alpha

It is employed to assess internal consistency and determine the level of dependability of a test. The average correlation between the test items and the relationship between the number of test items and the average correlation is evaluated for each axis in relation to all other questionnaire axes (Sheetal et al., 2016). The calculation of Cronbach's alpha coefficient is determined using equation (3), as presented by Sheetal et al. in 2016.

$$\text{Cronbach's alpha } \alpha = \frac{N.C}{V + (N-1).C}$$

Where:

N = the number of items

C = the average inter-item variance between items

V = the average variance of all items

An increase in both the number of components and the average correlation between them will increase Cronbach's alpha coefficient. This is because a low average correlation between the elements will lead to a high Cronbach's alpha, as there is an inverse relationship between the two.

The permissible range for the value limit of Cronbach's alpha is between 0.0 and +1.0. Any value below this range will not be approved, as a higher value indicates a greater level of acceptable internal consistency.

3.5.4 Correlation coefficient test

The correlation test assesses the magnitude of the association between two variables, which might take values between 1 and -1. The study involves two variables, x and y . The researcher determines the value of the independent variable, x , while the dependent variable, y , is influenced by the unknown outcome and relies on the values of x . Types of Correlation:

- 1) Positive Correlation: A positive correlation refers to a connection between two variables (X , Y) in which a change in one variable results in a corresponding change in the other variable in the same direction.
- 2) Negative correlation refers to a connection between two variables (X , Y) in which a change in one variable results in a corresponding change in the opposite direction in the other variable.

4. RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of the most efficient practices in green construction management. Also, this chapter introduces the benefits and disadvantages of using green construction practices. The findings were executed by analyzing questionnaire data that was designed to present practices, benefits and disadvantages of using green construction management. Statistical analysis using SPSS was adopted to analyze data, and the relative importance index was utilized to rank data; then, the results were discussed.

4.2 General Information

This section focuses on assessing the respondents' proficiency in completing the questionnaire based on their educational qualifications, years of experience in construction projects, involvement in green building projects, and job positions.

The respondents were specifically selected to provide information about their educational qualifications, and the frequencies and percentages of the respondents' educational qualifications were then computed. Table 4.1 displays the frequencies and percentages of the educational qualifications of the respondents, whereas Figure 4.1 illustrates the percentages of the respondents' educational qualifications.

Table 4.1: Scientific Qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than bachelor	6	7	7	7
	Bachelor	51	60.0	60.0	67.1
	Master	23	27.1	27.1	94.1
	Doctoral	5	5.9	5.9	100.0
	Total	85	100.0	100.0	

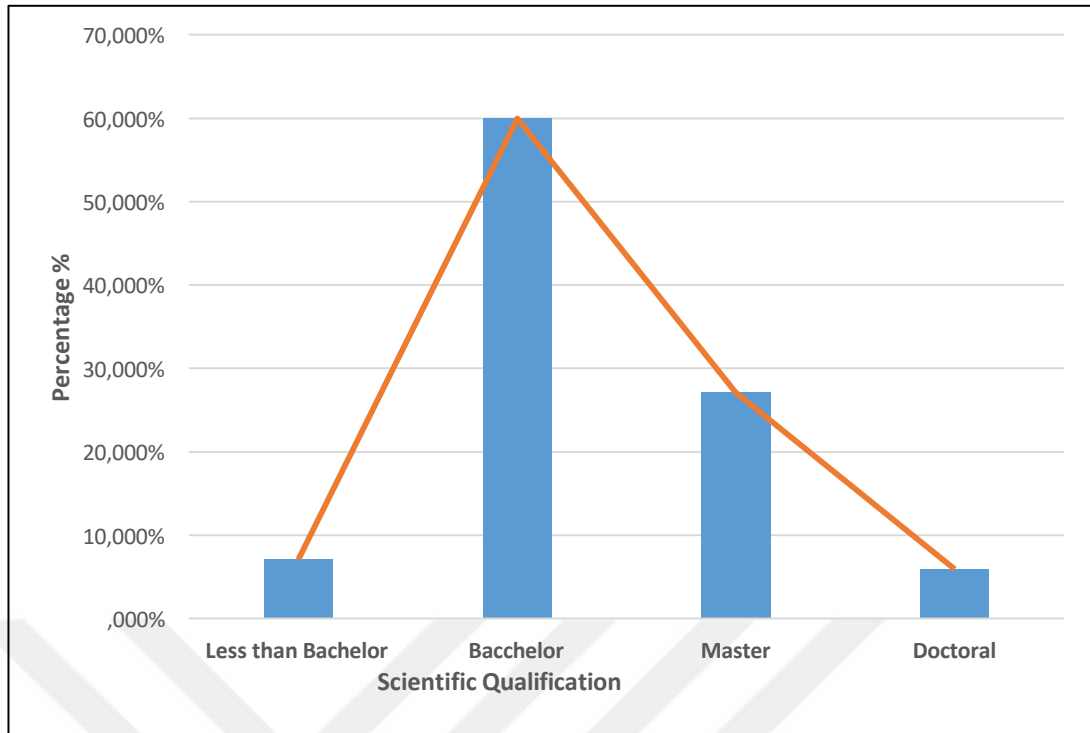


Figure 4.1: Scientific Qualification

Figure 4.1 and Table 4.1 illustrate that 60% of respondents have a bachelor's degree, while 27.1% have a Master's degree. Only 5.9% and 7% have a Doctoral degree and less than a Bachelor's degree, respectively.

Also, respondents were asked about their experience in construction projects in order to ensure that they had adequate experience and knowledge in construction projects, as illustrated in Figure 4.2 and Table 4.2.

Table 4.2: Years Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5-10 years	9	10.6	10.6	10.6
	11-15 years	11	12.9	12.9	23.5
	16-20 years	28	32.9	32.9	56.5
	21-25 years	37	43.6	43.6	100.0
	Total	85	100.0	100.0	

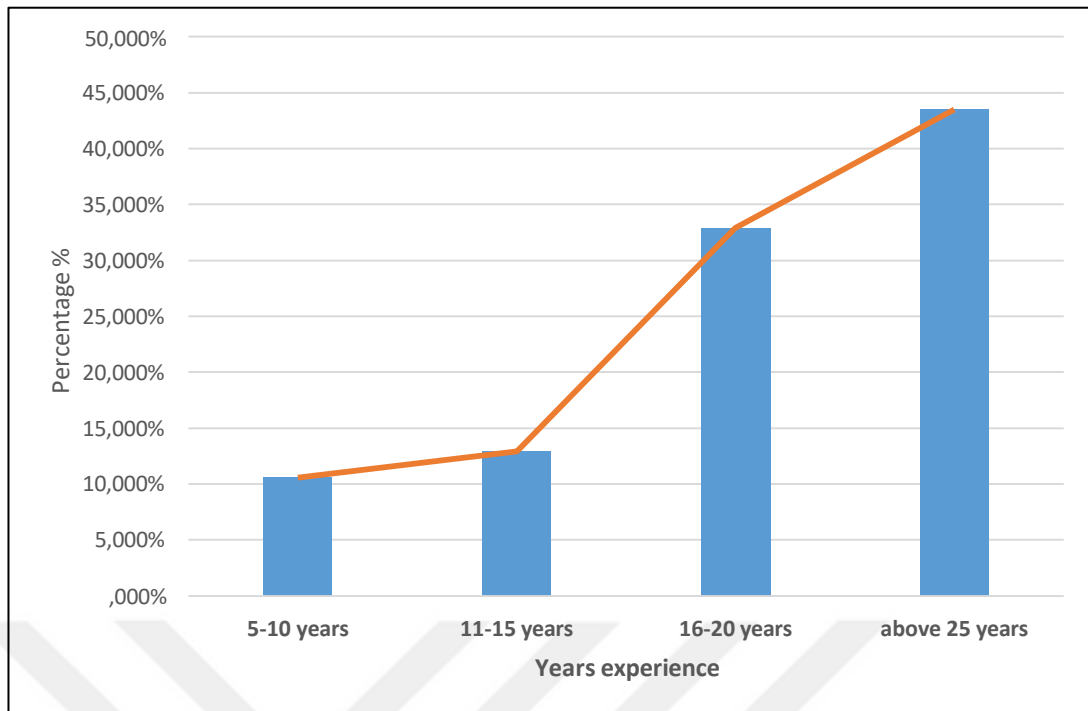


Figure 4.2: Years Experience

Figure 4.2 and Table 4.2 illustrate that 43.6% and 32.9% of respondents have years of experience above 25 years and have 16-24 years of experience, respectively. Only 12.9% of respondents have years of experience ranging from 11 to 15 years, and respondents have experience 5-10; their rate was 10.6 %

Moreover, respondents were asked about their job positions in construction projects, and the results are presented in Figure 4.3 and Table 4.3.

Table 4.3: Job Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	project manager	29	34.1	34.1	34.1
	contractor	19	22.4	22.4	56.5
	site supervision	19	22.4	22.4	78.9
	Engineer	18	21.1	21.1	100.0
	Total	85	100.0	100.0	



Figure 4.3: Job Position.

Figure 4.3 and Table 4.3 show that the percentages of project managers are 34.1% and the percentages of engineers are 21.1%, while percentages of site supervision are 22.4% and contractor's percentages are 22.4%.

In order to ensure that respondents had been involved broadly in green building projects, respondents were asked whether they had been involved in green construction management significantly or had limited involvement.

Table 4.4: Involvement in green construction projects.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	76	89.4	89.4	89.4
	No	9	10.6	10.6	100.0
	Total	85	100.0	100.0	

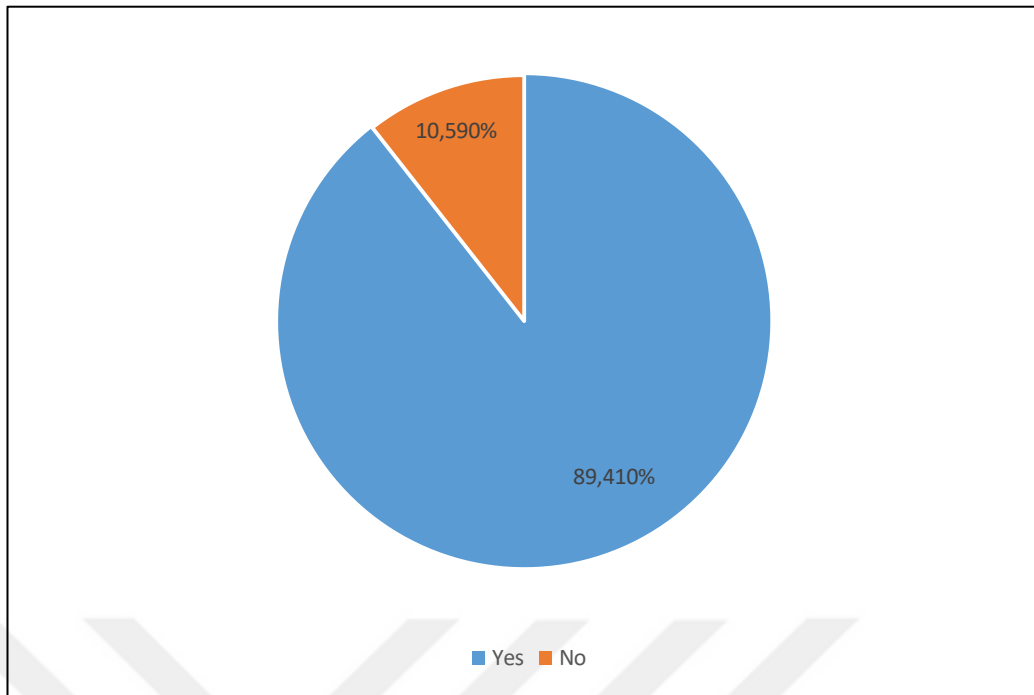


Figure 4.4: Involvement In Green Construction Projects.

