Critical Success Factors for Sustainable Project Management in Green Building Projects in Yemen

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ABSTRACT

This study examines the critical success factors influencing sustainable project management and the success of green building projects in Yemen. It identifies and prioritises the most influential factors, assesses the principal implementation barriers, tests the relationships between the identified factors and multidimensional project success, and proposes a context-specific implementation framework. A quantitative, cross-sectional research design was adopted using a structured bilingual questionnaire developed for construction-industry professionals. The final research dataset comprised 393 cases and was examined using descriptive statistics, the Relative Importance Index (RII), reliability and validity assessment, and Partial Least Squares Structural Equation Modelling. The measurement model demonstrated satisfactory reliability and validity, with outer loadings ranging from .706 to .866, Cronbach's alpha from .884 to .957, composite reliability from .913 to .961, and average variance extracted from .579 to .702. Discriminant validity and model fit were also established, with a maximum HTMT value of .589 and an SRMR value of .038. Client- and stakeholder-related factors received the highest overall importance ranking (RII = .917), while robust quality assurance and quality control emerged as the highest-ranked individual factor (RII = .953). High initial cost was identified as the most substantial barrier to green building implementation (RII = .951). The structural model explained 51.1% of the variance in project success. Project management-related factors were the strongest significant predictor (β = .326), followed by project-related factors (β = .265), client- and stakeholder-related factors (β = .223), and project team-related factors (β = .144). Organisational and institutional factors and external-environment factors did not demonstrate significant direct effects. Three contextual interaction effects were significant, indicating partial moderation. The study concludes that improving green building project success in Yemen requires integrated project management, early definition of sustainability requirements, stronger stakeholder commitment, enhanced professional capability, cost-sensitive procurement strategies, and progressive institutional support.

Keywords: critical success factors; sustainable project management; green building; Yemen; PLS-SEM

INTRODUCTION

Background of the Study

The global construction industry is one of the largest contributors to environmental degradation, energy consumption, and greenhouse gas emissions. According to the United Nations Environment Programme, the buildings and construction sector accounts for approximately 37 per cent of global energy-related carbon dioxide emissions and roughly 34 per cent of total final energy demand (UNEP, 2024). In response to these pressures, sustainable construction and particularly the development of green buildings has emerged as a central pillar of the global transition toward climate-responsive built environments and the Sustainable Development Goals (SDGs), most notably SDG 11 on sustainable cities and communities and SDG 13 on climate action (United Nations, 2023).

A green building, broadly defined, is a structure that has been designed, constructed, operated, maintained, and eventually decommissioned in an environmentally responsible and resource-efficient manner throughout its life cycle (World Green Building Council, 2023). The realisation of such buildings, however, depends not only on architectural and engineering choices but also on the way construction projects are planned, organised, executed, and monitored. This places sustainable project management at the heart of the green building agenda. Sustainable project management has been characterised in recent literature as the integration of environmental, social, and economic considerations into the traditional iron-triangle constraints of time, cost, and quality, with the explicit goal of delivering long-term value rather than short-term outputs (Kineber et al., 2024; Khalfan et al., 2023).

Empirical studies conducted over the last decade have consistently shown that the successful delivery of green building projects is contingent on a relatively well-defined set of Critical Success Factors (CSFs). These factors typically include clear sustainability goals at project inception, owner and top-management commitment, early involvement of multidisciplinary project teams, competent and adequately trained project managers, effective communication and collaboration among stakeholders, robust project planning and control mechanisms, supportive government policies and incentives, and the availability of green materials and technologies (Darko et al., 2023; Kineber et al., 2024; Chen et al., 2024). The relative importance of these factors has been shown to vary considerably across contexts, particularly between developed and developing economies, where institutional capacity, market readiness, regulatory frameworks, and cultural attitudes differ substantially (Taherkhani, 2024; Alghuried, 2026).

Within the Middle East, green building has gained visible momentum, particularly in the Gulf Cooperation Council (GCC) states, where national rating systems such as Estidama in the United Arab Emirates and Mostadam in the Kingdom of Saudi Arabia have been integrated into wider policy frameworks (Alghuried, 2026). Conflict-affected and least-developed Arab countries, however, present a fundamentally different reality. The Arab Sustainable Development Report 2024 underscores that countries experiencing protracted conflict and fragility Yemen prominent among them face structural deficits in governance, finance, and institutional capacity that significantly constrain progress on environmentally oriented SDGs (United Nations Economic and Social Commission for Western Asia [ESCWA], 2024).