Table 4.4 and Figure 4.4 show That 89.41% of respondents are involved significantly in green construction management, while only 10.6% present limited involvement in green construction projects.

4.3 Reliability Analysis

The criteria used to ensure the reliability of statistical tests is the consistency of statistical tests, which is Cronbach's alpha coefficient that expresses the level to which a group of questions or statements is correlated together as a coherent group.

The following rule is used to interpret Cronbach's alpha coefficient for questions that have selections to answer or questions based on Likert measurement (McClave et al., 2014):

- i. The scale is considered excellent if its value is higher than 0.9.
- ii. The scale considers good if its value ranges from (0.8-0.9).
- iii. The scale is considered reasonable if its value ranges from (0.7-0.8).
- iv. The scale is considered questionable if its value ranges from (0.6-0.7).
- v. The scale is considered poor if its value ranges from (0.5-0.6).
- vi. If the scale is smaller than 0.5, the measurement can't be accepted.

The findings in Table 4.5, according to reliability analysis, showed that the value of (α) coefficient ranges from (0.962 to 0.977), which indicates that it is highly

trustworthy and reliable according to the mentioned rule. Table (4.5) illustrates the value of the (α) coefficient according to each section of the survey.

Table 4.5: Reliability analysis findings for the developed sections.

Section Designation	(α)
Green Practices	0.962
Green Construction Benefits	0.967
Green Construction Disadvantages	0.977

Also, reliability analysis was conducted to achieve consistency for all statements of a questionnaire, and the value of the alpha coefficient is illustrated in Table 4.6.

Table 4.6: Reliability Analysis.

Cronbach's Alpha	N of Items
0.97	115

It can be noted in Table 4.6 that the reliability coefficient for all statements of sections shows a high value up to 0.97.

4.4 Internal Consistency

To extract the implications of the construct validity of the scale, the correlation coefficients were extracted for each item and its association with the section to which it belongs. This procedure was done by calculating the Pearson correlation coefficient for each statement with its section, and this is shown in Table 4.7, Table 4.8, and Table 4.9.

Table 4.7: Pearson Correlation between Each Practice and Total Degree of Practices

No.	Pearson Coefficient	sig(2-tailed)	NO.	Pearson Coefficient	sig(2-tailed)
1	0.652	0.001	20	0.810	0.001
2	0.679	0.001	21	0.765	0.001
3	0.972	0.001	22	0.748	0.001
4	0.676	0.001	23	0.791	0.001
5	0.696	0.001	24	0.693	0.001
6	0.706	0.001	25	0.794	0.001
7	0.693	0.001	26	0.861	0.001
8	0.669	0.001	27	0.714	0.001
9	0.740	0.001	28	0.752	0.001
10	0.695	0.001	29	0.763	0.001
11	0.693	0.001	30	0.835	0.001
12	0.641	0.001	31	0.826	0.001
13	0.744	0.001	32	0.831	0.001
14	0.785	0.001	33	0.815	0.001

Table 4.7: (Cont.) Pearson Correlation between Each Practice and Total Degree of Practices

No.	Pearson Coefficient	sig(2-tailed)	NO.	Pearson Coefficient	sig(2-tailed)
15	0.693	0.001	34	0.790	0.001
16	0.552	0.001	35	0.785	0.001
17	0.649	0.001	36	0.790	0.001
18	0.686	0.001	37	0.770	0.001
19	0.765	0.001	38	0.824	0.001

All correlation coefficients were deemed acceptable and statistically significant; hence, none of these items were excluded.

Also, Table 4.7 indicates that there is a clear internal consistency between the questionnaire statements, as the values of the correlation coefficients indicate a strong connection between each practice and the total value of practices to which it belongs at a significance level of 0.01.

Table 4.8: Pearson Correlation between each Benefit and Total Degree of Benefits

No.	Pearson Coefficient	sig(2-tailed)	NO.	Pearson Coefficient	sig(2-tailed)
1	0.313	0.001	21	0.911	0.001
2	0.334	0.001	22	0.638	0.001
3	0.317	0.001	23	0.672	0.001
4	0.676	0.001	24	0.688	0.001
5	0.342	0.001	25	0.679	0.001
6	0.661	0.001	26	0.854	0.001
7	0.304	0.001	27	0.677	0.001
8	0.664	0.001	28	0.688	0.001
9	0.363	0.001	29	0.992	0.001
10	0.336	0.001	30	0.761	0.001
11	0.666	0.001	31	0.805	0.001
12	0.773	0.001	32	0.701	0.001
13	0.669	0.001	33	0.752	0.001
14	0.317	0.001	34	0.787	0.001
15	0.636	0.001	35	0.792	0.001
16	0.616	0.001	36	0.854	0.001
17	0.627	0.001	37	0.992	0.001
18	0.346	0.001	38	0.751	0.001
19	0.377	0.001	39	0.871	0.001
20	0.616	0.001	-	-	-

It should be noted that all correlation coefficients were of acceptable and statistically significant degrees, and therefore, none of these items were deleted.

Also, Table 4.8 indicates that there is a clear internal consistency between the questionnaire statements, as the values of the correlation coefficients indicate a strong connection between each benefit and the total value of challenges to which it belongs at a significance level of 0.01.

Table 4.9: Pearson Correlation between Each Challenge and Total Degree of Challenges

No.	Pearson Coefficient	sig(2-tailed)	NO.	Pearson Coefficient	sig(2-tailed)
1	0.662	0.001	22	0.911	0.001
2	0.367	0.001	23	0.788	0.001
3	0.636	0.001	24	0.672	0.001
4	0.858	0.001	27	0.688	0.001
5	0.900	0.001	26	0.679	0.001
6	0.676	0.001	23	0.674	0.001
7	0.663	0.001	26	0.660	0.001
8	0.363	0.001	27	0.703	0.001
9	0.636	0.001	30	0.706	0.001
10	0.336	0.001	31	0.716	0.001
11	0.632	0.001	32	0.604	0.001
12	0.372	0.001	33	0.631	0.001
13	0.671	0.001	34	0.677	0.001
14	0.672	0.001	37	0.637	0.001
15	0.704	0.001	36	0.673	0.001
16	0.637	0.001	33	0.854	0.001
17	0.631	0.001	36	0.376	0.001
18	0.637	0.001	37	0.743	0.001
19	0.661	0.001	40	0.732	0.001
20	0.603	0.001	41	0.637	0.001
21	0.337	0.001	-	-	-

It should be noted that all correlation coefficients were of acceptable and statistically significant degrees, and therefore, none of these items were deleted.

Also, Table 4.9 indicates that there is a clear internal consistency between the questionnaire statements, as the values of the correlation coefficients indicate a

strong connection between each challenge and the total value of challenges to which it belongs at a significance level of 0.01.

4.5 Critical Factors That Apply to Achieve Efficient Green Construction Management

Green Construction Practices have been categorized into five groups. The groups are regarded as environmental practices, resource management, energy efficiency, health and safety practices and waste reduction. Practices in each group were described using the mean score and ranked according to relative importance index value.

As for environmental practices, All the environmental practices studied in Table 4.10 achieved an arithmetic mean higher than the hypothesized mean of (3), with relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in The respondents studied these indicators of environmental practices and the necessity of practising and applying them. Table 4.10 shows that all the suggested environmental practices are highly frequented and extremely significant. The most significant and frequent practices from the respondents' point of view in calculating the relative importance index are collecting rainwater and greywater in order to re-treat it and use it for various purposes, which contributes to reducing the demand for water. Also, respondents show that it is significant to provide efficient HRM that significantly contributes to managing resources and achieving sustainability. Moreover, using eco-friendly materials and eco-friendly equipment enhances sustainability in green construction projects. Respondents also emphasized practices related to water treatment and recycled water. Finally, respondents indicated, from their point of view, the importance of dealing with suppliers and contractors with experience and knowledge of green building practices, as a contractor with experience in green building practices contributes significantly to the effective management of resources to achieve sustainability and mitigate the negative environmental impact of building projects. The study also showed that the use of environmentally friendly construction materials, such as concrete embedded with nanomaterials, concrete embedded with dirt (Zeynali et al., 2023), waste glass (Esmaeili & AL-Mwanes, 2021), and other

environmentally friendly construction materials, is highly effective in preserving the environment and reducing GHG emissions.

Table 4.10: Ranking Environmental Practices

No.	Resource management	Mean	Standard deviation	R.I.I	Rank	description
EP 1	Usage of eco-friendly materials	4.35	0.97	0.87	4	H
EP 2	A regular program of leak inspections at the building	4.14	1.14	0.83	7	H
EP 3	The use of treated and recycled water	4.24	1.19	0.85	5	H
EP 4	Collecting rainwater and greywater	4.48	0.87	0.90	1	H
EP 5	The use of relevant water-saving control systems	4.19	1.18	0.84	6	H
EP 6	Efficient human resource management	4.45	0.79	0.89	2	H
EP 7	Using eco-friendly equipment	4.42	0.93	0.88	3	H
EP 8	Using eco-friendly technologies	4.22	1.16	0.84	6	H
EP 9	Dealing with suppliers and contractors who support green practices	4.15	1.16	0.83	7	H
EP 10	Provide skilled labour in sustainable and green construction	4.12	1.24	0.82	8	H
EP 11	Limiting the materials used to reduce waste	4.33	1.06	0.87	4	H

Figure 4.5 presents the relative importance index of environmental practices where it can be noted that collecting rainwater and greywater ranked as the top among environmental practices, and this practice is recommended by several recent studies (Habibullah et al., 2023; Rodrigues et al., 2023; LEONG et al., 2017) that have confirmed that this method is very effective in providing fresh water from recycling grey water to benefit from it for multiple purposes, as this contributes to water sustainability in the future. Also, the study shows that effective human resources management also ranks second in achieving environmental sustainability, as the adequate performance of human resources contributes to reducing waste of time, cost, time, and construction materials in construction projects and achieving the

required quality. This result is consistent with several studies that emphasize the importance of human resources management in achieving sustainability (Piwowar-Sulej, 2021; Anwar & Abdullah, 2021). The study also showed that the use of environmentally friendly construction materials, such as concrete integrated with nano clay (Zeynali et al., 2023), waste glass (Esmaeili & AL-Mwanes, 2021), and other environmentally friendly construction materials, is highly effective in preserving the environment and reducing carbon emissions.

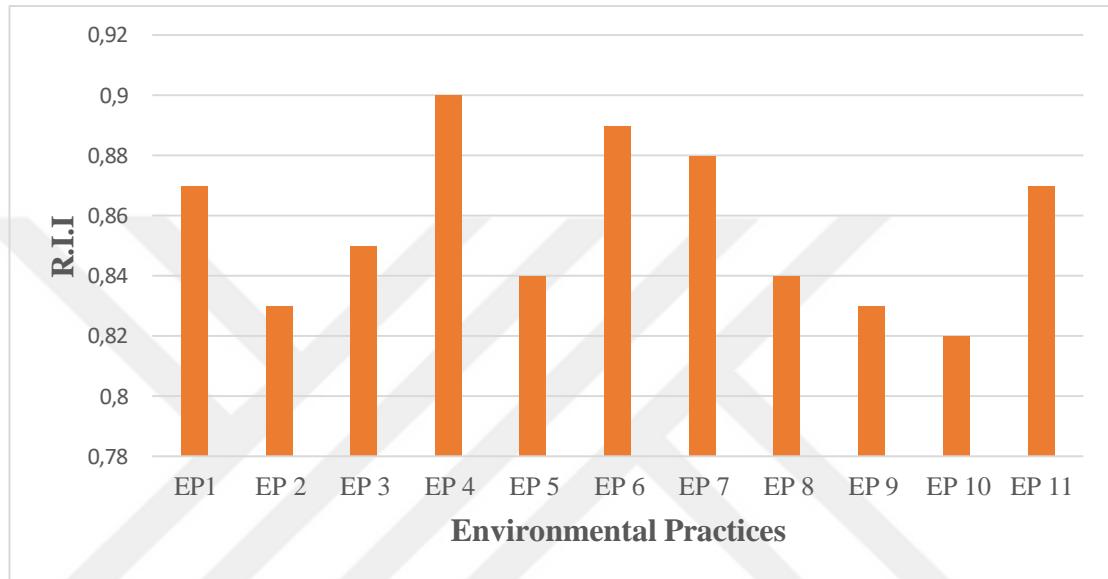


Figure 4.5: Ranking Environmental Practices

As for Resource management practices presented in Table 4.11, It is shown that controlling pollution to a minimum, using eco-friendly technology and selecting suppliers to use natural resources are the most significant resource management practices that achieved arithmetic mean higher than the hypothesized mean of (3), with relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in The respondents studied these indicators of resource management practices and the necessity of practising and applying them. Also, Table 4.11 depicts that these practices are highly frequented and extremely significant. Also, the study shows that the most frequent environmental practices, according to the respondents' opinion, are the use of environmentally friendly technology and reducing pollution in the construction project to the minimum possible, as this contributes to reducing carbon emissions and reducing greenhouse gases. Respondents also stressed the importance

of choosing suppliers that use materials from environmentally friendly natural sources as well.

Table 4.11: Ranking Resource Management Practices

No.	Resource management practice	Mean	Standard deviation	R.I.I	Rank	description
RM 1	Preparing an emergency plan for rapid response to natural disasters	1.21	0.41	0.24	6	M-L
RM 2	Environmental assessment	2.08	1.17	0.42	5	M
RM 3	Determining a skilled staff with ecological policies	2.38	1.24	0.48	4	M
RM 4	Controlling pollution to the minimum	4.51	0.83	0.90	3	H
RM 5	Using eco-friendly technology	4.66	0.70	0.93	1	H
RM 6	Selecting suppliers use natural resources	4.53	0.73	0.91	2	H

Figure 4.6 shows that one of the most important resource management practices is the use of environmentally friendly technology. This has been proven through several studies, including studies that have proven the effectiveness of using nanotechnology in sustainable construction projects. The effectiveness of nanotechnology has been proven in controlling water and air pollution, water recycling, and recycling processes. Manufacturing and producing environmentally friendly materials were proven by several studies (Khan, 2020; Sha et al., 2021; Harja & Ciobanu, 2021). Selecting suppliers to use natural resources” was ranked the second resource management practice in terms of significance according to R.I.I value and this practice was recommended by several studies that advised collaborating with suppliers using natural resources that can be recycled, and reused and contributes sustainability in addition selecting the widely available resource, such as greenery and earth materials (Benachio et al., 2020; Nasir et al., 2017). The third resource management that proved its significance is to control pollution to a minimum, and this is achieved by recycling, effective waste management, and reusing construction waste (Kabirifar et al., 2020; Nawaz et al., 2022).

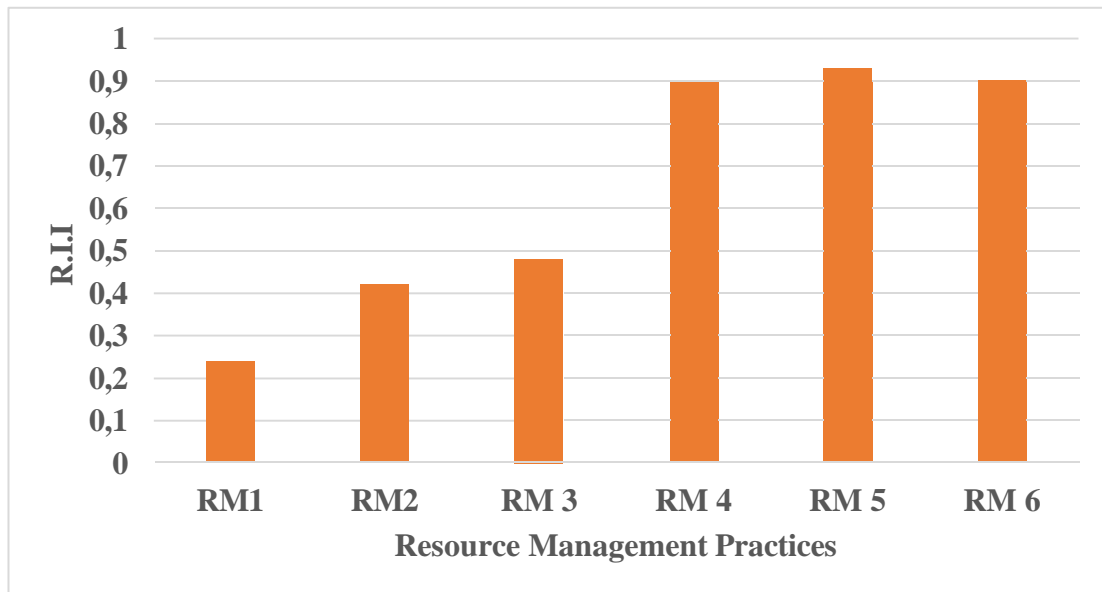


Figure 4.6: Ranking Resource Management Practices

As for energy efficiency practices, All the energy efficiency practices studied in Table 4.12 achieved an arithmetic mean higher than the hypothesized mean of (3), with a relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in The respondents studied these indicators of energy efficiency practices and the necessity of practicing and applying them. Table 4.12 ranks energy efficiency practices in green construction projects using mean values standard deviation relative importance index. It is illustrated that respondents think that the most efficient method is Respondents believe that the use of renewable energy is one of the essential energy efficiency practices in construction projects, as solar cells can be used to generate electricity, lighting devices, and equipment whose operation depends on renewable energy. Respondents also emphasized the adoption of means of transportation that consume less energy and fuel, in addition to the use of construction materials whose manufacturing depends on providing small amounts of energy for manufacturing. Respondents also indicated that all of the mentioned practices are very important, as the relative importance coefficient indicated high values of importance according to the scale.

Table 4.12: Ranking Energy Efficiency

No.	Energy Efficiency	Mean	Standard deviation	R.I.I	Rank	description
EE1	Energy cost assessment of building	3.86	1.45	0.77	7	H-M
EE2	Prepare an emergency plan for the failure of energy systems	4.00	1.37	0.80	4	H
EE3	Selecting materials consumes less energy during the fabrication process	3.81	1.43	0.76	6	H-M
EE4	Adopting equipment consumes less energy	4.56	0.76	0.91	2	H
EE5	Using green transport means with less adverse environmental impacts	4.54	0.78	0.91	2	H
EE6	Using renewable energy resources	4.67	0.64	0.93	1	H
EE7	High utilization of natural lighting and cooling systems	4.47	0.85	0.89	3	H

Figure 4.7 Presents R.I.I values of energy efficiency practices where it can be shown that using renewable energy resources is the most significant practice to reduce energy, and this was proved using several studies (Taghizadeh-Hesary & Yoshino, 2020; Sen & Ganguly, 2017) stated that renewable technologies harness energy from sources such as solar, wind, and geothermal power, which are abundant and naturally replenished. By utilizing these sources, construction projects can significantly reduce their reliance on traditional fossil fuels. Also, the use of environmentally friendly transportation and the use of construction equipment with less energy ranked second in terms of reducing energy consumption, as it has been proven through several studies aimed at using equipment that has less energy or that can be operated using renewable energy such as solar energy (Chel & Kaushik, 2018).

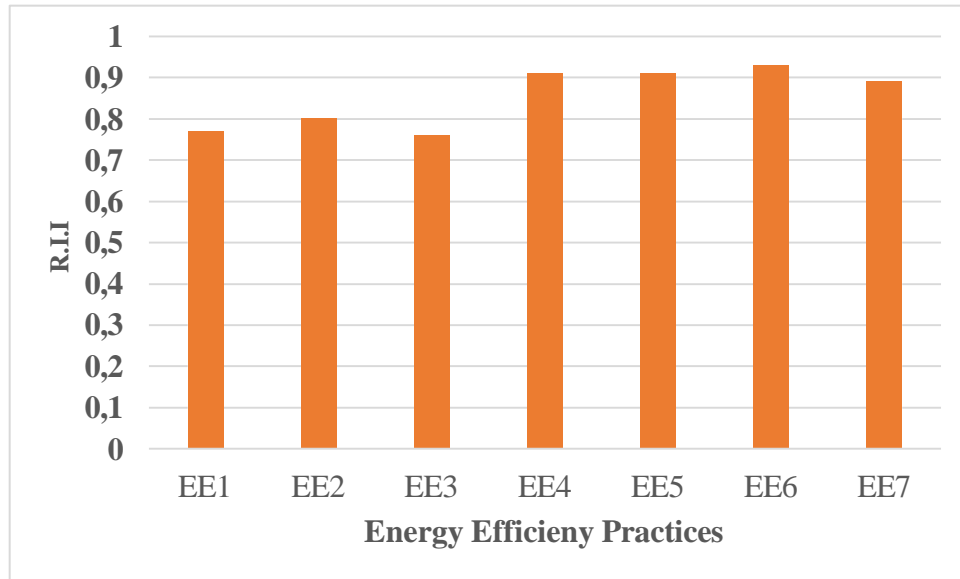


Figure 4.7: Ranking Energy Efficiency Practices.

As for health and safety practices, Table 4.13 shows that all health and safety practices achieved an arithmetic mean higher than the hypothesized mean of (3), with relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in The respondents studied these indicators of health and safety practices and the necessity of practising and applying them. Respondents also evaluated health and safety practices related to green construction projects, and the relative importance factor indicated that all of the health and safety practices mentioned are the most important and most frequent in terms of practice in green construction projects to achieve sustainability. Table 4.13 ranks health and safety practices in green construction projects using mean values standard deviation relative importance index. Also, It was indicated the significance of preparing an emergency plan to deal with potential risks for green construction projects and providing solutions for each risk. Respondents stressed the importance of training workers on green equipment and technology to ensure their safety and reduce accidents, in addition to strengthening safety procedures at the site by keeping workers safe from diseases and accidents by providing the necessary temporary medical centre and health facilities and providing a healthy source of drinking water and other temporary housing for temporary periods rest. Follow health and safety procedures and ensure that the site is safe from potential risks.