Yemen represents a distinctive and under-researched case in this regard. The country has been described as experiencing one of the world’s worst humanitarian and developmental crises, with the construction sector simultaneously bearing the consequences of damaged infrastructure and shouldering the responsibility of post-conflict reconstruction (United Nations Office for the Coordination of Humanitarian Affairs [OCHA], 2024). Despite political instability and a fragmented institutional landscape, the Yemeni construction sector continues to operate, gradually expanding to meet pressing housing and reconstruction needs (Alyamani et al., 2023). Earlier work by Gamil and Abdul Rahman (2020) on construction failure in Yemen identified entrenched problems such as poor project planning, inadequate financing, weak regulatory enforcement, and a shortage of skilled professionals, all of which directly impinge upon any future shift towards green and sustainable building practices.

Paradoxically, Yemen also has a long-standing vernacular tradition of environmentally responsive architecture. The earthen tower-houses of Sana’a, Shibam, and Hadhramaut have for centuries demonstrated passive cooling, the use of locally sourced materials, and high thermal performance qualities that align closely with contemporary green building principles (Al-Sakkaf et al., 2023). This cultural heritage offers a potentially powerful foundation for re-imagining sustainable construction in Yemen, provided that contemporary project management practices can be adapted to enable, rather than displace, such locally rooted approaches.

Despite the global maturation of green building research and the regional attention now devoted to sustainable construction in the Middle East, there remains a striking shortage of context-specific empirical evidence on how sustainable project management can be successfully implemented in Yemen. The combination of conflict-related risks, fragmented governance, financial volatility, scarce green materials, and limited professional capacity creates a distinctive risk environment in which conventional CSF frameworks may not transfer directly. It is against this backdrop that the present study seeks to investigate the Critical Success Factors for Sustainable Project Management in Green Building Projects in Yemen, with a view to contributing both to academic knowledge and to practical guidance for industry stakeholders and policymakers.

Problem Statement

The construction industry is widely recognised as a key driver of economic development; however, it is simultaneously among the most resource-intensive and environmentally damaging sectors worldwide. Recent global reports indicate that buildings and construction continue to be responsible for more than one-third of operational energy demand and energy-related carbon emissions, despite the rapid uptake of energy-efficient technologies (UNEP, 2024). The mainstreaming of green buildings is therefore central to climate change mitigation, sustainable urbanisation, and the achievement of internationally agreed environmental targets.

While a substantial body of research has investigated CSFs for green building projects in developed economies and, more recently, in selected developing economies such as China, Malaysia, Ghana, Egypt, Saudi Arabia, and Turkey (Akçay, 2023; Mohammed et al., 2022; Alghuried, 2026), evidence from conflict-affected and fragile contexts in the Arab region remains scarce. Existing studies on the Yemeni construction sector have predominantly focused on causes of project failure, delay, and cost overrun in conventional construction projects (Gamil & Abdul Rahman, 2020; Alyamani et al., 2023), with limited explicit attention to sustainability dimensions, green building practices, or the project management capabilities required to deliver them.

Three interrelated gaps motivate the present research. First, the empirical literature on Critical Success Factors for green building projects has largely been developed in relatively stable institutional environments; consequently, the applicability of the resulting frameworks to a conflict-affected and resource-constrained setting such as Yemen has not been established. Second, sustainable project management as an integrated construct combining environmental, social, and economic objectives with traditional time, cost, and quality constraints has rarely been examined in the Yemeni construction context, where project management practices are themselves still maturing. Third, although Yemen possesses a culturally rich tradition of climate-responsive vernacular construction, there is no systematic study that links this heritage to a contemporary project management framework capable of mainstreaming green building practices in current reconstruction and development projects.

These gaps generate a practical problem with significant consequences. In the absence of context-specific knowledge about which factors most strongly determine project success, Yemeni clients, contractors, consultants, and policymakers are forced to rely on imported models that may underestimate the influence of political instability, currency volatility, security risks, weak regulatory enforcement, and informal labour markets. Reconstruction and development projects therefore risk replicating energy-intensive, environmentally insensitive practices precisely at a moment when the country has both the opportunity and the obligation to adopt more sustainable trajectories. Addressing this knowledge gap is therefore not only academically important but also relevant for the long-term resilience and sustainability of the Yemeni built environment.

Research Questions

In light of the problem articulated above, this study seeks to answer the following central research question:

What are the Critical Success Factors for sustainable project management in green building projects in Yemen, and how do they influence project success?

This central question is further broken down into the following specific research questions:

1. What are the Critical Success Factors that influence the implementation of sustainable project management in green building projects in Yemen?
2. What are the main barriers and challenges hindering the adoption of sustainable project management and green building practices in the Yemeni construction industry?
3. What is the relative importance of the identified Critical Success Factors as perceived by Yemeni construction professionals (clients, consultants, contractors, and project managers)?
4. What is the relationship between the identified Critical Success Factors and the overall success of green building projects in Yemen, measured in terms of sustainability, time, cost, and quality outcomes?

5. What framework can be proposed to enhance the effective implementation of sustainable project management in green building projects in Yemen?

Research Objectives

The general objective of this study is to identify, analyse, and prioritise the Critical Success Factors for sustainable project management in green building projects within the Yemeni construction industry, and to propose an integrated framework that supports their effective implementation. To achieve this general objective, the study pursues the following specific objectives:

1. To identify the Critical Success Factors that influence the implementation of sustainable project management in green building projects in Yemen.
2. To examine the main barriers and challenges hindering the adoption of sustainable project management and green building practices in the Yemeni construction industry.
3. To evaluate the relative importance of the identified Critical Success Factors from the perspective of Yemeni construction professionals.
4. To analyse the relationship between the identified Critical Success Factors and the success of green building projects in terms of sustainability, time, cost, and quality outcomes.
5. To propose a context-specific framework for enhancing sustainable project management in green building projects in Yemen.

Significance of the Study

The significance of this study can be appreciated from three complementary perspectives: theoretical, practical, and policy-related. From a theoretical standpoint, the research extends the existing literature on Critical Success Factors and sustainable project management by examining a context a conflict-affected, low-income Arab country that has been substantially under-represented in international research. By doing so, it contributes to the ongoing debate about the contextual transferability of CSF frameworks and the extent to which models developed in stable economies remain valid under conditions of political and economic fragility (Taherkhani, 2024).

From a practical perspective, the findings are expected to provide Yemeni construction professionals including clients, consultants, contractors, and project managers with a structured understanding of the factors most strongly associated with the successful delivery of green building projects. This is particularly relevant in the context of post-conflict reconstruction, where decisions taken today regarding building stock will shape the country's environmental performance, energy demand, and resilience for decades to come.

From a policy perspective, the study aims to inform government agencies, regulatory bodies, donors, and international development partners about the institutional, regulatory, and capacity-building interventions required to support a meaningful transition towards green construction in Yemen. In aligning the Yemeni construction sector with the broader regional momentum reported in the Arab Sustainable Development Report 2024 (ESCWA, 2024) and global commitments such as the Paris Agreement, the research offers a foundation on which more comprehensive sustainability strategies can be built.

Scope and Limitations of the Study

Scope of the Study

The scope of this study is delineated along four main dimensions: thematic, geographical, sectoral, and temporal. Thematically, the study focuses on Critical Success Factors for sustainable project management in green building projects, with sustainability understood as the integration of environmental, social, and economic considerations alongside the conventional project constraints of time, cost, and quality. Geographically, the study is conducted within the Republic of Yemen, with particular emphasis on the major urban centres in which formal construction activity is concentrated, such as Sana'a, Aden, Taiz, Hadhramaut, and Al-Mukalla. Sectorally, the research targets professionals involved in the planning, design, supervision, and execution of building projects, including clients, consultants, contractors, project managers, engineers, and architects. Temporally, the empirical work is conducted using primary data collected during the academic year of the study, while the literature reviewed primarily covers the most recent three to five years to ensure the currency of the conceptual foundation.

Limitations of the Study

Several limitations are explicitly acknowledged. First, the ongoing political and security situation in Yemen restricts physical access to certain regions and may limit the geographical representativeness of the sample, particularly for areas affected by active conflict. Second, the relatively small number of formally certified green building projects in Yemen means that the study must rely largely on professionals' perceptions and on projects that incorporate sustainability features without holding formal certification, rather than on a large statistical population of completed green buildings. Third, the research adopts a cross-sectional design and therefore captures perceptions at a particular point in time; the volatile economic and institutional environment in Yemen may shift the relative importance of certain factors over the longer term. Fourth, the study focuses on the perspectives of construction industry professionals and does not directly capture the views of end-users or local communities, an area that may be addressed in future research.

Definition of Key Terms

To ensure conceptual clarity, the following key terms are defined as they are used in this thesis.

Sustainable Project Management: The integration of environmental, social, and economic considerations into the planning, execution, monitoring, control, and closing of projects, alongside the traditional objectives of time, cost, and quality, with the aim of delivering long-term value to stakeholders and the broader society (Khalfan et al., 2023).

Green Building: A building that, in its design, construction, operation, maintenance, renovation, and eventual demolition, applies practices aimed at increasing efficiency in the use of energy, water, and materials, while reducing impacts on human health and the environment throughout the life cycle (World Green Building Council, 2023).

Critical Success Factors (CSFs): The limited number of areas in which satisfactory performance is essential for an organisation, project, or initiative to achieve its goals; in the context of construction, CSFs refer to the conditions, practices, and resources whose presence is strongly associated with project success (Kineber et al., 2024).