Table 4.13: Ranking Health and Safety Practices

No.	Health and Safety	Mean	Standard deviation	R.I.I	Rank	description
HS1	Ensuring that the Construction site is healthy and safe for all project members and labourers	4.11	1.42	0.82	6	H
HS2	Follow health and safety policies and regulations	4.49	1.08	0.90	4	H
HS3	Training labour and project members on green health and safety regulations	4.09	1.36	0.82	6	H
HS4	Prepare emergency plans related to health and safety risks	4.16	1.40	0.83	5	H
HS5	Prioritizing worker wellness strategies	4.56	0.73	0.91	3	H
HS6	Promoting safety protocols	4.64	0.67	0.93	2	H
HS7	Training labour on green technologies	4.68	0.68	0.94	1	H
HS6	Training labour on green equipment	4.66	0.68	0.93	2	H

Figure 4.8 expresses the ranking of health and safety practices in green construction. It can be noted that the most significant factors of health and safety practices are conducting training courses for labour on green technologies and green equipment in green construction management and that comply with several studies that strongly recommended conducting training for labour on technologies and equipment in construction projects since that assists for labour protection from incidents and enable them for correct using of these equipment and technologies (Chan et al., 2018; Wanget al., 2018). Also, “promoting safety protocols” is considered the third significant factor in health and safety practices that can promote health and safety procedures in construction management by updating regulations and policies related to health and safety practices (Bavafa et al., 2018; Lyu et al., 2018).



Figure 4.8: Ranking Health and Safety Practices

In the field of waste reduction, Table 4.14 shows that waste reduction practices achieved an arithmetic mean higher than the hypothesized mean of (3), with relative importance greater than 0.7, which is the accepted value for relative importance. Standard deviation values indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in the respondents studied these indicators of waste reduction practices and the necessity of practising and applying respondents confirmed as illustrated in Table 4.14 that processing building materials, reusing them, recycling them, and selecting materials result in a small amount of waste are the most significant practices to reduce waste.

Table 4.14: Ranking Waste Reduction Practices.

No.	Waste reduction	Mean	Standard deviation	R.I.I	Rank	description
WR1	Collecting, transporting and processing.	4.06	1.51	0.81	7	H
WR2	Storage of waste	4.08	1.41	0.82	4	H
WR3	Reuse waste	4.19	1.33	0.84	3	H
WR4	Recycling waste	3.82	1.60	0.85	2	H
WR5	Disposal of waste	2.4	0.61	0.46	6	M
WR6	Selecting material results in low-waste	4.37	1.31	0.77	1	H

Figure 4.9 shows the ranking of waste reduction practices in construction projects. The most significant practice, according to respondents' opinions, is to select the material to result in low waste, and several studies affirmed this solution

(Luangcharoenrat et al., 2019; Islam et al., 2019). Also, the second, third, fourth and fifth significant factors are recycling waste, reusing waste, storage waste, and processing waste, which are considered efficient tools according to lean construction to reduce waste in sustainable construction projects (Tafesse et al., 2022; Radina et al., 2023; Lamba et al., 2023) where recycling, reusing and waste processing contributes to reduce wastage, maintain resources and achieve clean environment.

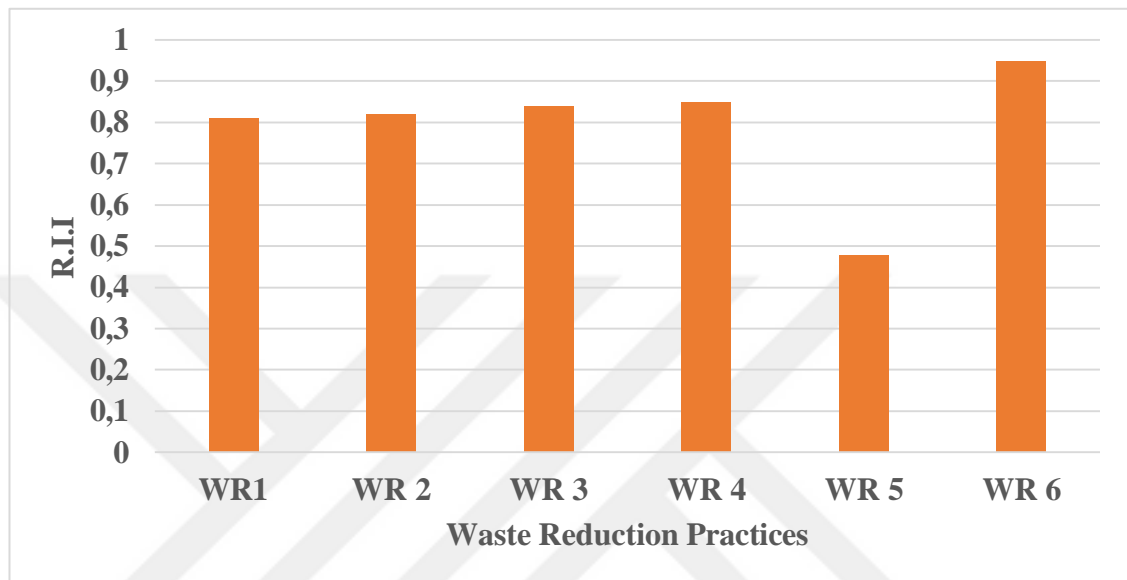


Figure 4.9: Ranking Waste Reduction Practices

4.6 Vital Benefits of the Application of Green Construction Management

After evaluating the proposed green building practices and explaining their importance in green construction projects, the benefits resulting from green building practices were evaluated, and these benefits were classified into several areas: environmental benefits, economic benefits, sustainability benefits, health benefits, and social benefits.

As for environmental benefits, Table 4.13 shows that all environmental benefits achieved arithmetic mean higher than the hypothesized mean of (3), with relative importance greater than 0.7, which is the accepted value for relative importance. Standard deviation values indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest. The respondents studied these indicators of environmental benefits and the necessity to be aware of them. Table 4.15 shows the evaluation of the environmental benefits resulting from green construction practices from the respondents' point of view. The evaluation was based

on the factor of relative importance. The respondents saw that one of the most important benefits of green construction practices is reducing the phenomenon of global warming, and this is due to reducing the emission of GHG gases and reducing pollution. Waste, dust, and pollutants resulting from construction practices during the implementation of the project contribute to environmental damage and limit the use of building materials and resources. It results in a large amount of waste, which contributes to reducing the waste produced during the project's life cycle. It also contributes to the innovation of techniques and methods to reduce waste, such as recycling and reusing.

Table 4.15: Evaluation Environmental Benefits

No.	Environmental Benefits	Mean	Standard deviation	R.I.I	Rank	description
EN1	Preserving natural resources	4.39	1.09	0.88	3	H
EN2	Eliminating global warming	4.68	0.69	0.94	1	H
EN3	Preserving the safety of the environment	3.87	1.48	0.77	7	H-M
EN4	Preserving air, water and land ecosystem	4.01	1.34	0.80	6	H
EN5	Reducing producing waste and elimination	4.42	0.84	0.88	3	H
EN6	Reducing pollution	4.08	1.42	0.82	4	H
EN3	Controlling waste management, such as separating and recycling waste	4.15	1.43	0.83	5	H
EN6	Limiting the materials results in huge waste	4.62	0.69	0.92	2	H

Figure 4.9 illustrates the most significant benefits of adopting green construction practices; where it can be noted that green construction management can eliminate global warming by reducing GHG emissions according to several reasons, such as construction materials, construction methods, waste construction used, and that complies to study by (Wibowo et al., 2018). Also, green construction materials enable construction materials to result in high waste by replacing these materials with natural resources that can be recycled, processed and reused, and these results were confirmed by (Jalaei et al., 2021). Also, it can be noted that the second and fourth benefits in terms of significance are reducing production waste and

eliminating pollution, was proved by several studies (Tang et al., 2020; Hossein et al., 2020; Osmani et al., 2019).

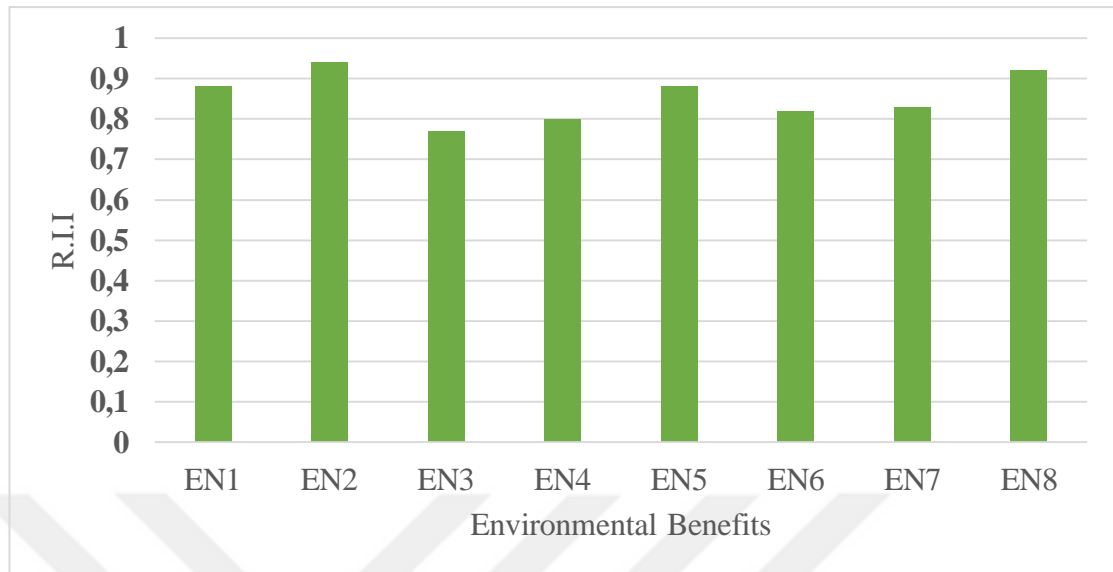


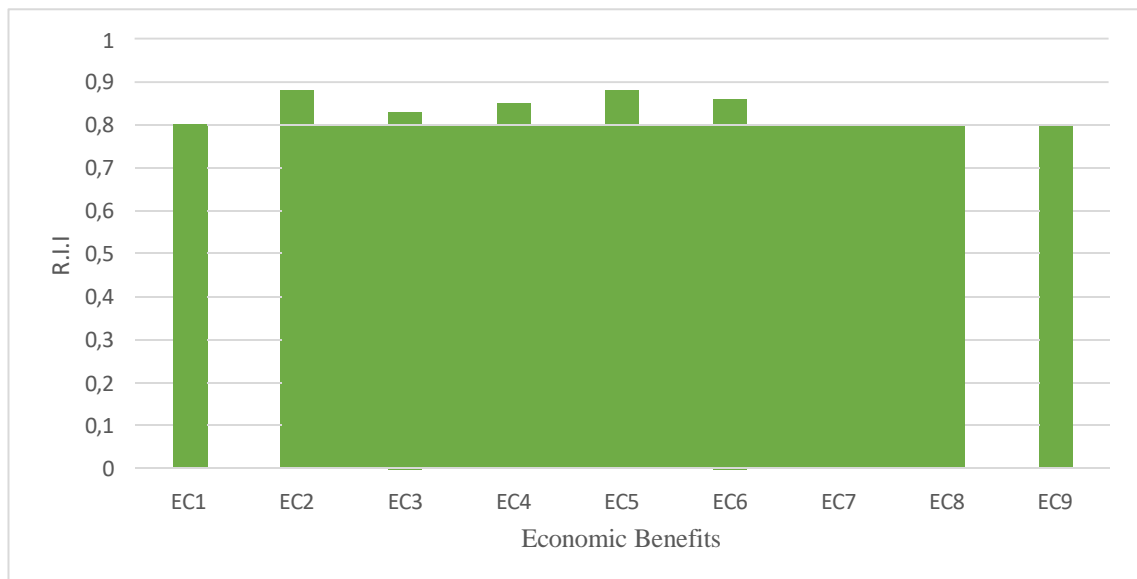
Figure 4.10: Ranking Environmental Benefits

As for economic benefits, Table 4.16 shows that all economic benefits achieved arithmetic mean higher than the hypothesized mean of (3), with relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in the respondents studied these indicators of economic benefits and the necessity to aware them. Also, the study demonstrates by Table 4.16 the beneficial contribution of green construction practices in achieving economic advantages. The respondents think that green construction practices contributed to upgrading economic development due to the adoption of sustainability principles in construction. Also, these practices enhance health costs by using eco-friendly resources that reduce illnesses. Moreover, Practices minimize water consumption and consequently reduce the cost of providing water sources. Furthermore, practices reduce the effect of environmental damage and consequently reduce costs to deal with these damages.