Project Success: The achievement of project objectives in terms of time, cost, quality, stakeholder satisfaction, and in the context of green building sustainability performance across environmental, social, and economic dimensions (Darko et al., 2023).

Sustainability: Development that meets the needs of the present without compromising the ability of future generations to meet their own needs, encompassing environmental protection, social equity, and economic viability (United Nations, 2023).

Yemeni Construction Industry: The collective of public and private organisations, professionals, and trades people engaged in the design, construction, supervision, operation, and maintenance of buildings and infrastructure within the Republic of Yemen.

Organization of the Thesis

This thesis is organised into five chapters, in line with the structural requirements set out in the UGM Master Programme Thesis Guideline.

Chapter One presents the introduction to the study, including the background, problem statement, research questions, research objectives, significance, scope and limitations, and definition of key terms. It establishes the rationale for the research and outlines the structure of the thesis.

Chapter Two provides a critical review of the relevant literature on sustainable project management, green building projects, and Critical Success Factors. The chapter examines the theoretical foundations of the study, synthesises empirical findings from developed and developing country contexts, and develops the conceptual framework that guides the subsequent empirical work.

Chapter Three describes the research methodology adopted in the study. It explains the research philosophy, design, and approach; outlines the sampling strategy, data collection instruments, and procedures; and details the techniques used to analyse both quantitative and, where applicable, qualitative data. The chapter also addresses the validity, reliability, and ethical considerations of the research.

Chapter Four presents the results of the empirical investigation and discusses the findings in the light of the existing literature. The chapter identifies and ranks the Critical Success Factors for sustainable project management in green building projects in Yemen, analyses the main barriers, and examines the relationships between the identified factors and project success outcomes.

Chapter Five concludes the thesis by summarising the key findings according to the research objectives, discussing the theoretical, practical, and policy implications, presenting the proposed framework, and offering recommendations for industry stakeholders, policymakers, and future researchers. The chapter also reflects on the limitations of the study and the contributions made to the body of knowledge.

Chapter Summary

This chapter has introduced the topic of Critical Success Factors for sustainable project management in green building projects, with specific reference to the Yemeni context. It has positioned the research within the broader global agenda for sustainable construction and the Sustainable Development Goals, while highlighting the distinctive challenges and opportunities presented by Yemen's conflict-affected, resource-constrained, yet culturally rich construction environment. The chapter has articulated the research problem, formulated five specific research questions and corresponding objectives, defined the scope and limitations of the work, clarified the key conceptual terms, and outlined the structure of the remainder of the thesis. The following chapter develops the theoretical and empirical foundations of the study through a critical review of the relevant literature.

LITERATURE REVIEW

Introduction

This chapter presents a critical review of the literature relevant to Critical Success Factors (CSFs) for sustainable project management in green building projects, with a particular focus on the contextual circumstances of developing and conflict-affected economies. The review is organised in a deductive sequence that moves from broad foundational concepts towards the specific empirical and theoretical positions that underpin the present research. It begins by tracing the evolution of sustainable development and sustainable construction, situating the discussion within global agreements such as the United Nations Sustainable Development Goals (SDGs) and the Paris Agreement (United Nations, 2023; UNEP, 2024). The chapter then examines the green building concept, its rating systems, and its current state in the Middle East and the Arab region, before turning to sustainable project management as a distinct and rapidly maturing field of inquiry.

The chapter proceeds to a detailed analysis of CSFs as developed in the project management literature, tracing their conceptual origins from Rockart's seminal work in the 1970s through to contemporary applications in green building research (Mavi & Standing, 2018; Kineber et al., 2024). It synthesises empirical findings from developed economies, emerging Asian markets, and developing countries in Africa and the Middle East, paying close attention to studies conducted in the past three to five years. The Yemeni construction context is then examined in depth, including its vernacular heritage of climate-responsive architecture, the structural weaknesses identified in earlier studies of project failure, and the implications of protracted conflict for sustainability transitions in the built environment. Finally, the chapter articulates the theoretical framework that underpins the present study-drawing on the Triple Bottom Line (TBL) framework, stakeholder theory, and institutional theory-and presents a conceptual model linking the identified CSFs to project success in green building projects in Yemen.

Sustainable Development and Sustainable Construction

The Concept of Sustainable Development

Sustainable development has evolved from a relatively narrow environmental concern in the early 1970s into a comprehensive global development paradigm that integrates environmental, social, and economic dimensions. The widely cited definition offered by the World Commission on Environment and Development-development that meets the needs of the present without compromising the ability of future generations to meet their own needs-remains the normative anchor of contemporary policy and academic discourse (Brundtland, 1987; United Nations, 2023). The adoption of the 2030 Agenda for Sustainable Development and the accompanying seventeen Sustainable Development Goals (SDGs) in 2015 reframed this normative commitment into a structured global programme of action.

Several of the SDGs are directly relevant to the construction sector. SDG 7 (affordable and clean energy), SDG 9 (industry, innovation, and infrastructure), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), and SDG 13 (climate action) collectively position the built environment at the centre of the global sustainability transition (United Nations, 2023; UNEP, 2024). Recent assessments indicate that, despite measurable progress in some indicators, the world is significantly off track in achieving the SDGs by 2030, with conflict-affected countries among the most severely lagging (ESCWA, 2024).

Sustainable Construction: Evolution and Definitions

Sustainable construction emerged in the 1990s as a sectoral application of sustainable development principles. Kibert (1994), in a contribution that continues to influence the field, defined sustainable construction as the creation and responsible management of a healthy built environment based on resource-efficient and ecological principles. More recent definitions extend this to encompass life-cycle thinking, the integration of social equity considerations, and explicit attention to the well-being of construction workers and end users (Petrelli et al., 2024; Khalfan et al., 2023).

The buildings and construction sector is responsible for roughly 37 per cent of global energy-related carbon dioxide emissions and approximately 34 per cent of final energy demand (UNEP, 2024). It also accounts for around half of global raw material extraction, between 30 and 40 per cent of solid waste, and a significant share of freshwater consumption. These figures explain why sustainable construction has become both an environmental and an economic priority. The global green building market is projected to grow at a compound annual rate of more than 10 per cent through to 2030, driven by regulatory tightening, investor pressure, and rising operational cost concerns (World Green Building Council, 2023).

Sustainable construction is now widely understood as resting on three interrelated dimensions: environmental responsibility (minimising negative impacts on ecosystems and natural resources), social inclusivity (delivering safe, healthy, and equitable outcomes for workers, users, and communities), and economic viability (delivering long-term value while remaining commercially feasible). This framing is conceptually aligned with the Triple Bottom Line (TBL) construct, which is examined in detail in Section 2.8 of this chapter.

Green Buildings

Definition and Core Principles

A green building is generally understood as a structure that, in its design, construction, operation, maintenance, renovation, and eventual demolition, applies practices aimed at increasing efficiency in the use of energy, water, and materials while reducing impacts on human health and the environment over the building's entire life cycle (World Green Building Council, 2023). Although terminology varies-sustainable building, high-performance building, low-carbon building, and net-zero building are also frequently used-the underlying logic is consistent: buildings should deliver superior environmental and human outcomes throughout their life cycle without imposing disproportionate costs on stakeholders.

Operationally, green buildings are typically characterised by features such as: high-performance building envelopes; energy-efficient mechanical and electrical systems; on-site renewable energy generation; water-efficient fixtures and rainwater harvesting; the use of locally sourced, recycled, or low-embodied-carbon materials; healthy indoor environments with adequate daylighting, ventilation, and acoustic comfort; sustainable site selection and ecological design; and integrated waste management practices (Chen et al., 2024; Alghuried, 2026). These features can be combined to varying degrees and assessed through formal certification systems.

Green Building Rating Systems

Green building rating systems provide structured criteria against which projects can be assessed, certified, and benchmarked. They have played a critical role in mainstreaming sustainability in the construction sector by translating abstract principles into measurable performance categories and credits. Table 2.1 summarises the principal rating systems relevant to the international and regional context, including those most pertinent to the Middle East.

Table 2.1 Selected Green Building Rating Systems Relevant to the International and Middle Eastern Context

Rating System	Origin	Key Assessment Categories	Relevance to the Arab Region
LEED	USA (USGBC)	Sustainable sites; water efficiency; energy and atmosphere; materials and resources; indoor environmental quality; innovation.	Globally recognised; widely used in the GCC; more than 200 LEED-certified projects in Saudi Arabia alone.
BREEAM	United Kingdom	Management; health and well-being; energy; transport; water; materials; waste; land use and ecology; pollution; innovation.	Used in select Middle Eastern projects, mainly by international developers and consultants.
Estidama (Pearl)	Abu Dhabi, UAE	Integrated development; natural systems; liveable buildings; precious water; resourceful energy; stewarding materials; innovating practice.	Mandatory for projects in Abu Dhabi; designed for hot-arid climates.
Mostadam	Saudi Arabia	Energy; water; health and comfort; materials and waste; sites and ecology; management and operations.	Aligned with Saudi Vision 2030; tailored to the Saudi Building Code and local climate.
GSAS/ QSAS	Qatar	Urban connectivity; site; energy; water; materials; indoor environment; cultural and economic value; management and operations.	Regional rating system applicable across the Gulf and wider MENA region.