Table 4.16: Evaluation of Economic Benefits

No.	Economic Benefits	Mean	Standard deviation	R.I.I	Rank	description
ec1	Minimizing ecological damage cost	4.07	1.39	0.81	5	H
ec2	Utilizing renewable natural resources	4.39	1.10	0.88	1	H
ec3	Minimizing energy depletion and cost	4.13	1.35	0.83	4	H
ec4	Minimizing health cost	4.27	1.29	0.85	3	H
ec5	Enhancing economic development	4.38	1.01	0.88	1	H
ec6	Minimizing water depletion and cost	4.29	1.10	0.86	2	H
ec7	Reducing infrastructural cost	3.92	1.51	0.78	7	H-M
ec8	Enhancing return on investment	3.65	1.70	0.73	8	H-M
ec9	Increase economic value	4.02	1.46	0.80	6	H

Figure 4.10 shows the economic benefits of green construction management in enhancing economic development by achieving sustainability in construction and adopting reusing and recycling resources. In addition, achieving sustainable construction enhances the economic aspect (Hossain et al., 2020). Also, utilizing natural resources that are available significantly at low cost, such as clay and earth materials (Harja et al., 2022).

**Figure 4.11:** Ranking Economic Benefits

In the field of sustainability, Table 4.17 shows that all sustainable benefits achieved arithmetic mean higher than the hypothesized mean of (3), with relative importance greater than 0.7, which is the accepted value for relative importance. Standard deviation values indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest. The respondents studied these indicators of sustainable benefits and the necessity to be aware of them. Also, the study demonstrates by Table 4.17 the beneficial contribution of green construction. Respondents believe in Table 4.17 that green construction practices preserve non-renewable fuels and contribute to their sustainability, as they depend on renewable energies and solar cells. They also contribute to the sustainability of the environmental balance due to reducing environmental degradation. They also reduce pressure on infrastructure, as stated in Table 4.17. By reducing future financial crises as a result of using sustainable resources and sustainable construction techniques, sustainability practices play an essential role in improving water quality by adopting modern sustainable technologies such as solar stills and improving indoor air quality by taking into consideration natural ventilation and natural cooling techniques.

Table 4.17: Evaluation of Sustainable Benefits

No.	Sustainable Benefits	Mean	Standard deviation	R.I.I	Rank	description
su1	Improving productivity	4.21	1.43	0.84	4	H
su2	Lower long-term subjected to ecological or health issues	3.73	1.73	0.75	6	H-M
su3	Reduce financial crisis	4.21	1.44	0.84	4	H
su4	Improves indoor environmental quality	3.54	1.72	0.71	7	H-M
su5	Prevent ecological degradation	4.62	0.77	0.92	2	H
su6	Enhance water quality	4.07	1.50	0.81	5	H
su7	Minimize strain on local utility infrastructure	4.44	1.10	0.89	3	H
su8	Building a sustainable future	4.04	1.60	0.81	5	H
su9	Decrease the demand for fossil fuels	4.66	0.72	0.93	1	H

Figure 4.11 ranks the sustainable benefits studied where it can be noted that the most significant benefits of contributing green construction practices in sustainability ranked as follows: decrease the demand for fossil fuels (Gustavsson et al., 2021),

preventing environmental deterioration (Kabirifar et al., 2020), reducing pressure on local facilities (Liu et al., 2020). Reducing the demand for fossil fuels is achieved through sustainability practices related to the use of renewable energy systems to secure energy. With regard to reducing environmental degradation, harmful construction practices preserve natural resources and encourage the use of renewable, reusable and manufacturing resources. Sustainability practices also work on the use of waste, such as plastic waste. And glass, reprocessed and combined with concrete, aggregate, and construction materials (Wang et al., 2020).

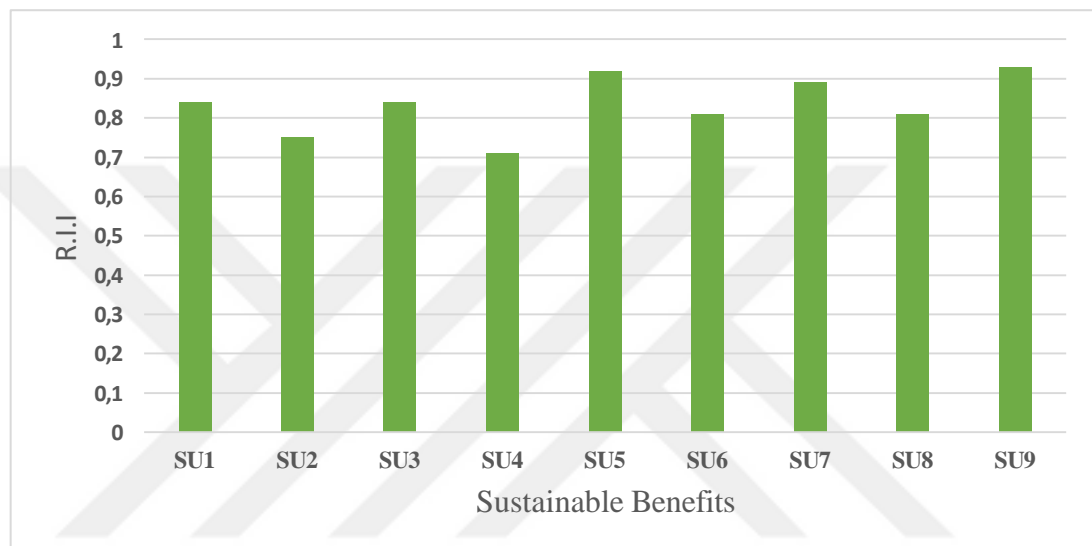


Figure 4.12: Ranking Sustainable Benefits.

In the field of sustainability, Table 4.18 shows that all health benefits achieved an arithmetic mean higher than the hypothesized mean of (3), with a relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in the respondents studied these indicators of health benefits and the necessity to aware them. Table 4.18 shows the benefits of green construction practices in the field of health, as these practices contribute to reducing pollution and waste resulting from the construction industry and reducing carbon dioxide emissions, which helps in reducing diseases and reducing the spread of toxins in the environment, in addition to ensuring the achievement of workers' well-being by maintaining their most significant health. Minimize the presence of pollutants and dust by utilizing environmentally sustainable and health-conscious resources, equipment, and materials.

Table 4.18: Evaluation Health Benefits

No.	Health Benefits	Mean	Standard deviation	R.I.I	Rank	description
H1	Enhancing health, comfort and well-fare	2.96	1.90	0.59	7	H
H2	Reducing environmental toxins	3.13	1.89	0.63	4	H-M
H3	Indoor air quality	4.56	6.10	0.91	3	H
H4	GHG emission reduction	4.68	0.76	0.94	2	H
H5	reducing illnesses and diseases	4.74	0.62	0.95	1	H

Figure 4.12 shows the ranking of health benefits where it can be noted that the most significant health benefits of green construction management ranked as follows: reducing illnesses (Lingard & Rowlinson, 2004), reducing GHG emission (Lu et al., 2020) and enhancing indoor air quality (Robichaud & Anantatmula, 2011).

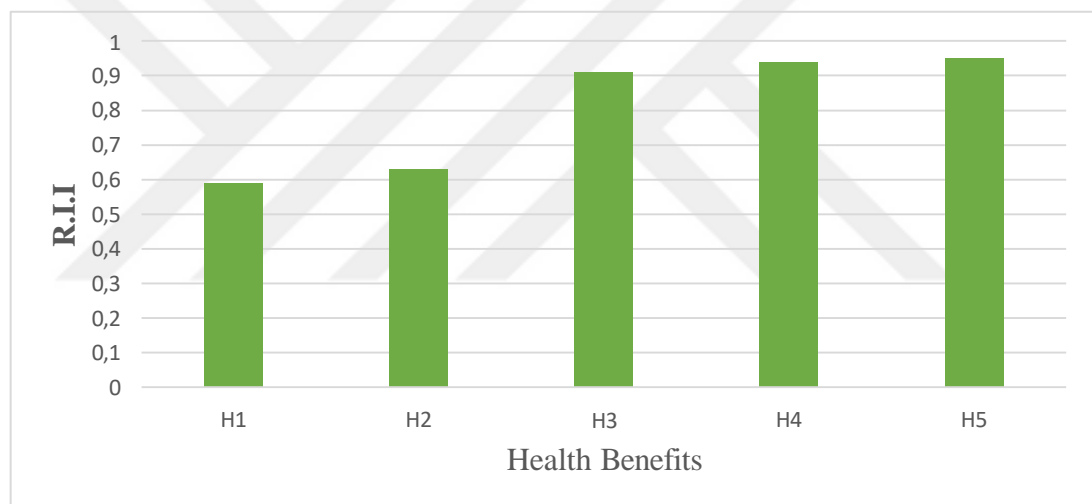


Figure 4.13: Ranking Health Benefits.

Table 4.19 shows that all social benefits achieved arithmetic mean higher than the hypothesized mean of (3), with relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in the respondents studied these indicators of social benefits and the necessity to aware them. Table 4.19 shows the social benefits resulting from adopting green construction practices by improving quality of life and contributing to society's culture and heritage, achieving the well-being of building occupants and achieving their satisfaction. It also contributes to raising awareness in society to adopt policies of green construction practices.

Table 4.19: Evaluation Social Benefits

No.	Social Benefits	Mean	Standard deviation	R.I.I	Rank	description
SO1	Enhancing life quality for people and the community as a whole	4.71	0.63	0.94	2	H
SO2	Satisfying human demands	4.69	0.66	0.94	2	H
SO3	Raising awareness, the multi-disciplinary societies	4.76	0.57	0.95	1	H
SO4	Increases profitable and competitive advantage	2.71	1.02	0.54	6	M
SO7	Enhance client satisfaction, comfort, and well-fare	4.59	0.76	0.92	3	H
SO6	Collaborative working environment	4.52	0.81	0.90	4	H
SO3	Maintaining culture/heritage	3.35	1.78	0.67	5	H-M

Figure 4.13 illustrates the most significant social benefits ranked as follows: raising awareness of multi-disciplinary societies, enhancing life quality for people and the community as a whole and satisfying human demands. These results are consistent with those of several studies (Darko & Chan, 2017). The quality of life improves through green construction practices by improving energy efficiency, using cooling systems natural lighting, adopting renewable energy technologies, and other practices that raise the awareness of communities about the benefits of green construction.

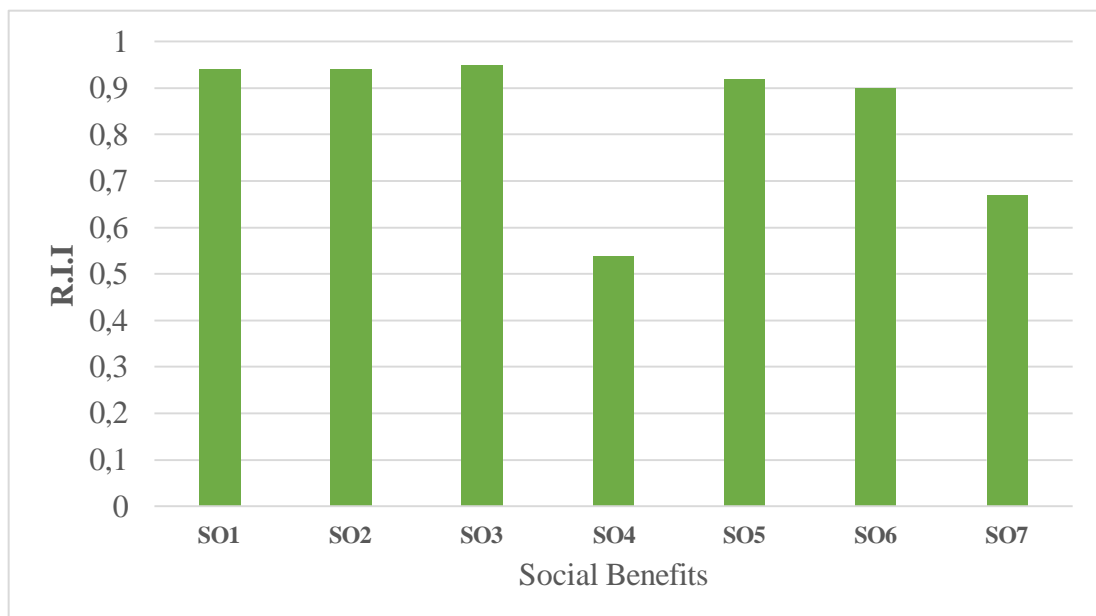


Figure 4.14: Ranking Social Benefits

4.7 Common Challenges That Limit Applying Green Construction Practices

The disadvantages that occur as a result of adopting green construction practices in construction projects were also evaluated. According to the literature review in the second chapter, the disadvantages resulting from green construction practices were classified into four groups: disadvantages related to technology, disadvantages related to resources, disadvantages related to the economy, and disadvantages related to organization. Respondents rated these disadvantages according to their severity, and the evaluation was made using a relative importance index. Table 4.20 shows that all Technology disadvantages achieved arithmetic mean higher than the hypothesized mean of (3), with a relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in The respondents studied these indicators of technology disadvantages and the necessity to aware them. Figure 4.20 ranks technology disadvantages by severity. One of the most significant drawbacks is the contractor and consultants' lack of green construction experience, followed by their lack of awareness of technology alternatives and alternative solutions if none are accessible. The slow production of green equipment also causes delays. Cost overruns, delays in approvals for new green technology, and a lack of information, knowledge, and awareness of green construction practices are the biggest risks to green construction policies in construction project delivery.

Table 4.20: Evaluation Technology Disadvantages

No.	Technology disadvantages	Mean	Standard deviation	R.I.I	Rank	description
T1	Information shortage	2.85	1.66	0.57	6	M
T2	Lack of awareness of alternative process technology	4.18	1.46	0.84	3	H
T3	Taking a long period to approve a process for new green technologies	3.38	1.72	0.68	5	H-M
T4	Lack of equipment productivity in sustainable construction	3.74	1.74	0.75	4	H-M

Table 4.20: (Cont.) Evaluation Technology Disadvantages

No.	Technology disadvantages	Mean	Standard deviation	R.I.I	Rank	description
T5	Contractor knowledge gap on green construction	4.48	0.83	0.90	1	H
T6	Experience a shortage of consultants about sustainable construction practices	4.39	1.00	0.88	2	H

Figure 4.14 depicts the ranking of technology disadvantages according to their significance as follows: contractor knowledge gap on green construction, experience shortage of consultants about sustainable construction practices, and lack of awareness of alternative process technology and these drawbacks affirmed by (Abdelaal & Guo, 2021; Ghaffarianhoseini et al., 2017).

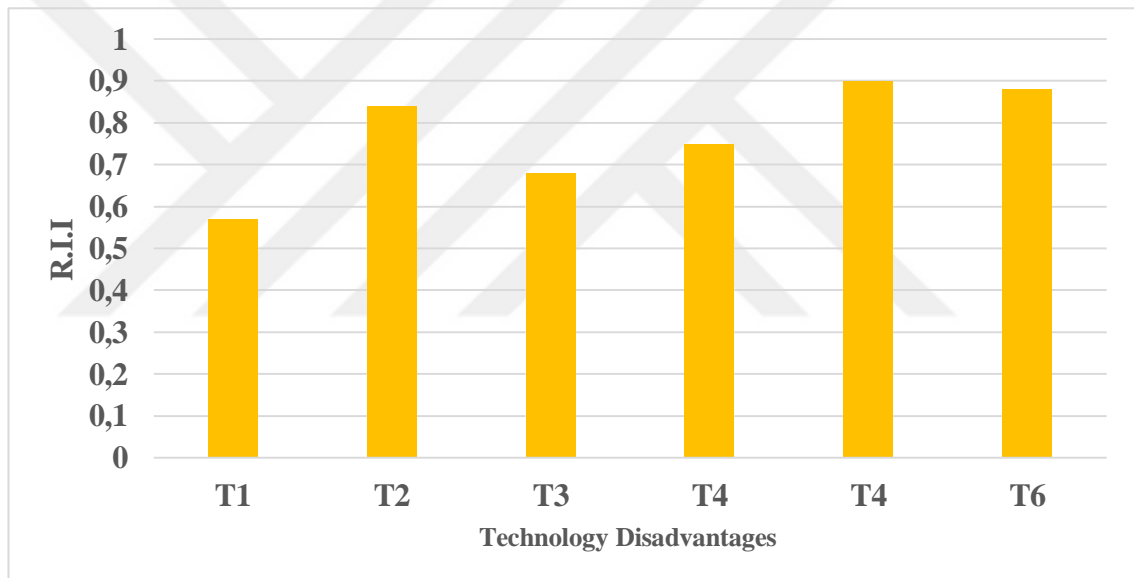


Figure 4.15: Ranking Technology Disadvantages.

Table 4.21 shows that all resource disadvantages achieved an arithmetic mean higher than the hypothesized mean of (3), with a relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest in the respondents studied these indicators of resource disadvantages and the necessity to aware them. Table 4.21 displays the drawbacks arising from resource management, including a scarcity of documents and information on new environmentally friendly technologies, a deficiency in standards and regulations, a lack of green suppliers, challenges in understanding the green

specifications in contract details, a shortage of human resources, and a lack of necessary skills.

Table 4.21: Evaluation of Resource Disadvantages

No.	Resource management Disadvantages	Mean	Standard deviation	R.I.I	Rank	description
R1	Lack of awareness of alternative chemical	3.66	1.69	0.73	7	H-M
R2	Lack of awareness of raw material inputs	3.40	1.65	0.68	8	H-M
R3	Human resources shortage and skills	4.41	0.85	0.88	5	H
R4	Difficulty in comprehending the green specifications in the contract details.	4.51	0.87	0.90	4	H
R4	Ambiguity over environmentally friendly materials and equipment	2.80	1.58	0.56	9	M
R6	Lack of local green material or equipment.	3.72	1.48	0.74	7	H-M
R7	Insufficient proficiency in the technical aspects of green technology and procedures.	3.73	1.27	0.75	6	H-M
R8	Labour awareness shortage of the right techniques and procedures.	4.62	0.71	0.92	2	H
R9	Inappropriate selection of subcontractors to introduce green construction services.	3.39	1.58	0.68	8	H-M
R10	Lack of standards and regulations.	4.59	0.79	0.92	2	H
R11	Lack of experience in skills of project manager regarding green construction	3.68	1.63	0.74	7	H-M
R12	Lack of green suppliers	4.54	0.80	0.91	3	H
R13	Inadequate documentation and limited access to knowledge regarding emerging green technologies.	4.64	0.72	0.93	1	H

Figure 4.15 Ranks the resource disadvantages according to their significance, where it can be noted the most significant resource disadvantages ranked as follows: Inadequate documentation and limited access to knowledge regarding emerging

green technologies, lack of standards and regulations, lack of green suppliers, difficulty in comprehending the green specifications in the contract details and human resources shortage and skills and these outcomes affirmed by several studies (Chan et al., 2018; Darko et al., 2017; Tracy et al., 2017).

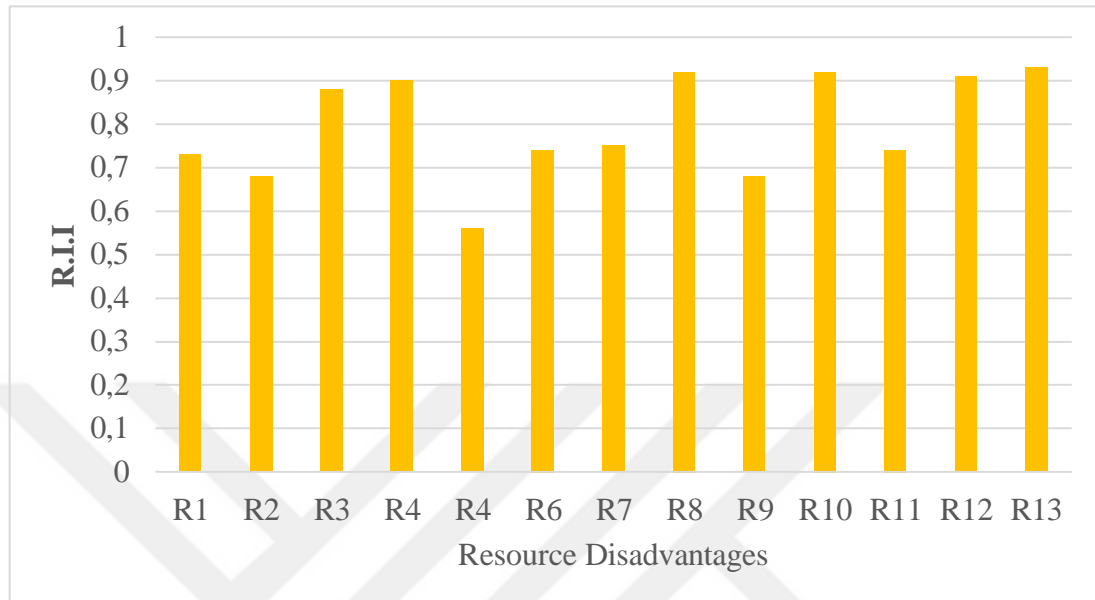


Figure 4.16: Ranking Resource Disadvantages

Table 4.22 shows that all economic disadvantages achieved arithmetic mean higher than the hypothesized mean of (3), with relative importance greater than 0.7, which is the accepted value for relative importance, and standard deviation values that indicate a slight dispersion in the answers of the respondents, and this indicates the extent of interest. The respondents studied these indicators of economic disadvantages and the necessity to be aware of them. Respondents also evaluated the economic disadvantages shown in Table 4.22, the most important of which are the fluctuations in the prices of green materials and their change between the design stage and during project implementation. The materials and equipment needed for green starch practices are much higher than traditional materials and equipment, and this causes high costs for project implementation. Green building projects also suffer from a lack of Accuracy in estimating the project cost because it is not as common as traditional buildings.