Table 2.1 (continued) Selected Green Building Rating Systems Relevant to the International and Middle Eastern Context

Rating System	Origin	Key Assessment Categories	Relevance to the Arab Region
EDGE	IFC / World Bank	Energy; water; materials (with a 20% reduction threshold across each category).	Designed for emerging economies; lighter certification load; suitable for low-cost contexts.

Source: Compiled by the researcher based on Alghuried (2026), EcoMENA (2023), and World Green Building Council (2023).

As Table 2.1 illustrates, the rating systems in current use differ in their structure, weighting of categories, and degree of contextual adaptation. LEED remains the most internationally recognised system, but recent research suggests that locally developed systems such as Mostadam in Saudi Arabia and Estidama in Abu Dhabi are increasingly preferred because they reflect regional climate, regulatory, and cultural specificities (Alghuried, 2026). For a country such as Yemen, where no national rating system currently exists and where formal certification capacity is limited, EDGE and adapted versions of regional systems may offer more practical entry points than full LEED or BREEAM certifications.

Green Buildings in the Middle East and the Arab Region

The Middle East has witnessed a substantial expansion of green building activity over the past decade, although progress has been highly uneven across countries. The Gulf Cooperation Council (GCC) states, particularly the United Arab Emirates, Saudi Arabia, and Qatar, have integrated green building requirements into national development visions, building codes, and procurement policies (Alghuried, 2026). Projects such as Masdar City in Abu Dhabi, the King Abdullah Financial District in Riyadh, and several Expo and FIFA legacy developments have positioned the region as a credible participant in the global green construction movement (ESCWA, 2024).

Outside the GCC, however, the picture is markedly different. In conflict-affected Arab countries-Yemen, Syria, Libya, and Sudan-green building remains a marginal concern, overshadowed by the urgent imperatives of reconstruction, humanitarian response, and basic service restoration (ESCWA, 2024). Yet precisely because of this, the choices made in current and forthcoming reconstruction projects will determine the long-term environmental footprint of these built environments for decades to come. The literature increasingly argues that integrating sustainable project management into reconstruction work is both a strategic imperative and an ethical obligation (Khalfan et al., 2023; ESCWA, 2024).

Sustainable Project Management

From Traditional to Sustainable Project Management

Project management, as traditionally conceived, has focused on delivering project outputs within the constraints of time, cost, and quality-commonly referred to as the iron triangle (Atkinson, 1999, as cited in Khalfan et al., 2023). While this framing has proved useful, scholars and practitioners have increasingly recognised that successful project delivery in the contemporary context requires the explicit incorporation of sustainability considerations. The Project Management Institute, the International Project Management Association, and the Global Reporting Initiative have all updated their guidance documents over the past decade to reflect this shift (PMI, 2021; Khalfan et al., 2023).

Sustainable project management has been defined as the planning, monitoring, and controlling of project delivery and support processes, with consideration of the environmental, economic, and social aspects of the life-cycle of the project’s resources, processes, deliverables, and effects, aimed at realising benefits for stakeholders and performed in a transparent, fair, and ethical way (Silvius & Schipper, 2014, as cited in Khalfan et al., 2023). More recent contributions emphasise that sustainable project management is not merely an additive consideration to traditional project management but represents a paradigmatic shift in how project success itself is defined (Petrelli et al., 2024; Egbebi, 2024).

Dimensions of Sustainable Project Management

Sustainable project management has been operationalised through several dimensions in the literature. Table 2.2 synthesises the principal dimensions identified in recent reviews.

Table 2.2 Principal Dimensions of Sustainable Project Management

Dimension	Key Considerations in Construction Projects
Environmental	Energy and water efficiency; reduction of greenhouse gas emissions; use of low-impact materials; waste minimisation; biodiversity protection; pollution prevention.

Social	Stakeholder engagement; worker health and safety; gender equity; cultural preservation; community well-being; fair labour conditions; ethical procurement.
Economic	Whole-life cost optimisation; risk-adjusted return on investment; local economic development; affordability; transparent financial management.
Time	Realistic scheduling; integration of sustainability deliverables into the schedule; proactive management of approvals and certifications.
Quality	Performance verification; commissioning of sustainability features; long-term durability; user comfort and satisfaction.
Governance	Clear roles and responsibilities; ethical conduct; compliance with regulations; transparency; stakeholder accountability.

Source: Adapted by the researcher from Khalfan et al. (2023), Petrelli et al. (2024), and Egbebi (2024).

As shown in Table 2.2, the literature now consistently expands the traditional time-cost-quality triangle into a multidimensional construct that includes environmental, social, economic, and governance considerations. This expansion has substantial implications for how project success is defined and how Critical Success Factors are identified. A project that is delivered on time and within budget but generates excessive carbon emissions, harms workers, or imposes long-term operational costs on owners can no longer be regarded as fully successful (Petrelli et al., 2024).