Table 4.22: Evaluation of Economic Disadvantages

No.	Economic Disadvantages	Mean	Standard deviation	R.I.I	Rank	description
ED1	High execution costs	3.65	1.58	0.73	5	H-M
ED2	High initial budget	4.25	1.27	0.85	4	H
ED3	Their economic viability is hindered by the fact that they do not recoup the initial expenditure in a timely manner.	4.42	1.11	0.88	3	H
ED4	Inaccuracy in project budgeting due to unfamiliarity with green projects	3.67	1.51	0.73	5	H-M
ED5	Additional costs due to green material and equipment	4.56	0.84	0.91	2	H
ED6	Inflation of green materials' prices	4.65	0.68	0.93	1	H

Figure 4.16 depicts the most significant economic disadvantages ranked as follows: Additional costs due to green material and equipment and Inflation of green materials' prices; these results match with sites conducted by (Chan et al., 2018; Darko et al., 2017).

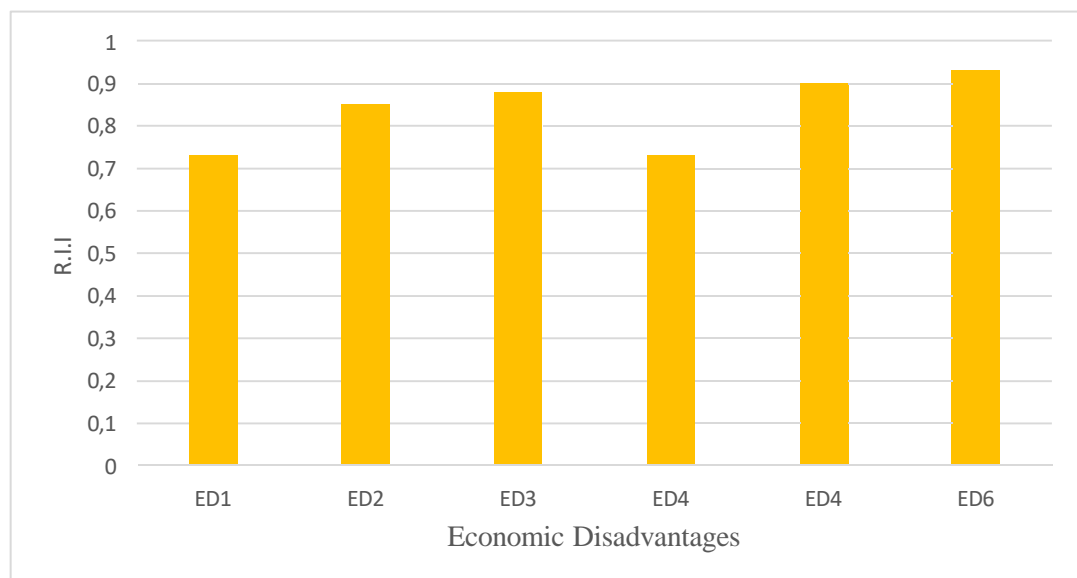


Figure 4.17: Ranking Economic Disadvantages.

Regarding the drawbacks arising from the organization, as indicated in Table 4.23, respondents perceive disadvantages stemming from inadequate communication among project stakeholders, as well as deficiencies in the planning methodology and

insufficient understanding of the essential planning required for sustainable green building projects. Due to the limited familiarity with green construction processes, there are drawbacks associated with the requirement for extensive and regular consultations with experts. Regarding green construction, respondents also express challenges in assessing the advancement of projects related to environmentally friendly building practices. Green construction projects often experience delays in implementation due to a lack of awareness about green construction practices. This results in significant time being spent on planning, calculating quantities, evaluating prices, and making necessary preparations before the project can begin—execution alongside modifications in regulations and laws.

Table 4.23: Evaluation Organization Disadvantages

No.	Organization Disadvantages	Mean	Standard deviation	R.I.I	Rank	description
OD1	Extended duration is necessary for the pre-construction phase.	4.48	0.98	0.90	5	H
OD2	Challenges in evaluating the level of accomplishment in sustainable construction	4.53	0.75	0.91	4	H
OD3	variation with the design during the construction process.	4.65	0.70	0.93	2	H
OD4	Insufficient implementation of a methodical strategy for the planning and execution of actions to achieve sustainability	4.67	0.68	0.93	2	H
OD7	Interpersonal communication and engagement among members of a project team	4.69	0.67	0.94	1	H
OD6	frequent meetings with green specialists	4.61	0.67	0.92	3	H
OD7	green consultant delay in providing information	3.67	1.76	0.73	3	H-M
OD8	Delay in government approvals for green construction	3.62	1.75	0.72	6	H-M
OD9	Revisions to laws and regulations governing sustainable construction	3.93	1.19	0.79	6	H-M

Figure 4.17 illustrates that the most common drawbacks related to the organizational field are Interpersonal communication and engagement among members of a project team, Insufficient implementation of a methodical strategy for the planning and execution of actions to achieve sustainability and variation with the design during the construction process and frequent meetings with green specialists.

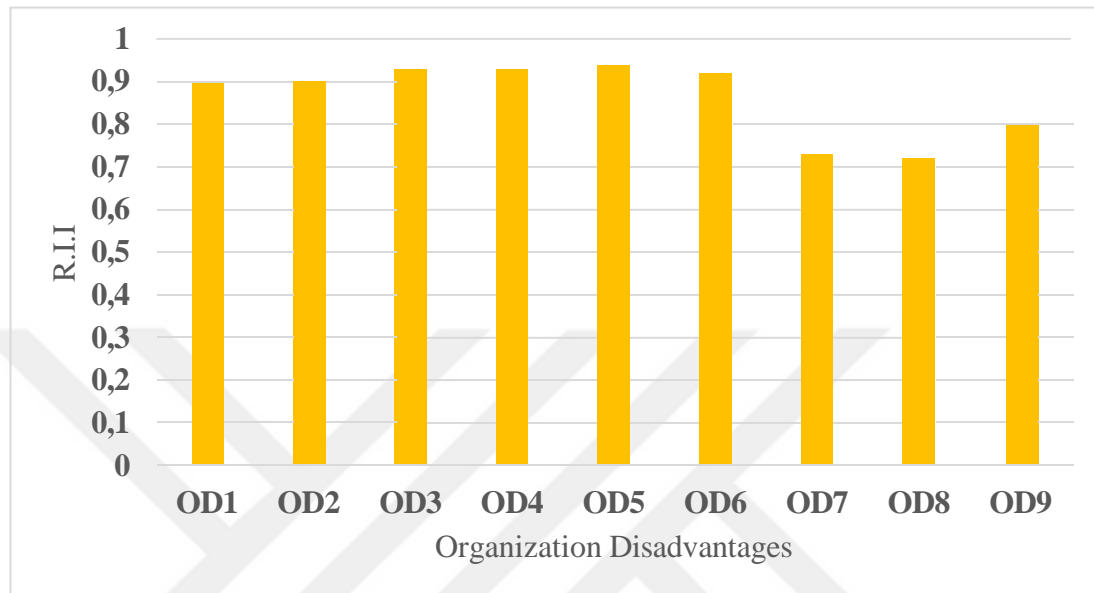


Figure 4.18: Ranking Organization Disadvantages.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

This study relied on evaluating sustainable green construction practices and then evaluating the benefits and disadvantages of these practices by reviewing relevant literature to collect information about practices related to green construction practices, which were classified into environmental practices, resource management, energy efficiency, health and safety procedures, and waste reduction. An assessment was conducted to evaluate the advantages of implementing green construction methods in relation to environmental, economic, sustainability, health, and social factors. Similarly, the drawbacks of adopting green construction practices were assessed in terms of economic, organizational, technological, and resource management elements.

The evaluation was based on conducting a questionnaire targeting experts in traditional and green project management, including contractors, project managers, engineers and site supervisors. The collected data was analyzed, and green construction practices and the benefits and disadvantages resulting from these practices were evaluated by calculating averages and then calculating the relative importance index.

5.2 Key Finding

5.2.1 Results of green construction practices

This study provided a comprehensive guide to green construction practices and their advantages and disadvantages in construction projects. This study was distinguished by presenting the essential effective practices in green construction practices, which were classified into four categories: environmental practices, resource management practices, energy efficiency practices, health and safety practices, and related practices. It reduces waste, as the study in the field of environmental practices for green construction management found that the most effective strategy for having a

positive impact on the environment is the effective management of rainwater and grey water through recycling water, using it for different purposes, and handling it. The study also demonstrated that the effective management of human resources management during a green construction project contributes significantly to saving resources, optimizing the use of energy, and reducing pollution, in addition to reducing waste of cost, time, and materials. The study also recommended using environmentally friendly construction materials, such as environmentally friendly concrete, which contributes effectively to reducing carbon emissions.

With regard to resource management, the study found several effective and essential practices in green construction management, the most important of which is the use of environmentally friendly technology such as nanotechnology, which has recently proven its effectiveness through many academic studies in recycling and sterilizing physical water, in addition to its beneficial contribution through its introduction into Building materials to reduce carbon emission. Adopting effective human resources management contributes significantly to preserving resources and reducing waste of cost, time and building materials. This is done by achieving effective communication between the project parties. The study also confirmed the adoption of suppliers who use natural resources in green construction that can be recycled. Recycling and reuse are widely available, such as earthen materials and clay.

With regard to energy efficiency, the study demonstrated that the use of renewable energy resources represents the most important practice in this field, as solar energy, wind energy, and other renewable resources contribute effectively to reducing dependence on fuel. The study also found that the use of environmentally friendly means of transportation, the habit of building construction, and low fuel consumption or use. Equipment that relies on solar energy to operate is an effective practice in reducing energy.

In the field of health and safety, the study emphasized the necessity of training workers on green construction technology and the use of green equipment to avoid accidents and ensure correct and optimal use. Upgrading safety protocols is also an essential practice in the field related to health and safety practices.

As for practices related to waste management, the study showed that one of the most essential practices of green construction in this field is choosing materials that result in little waste. The study also confirmed essential waste management practices that

are highly effective in reusing and recycling waste and helping it to ensure its use.
Optimized for green construction management

5.2.2 Results of green construction benefits

The study found many benefits in green construction management, which were classified into environmental benefits, economic benefits, social benefits, sustainability benefits, and health benefits.

As for environmental benefits, green construction practices can eliminate global warming by reducing GHG emissions for several reasons, such as construction materials, construction methods, and waste construction used. Also, green construction materials enable a limit on construction materials, resulting in high waste by replacing these materials with natural resources that can be recycled, processed, and reused. Moreover, reducing producing waste eliminates pollution.

As for the economic benefits, the study found that green construction practices enhance economic development by achieving sustainability in construction by adopting reusing and recycling resources; in addition, achieving sustainable construction enhances the economic aspect. It is, furthermore, utilizing natural resources that are available greatly at low cost, such as clay and earth materials.

Regarding sustainability, the most significant benefits of contributing to green construction practices in sustainability include decreasing the demand for fossil fuels, preventing environmental deterioration, and reducing pressure on local facilities. Reducing the demand for fossil fuels is achieved through sustainability practices related to the use of renewable energy systems to secure energy. With regard to reducing environmental degradation, harmful construction practices preserve natural resources and encourage the use of renewable, reusable and manufacturing resources. Sustainability practices also work on the use of waste, such as plastic waste and glass, reprocessed and combined with concrete, aggregate, and construction materials.