Critical Success Factors: Conceptual Foundations

Origins and Evolution of the CSF Concept

The concept of Critical Success Factors was originally formulated by Rockart in 1979 in the context of information systems management. Rockart defined CSFs as the limited number of areas in which satisfactory results will ensure successful competitive performance for the individual, department, or organisation (Rockart, 1979, as cited in Kineber et al., 2024). The concept was subsequently extended to project management by authors such as Pinto and Slevin in the late 1980s and was first applied systematically to construction projects in the 1990s.

In the construction context, CSFs are typically defined as the conditions, events, and circumstances that contribute to project results, or the inputs to the management system that lead directly or indirectly to the success of a project (Chen et al., 2024). The CSF approach is favoured by both researchers and practitioners because it focuses attention on a manageable number of high-leverage variables rather than on the much larger universe of factors that may potentially influence project outcomes.

CSFs in Conventional Construction Projects

A substantial body of research has identified CSFs for conventional construction projects. Frequently cited factors include: clear project goals and objectives; competent project management; effective communication; adequate financial resources; realistic scheduling; strong client commitment; effective risk management; and supportive external environments (Alghuried, 2026; Kineber et al., 2024). While these factors remain relevant for green building projects, the literature emphasises that green projects exhibit additional complexities-particularly relating to certification processes, integrated design, the procurement of green materials, and the management of multiple sustainability objectives-that require additional or differently weighted success factors.

Critical Success Factors in Green Building Projects

Synthesis of CSFs from the International Literature

A growing body of empirical research has examined CSFs specifically in green building projects. Drawing on recent reviews and primary studies, the present study synthesises the principal CSFs identified across multiple country contexts. Table 2.3 presents this synthesis.

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Table 2.3 Critical Success Factors for Green Building Projects: Synthesis of Recent Empirical Studies

No.	Critical Success Factor	Description	Key Sources
1	Clear sustainability goals and objectives	Early articulation of measurable environmental, social, and economic targets aligned with project vision.	Chen et al. (2024); Kineber et al. (2024)
2	Top-management and owner commitment	Active and sustained engagement of senior leadership and the project owner in promoting sustainability outcomes.	Alghuried (2026); Darko et al. (2023)
3	Competent and experienced project manager	Project manager with technical knowledge of green building, integrated design, and sustainability certification processes.	Kineber et al. (2024); Mohammed et al. (2024)
4	Early involvement of multidisciplinary project team	Integration of architects, engineers, sustainability consultants, contractors, and facility managers from the design stage.	Petrelli et al. (2024); Chen et al. (2024)
5	Effective communication and collaboration	Open, transparent, and timely information flow among all stakeholders throughout the project life cycle.	Akçay (2023); Alghuried (2026)

Table 2.3 (continued) Critical Success Factors for Green Building Projects: Synthesis of Recent Empirical Studies

No.	Critical Success Factor	Description	Key Sources
6	Adequate project planning and control	Robust scheduling, monitoring, and corrective action mechanisms that explicitly incorporate sustainability deliverables.	Chen et al. (2024); Khalfan et al. (2023)
7	Supportive government policies and incentives	Regulatory frameworks, tax incentives, expedited permits, and procurement preferences that reward green practices.	Taherkhani (2024); Debrah et al. (2024)
8	Availability of green materials and technologies	Local availability and affordability of certified materials, energy-efficient equipment, and renewable energy systems.	Mohammed et al. (2024); Alghuried (2026)
9	Access to green finance and adequate budget	Availability of dedicated financing instruments such as green loans, bonds, and grants, alongside realistic project budgets.	Debrah et al. (2024); UN-ESCWA (2024)
10	Knowledge, training, and awareness	Continuous professional development, capacity building, and public awareness initiatives addressing green building.	Akçay (2023); Taherkhani (2024)

Table 2.3 (continued) Critical Success Factors for Green Building Projects: Synthesis of Recent Empirical Studies

No.	Critical Success Factor	Description	Key Sources
11	Robust risk management	Systematic identification, assessment, and treatment of risks specific to green building, including certification and supply-chain risks.	Darko et al. (2023); Chen et al. (2024)
12	Integrated and innovative design	Use of integrated design processes, building information modelling, and innovative materials and methods.	Kineber et al. (2024); Petrelli et al. (2024)
13	Stakeholder engagement and community support	Genuine engagement with users, communities, and civil society regarding sustainability decisions.	Petrelli et al. (2024); Freeman (2023, as

			cited in Nguyen, 2026)
14	Cultural alignment and acceptance	Sensitivity to local cultural preferences and integration with vernacular building traditions where appropriate.	Alghuried (2026); Al-Sakkaf et al. (2023)
15	Quality assurance and post-occupancy evaluation	Verification, commissioning, and ongoing performance monitoring of sustainability features after handover.	Petrelli et al. (2024); Chen et al. (2024)

Source: Compiled by the researcher from the cited sources.