As for health benefits, the study showed that green construction management can reduce illnesses, reduce GHG emissions and enhance indoor air quality. Regarding the social benefits, this study helps improve the quality of life for citizens and society

5.2.3 Results of green construction disadvantages

This study highlighted the disadvantages of practices related to green construction practices, as these disadvantages were classified into disadvantages related to technology, resources, economics, and organization. As for technology disadvantages, it was revealed that the most prominent technology disadvantages are the contractor knowledge gap on green construction, the shortage of consultants about sustainable construction practices, and the lack of awareness of alternative process technology. The most significant resource disadvantages ranked as follows: Inadequate documentation and limited access to knowledge regarding emerging green technologies, lack of standards and regulations, lack of green suppliers, difficulty in comprehending the green specifications in the contract details and human resources shortage and skills

The most significant economic disadvantages are ranked as follows: Additional costs due to green materials and equipment and inflation of green materials' prices.

The most common drawbacks related to the organizational field are Interpersonal communication and engagement among members of a project team, Insufficient implementation of a methodical strategy for the planning and execution of actions to achieve sustainability and variation with the design during the construction process and frequent meetings with green specialists.

Challenges and Limitations: Although the research has beneficial contributions, it also admits various challenges and limitations. The issue of gaining complete and accurate data on green construction practices, benefits and disadvantages is noteworthy since it can limit the generalizability of findings. Methodological restrictions are acknowledged, which means although the selected study techniques are efficient, they might not completely present the green construction practices, which require more study utilizing a variety of study methods. Generalizability issues are noticed since findings from specific contexts may not be easily transferred to other construction projects; instead, they must be altered to take into account variations in project types, company cultures, and regulations.

Addressing Limitations via Future Research: Future study is necessary to enhance our awareness of this area. Working with industry stakeholders, such as government organizations, green management professionals, and construction companies, can

enhance data collection and conducting reports. The efficiency of green construction management can be better known by integrating quantitative and qualitative techniques in mixed-techniques study designs.

Significance Of the Study

This study contributed to providing a comprehensive guide to green construction practices from multiple aspects, including practices related to the environment, resource management, energy efficiency, waste management, and health and safety management. These practices represent a comprehensive guide that enables stakeholders, including project managers, contractors, consultants, and engineers, to identify green construction practices. It also enables academics to take this guide as a reference to conduct future, more in-depth studies in green construction management. This study serves as evidence for awareness of the benefits of green construction for its adoption and encouragement for its use, in addition to the disadvantages of using green construction to overcome these disadvantages.

5.3 Recommendations

This chapter provides practical ideas for several construction industry parties to develop efficient green construction management and, eventually, eliminate accidents. Incorporation and cooperation from all stakeholders concerned are essential to execute these suggestions.

5.3.1 Recommendations for construction firms

Execute a Comprehensive Green Construction Management Programme: develop a comprehensive green construction management programme to comply with every project's unique demands. It is significant to regularly assess and modify this programme to take into account variations in the project's scope, staffing, and rules. During the project stage, It is necessary to select contractors who have adequate experience in green construction. Ensure labour has enough knowledge of green construction techniques, technology and materials. Due to the lack of knowledge in green construction management in Iraq, workshop training should be executed by adopting foreign experts in green construction.

Provide Innovation and Employing Technology: The use of modern and advanced technology such as building information modelling, information technology and

drones is of great importance in tracking the stages of green construction management in order to improve and develop it and avoid difficulties. Although these techniques require a high budget, they are efficient tools for promoting green construction management.

Provide Financial Incentives for green construction management: Tax benefits and financial incentives to companies investing in green construction technologies and training courses. This motivates the construction industry to adopt green construction strategies. Develop initiatives that motivate the generation and employment of green construction solutions.

Upgrade Research and Knowledge participation: introduce finance for studies related to green and sustainable green construction practices. The development of new green construction rules and best practices

5.3.2 Recommendations for academic field

This study recommends that researchers and academics seek to promote green construction management through research into materials that are combined with building materials and reduce environmental impacts. It is a novel field in the green construction industry and requires extensive investigation and research in this field.

This study also recommends periodically updating studies on the benefits and disadvantages of green construction to raise awareness of the extent of its application. This study also recommends more research techniques related to green construction, such as reuse and recycling, as well as the essential effective practices in waste management and improving energy efficiency. The challenges researchers may face are keeping up to date in this field and knowing the most innovative strategies in this regard, in addition to investigating their efficiency accurately. This study recommends investigating the use of technologies related to building information modelling, IOT, and artificial intelligence in green construction management. However, these technologies are considered new, and the scope of research on them is still limited; therefore, they require further investigation to ensure the accuracy of the results.

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APPENDICES

Appendix-A: Questionnaire

This questionnaire consists of 4 sections:

Section A: General information.

Section B includes green building practices divided into four categories: resource management, energy efficiency, health and safety management, environmental management and waste reduction.

While Section C includes the benefits resulting from the application of green building practices, classified into several aspects: benefits related to sustainability, economic benefits, social, environmental and health benefits.

Section D includes the disadvantages resulting from the application of sustainability principles in construction projects, which are disadvantages related to the economy, technology, resources, and organization.

SECTION A – GENERAL INFORMATION

1. Scientific Qualification: less than Bachelor Degree Bachelor Degree
Master Degree Doctoral
2. Number of years of experience in construction projects: 5-10 years 11-15 years 16-20 years 20-25 years More than 25 years
3. work position: project Manager Site Supervision contractor engineer.
4. How have you participated in green construction projects?
 Yes No.

Section B includes green building practices divided into five categories:

The following is a list of practices in green construction:

Rank on a scale of 1-5 according to the frequency of using these practices in green construction projects.

- 1- Not at all.
- 2- Rarely
- 3- Sometimes
- 4- Often
- 5- Always.

No	environmental practices	frequentlevel				
		1	2	3	4	5
1	Preparing an emergency plan for rapid response to natural disasters					
2	Environmental assessment					
3	determining a skilled staff with ecological policies					
4	controlling pollution to the minimum					
5	using eco-friendly technology					
6	selecting suppliers uses natural resources					
Resource management						
1	usage of eco-friendly materials					
2	a regular program of leak inspections at the building					
3	the use of treated and recycled water					
4	catch rainwater and greywater					
5	the use of relevant water-saving control systems					
6	efficient human resource management					
7	using eco-friendly equipment					
8	using eco-friendly technologies					
9	Dealing with suppliers and contractors who support green practices					
10	Provide skilled labour in sustainable and green construction					
11	Limiting the materials used to reduce waste					

Energy efficiency					
1	energy cost assessment of building				
2	prepare an emergency plan for the failure of energy systems				
3	selecting materials consumes less energy during the fabrication process				
4	adopting equipment consumes less energy				
5	using green transport means with less adverse environmental impacts				
6	using renewable energy resources				
7	high utilization of natural lighting and cooling systems				
Health and safety practices					
1	ensuring that the Construction site is healthy and safe for all project members and labors				
2	follow health and safety policies and regulations				
3	training labour and project members on green health and safety regulations				
4	prepare emergency plans related to health and safety risks				
5	Prioritizing Worker Wellness Strategies				
6	promoting safety protocols				
7	training labour on green technologies				
8	training labour on green equipment				

Waste reduction					
1	collecting, transporting and processing.				
2	storage of waste				
3	reuse waste				
4	recycling waste				
5	disposal of waste				
6	selecting material contributes to reducing waste				

Section C includes benefits results from green construction practices divided into five categories:

The following is a list of benefits of green construction management.

Rank on a scale of 1-5 according to the importance of using these practices in green construction projects.

- 1- Strongly disagree.
- 2- Disagree.
- 3- Neutral.
- 4- Agree.
- 5- Strongly agree.

No	Environmental Benefits	importancelevel				
		1	2	3	4	5
1	preserving natural resources					
2	eliminating global warming					
3	preserving the safety of the environment					
4	preserving air, water and land ecosystem					
5	reducing producing waste and elimination					
6	reducing pollution					
7	Controlling waste management, such as separating and recycling waste.					
8	Limiting the materials used to reduce waste					
Economic Benefits						
1	minimizing ecological damage cost					
2	utilizing renewable natural resources					
3	minimizing energy depletion and cost					
4	minimizing health cost					
5	enhancing economic development					
6	minimizing water depletion and cost					
7	reducing infrastructural cost					
8	enhancing return on investment					
9	Increase economic value					

Sustainable Benefits						
1	improving productivity					
2	Lower long-term subjected to ecological or health issues.					
3	reduce financial crisis					
4	Improves indoor environmental quality					
5	prevent ecological degradation					
6	enhance water quality					
7	Minimize strain on local utility infrastructure.					
8	building a sustainable future					
9	Decrease the demand for fossil fuels					

Healthy Benefits						
1	enhancing health, comfort and well-fare					
2	reducing environmental toxins					
3	indoor air quality					
4	GHG emission reduction					
5	reducing illnesses and diseases					
social benefits						
1	enhancing life quality for people and the community as a whole					
2	satisfying human demands					
3	raising awareness, the multi-disciplinary societies					
4	Increases profitable and competitive advantage					
5	introduces favourable natural and social environments					
6	enhance client satisfaction, comfort, and well-fare					
7	Collaborative working environment					
8	maintaining culture/heritage					

Section D includes disadvantages results from green construction practices divided into five categories:

The following is a list of disadvantages of green construction management.

Rank on a scale of 1-5 according to the frequency of these defects in green construction projects.

- 1- Not at all.
- 2- Rarely.
- 3- Sometimes.
- 4- Often.
- 5- Always.

No	Technology disadvantages	importancelevel				
		1	2	3	4	5
1	information shortage					
2	lack of awareness of alternative process technology					
3	Taking a long period to approve a process for new green technologies					
4	lack of equipment productivity in sustainable construction					
5	experience shortage of contractors in green construction practices					
6	experience a shortage of consultants about sustainable construction practices					
Resources disadvantages						
1	lack of awareness of alternative chemical					
2	lack of awareness of raw material inputs					
3	human resources shortage and skills					
4	difficulty in comprehending the green specifications in the contract details.					
5	uncertainty with green material and equipment					
6	lack of local green material or equipment.					
7	lack of technical skill regarding green technologies and techniques					
8	labour awareness shortage of the proper techniques and procedures.					
9	inappropriate selection of subcontractors to introduce green construction services.					
10	integration of standards and regulations.					
11	lack of experience in skills of project manager regarding green construction					
12	lack of green suppliers					

13	Lack of documents and information for new green technologies					
Economic Disadvantages						
1	high execution costs					
2	high initial budget					
3	they do not make up for the initial cost quickly enough to make them economically viable.					
4	Inaccuracy in project budgeting due to unfamiliarity with green projects					
5	Additional costs due to green material and equipment					
6	Inflation of green materials' prices					

Organization disadvantages						
1	longer time required during the pre-construction process					
2	difficulty in assessing the progress of completion in green construction					
3	variation with the design during the construction process.					
4	Lack of a systematic approach to planning and acting for the fulfillment of sustainability					
5	communication and interest among project team members;					
6	frequent meetings with green specialists					
7	green consultant delay in providing information					
8	Delay in government approvals for green construction					
9	Changes in sustainable construction codes and regulations					

RESUME

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EDUCATION:

- Bachelor: 2019-2020 AL Mansour University college Civil Engineering
- Master: MCE From Istanbul Gedik University – Civil Engineering

COURSES:

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- Institution of Occupational Safety and Health

SKILLS:

- MICROSOFT OFFICE
- AUTOOCO