Although the factors listed in Table 2.3 enjoy broad consensus, the relative importance attributed to each varies considerably across studies and country contexts. In studies conducted in developed economies, factors related to design integration, certification, and supply-chain reliability tend to dominate, whereas in developing-country studies, factors related to government policy, financing, and capacity building typically rise to the top of the ranking (Taherkhani, 2024; Chen et al., 2024). This contextual variation is one of the key motivations for the present study, which seeks to determine how CSFs are ranked and interrelated in the specific environment of Yemen.

Categorisation of CSFs

To facilitate empirical analysis, the literature commonly groups CSFs into a smaller number of higher-order categories. Six broad categories appear repeatedly across recent studies (Kineber et al., 2024; Chen et al., 2024; Alghuried, 2026):

Project-related factors: factors intrinsic to the specific project, such as scope clarity, sustainability targets, project complexity, and design integration.

Project management-related factors: factors related to the planning, execution, monitoring, and control practices used to deliver the project.

Project team-related factors: factors related to the competence, motivation, collaboration, and continuity of the project team.

Client- and stakeholder-related factors: factors related to the engagement, commitment, and capability of clients, end users, and other stakeholders.

Organisational and institutional factors: factors related to the organisations executing the project and the wider institutional environment, including governance, procurement, and corporate culture.

External environment factors: factors in the macro environment, including political stability, regulatory frameworks, market conditions, technology availability, and cultural acceptance.

This six-category structure is adopted in the present study as the organising framework for both the empirical data collection instrument and the conceptual model presented in Section 2.10.

Barriers to Green Building Implementation in Developing Countries

A complementary stream of research has examined the barriers that hinder the adoption of green building practices, particularly in developing countries. Understanding these barriers is essential because the effectiveness of any CSF framework depends on the capacity of the operating environment to support the underlying behaviours. Akçay (2023), in a study of the Turkish construction industry, identified higher construction cost, lack of knowledge about green buildings, lack of an authorised national rating system, unavailability of green materials, and inadequate market demand as the leading barriers. Taherkhani (2024), in a systematic review of 30 developing countries with an empirical focus on Iran, classified barriers using the PESTEL framework and found that political, economic, and educational barriers were the most pervasive.

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Recent research from the Middle East has confirmed and extended these findings. Alghuried (2026) reported that cultural preferences for traditional construction practices, resistance to change, prioritisation of economic factors over environmental and social considerations, a limited number of completed green building projects, delays in the permit and approval processes, and a lack of leadership and coordination are particularly salient barriers in the Middle Eastern context. Mohammed et al. (2024) and Debrah et al. (2024) emphasised the centrality of green finance, noting that the absence of appropriate financing instruments often constitutes the binding constraint on green building diffusion in developing economies.

Table 2.4 synthesises the principal barriers reported in the literature, categorising them by domain and assessing their likely relevance to the Yemeni context based on related work on Yemeni construction failure (Gamil & Abdul Rahman, 2020; Alyamani et al., 2023).

Table 2.4 Barriers to Green Building in Developing Countries and Their Likely Relevance to Yemen

Barrier Category	Representative Barriers	Likely Relevance to Yemen
Economic and financial	Higher initial construction costs; limited access to green finance; currency volatility; lack of incentives.	Very high - protracted economic crisis, currency depreciation, and limited banking sector.
Political and regulatory	Absence of green building codes; weak enforcement; delays in permits; unstable policy environment.	Very high - fragmented governance and dual administration.
Knowledge and awareness	Limited awareness among clients and professionals; insufficient academic curricula; lack of demonstration projects.	High - limited number of completed certified projects.
Technical and market	Unavailability of green materials and certified products; small market demand; limited technology transfer.	High - disrupted supply chains and reduced imports.
Cultural and social	Cultural preferences for conventional construction; resistance to change; weak end-user engagement.	Medium - partially offset by the existence of a rich vernacular sustainable architecture tradition.
Institutional and managerial	Inadequate project management capacity; absence of leadership; fragmented stakeholder coordination.	High - corroborated by earlier studies of Yemeni construction failure.

Source: Compiled by the researcher from Akçay (2023), Taherkhani (2024), Alghuried (2026), Mohammed et al. (2024), Debrah et al. (2024), Gamil and Abdul Rahman (2020), and Alyamani et al. (2023).

Theoretical Framework

Three complementary theories provide the theoretical foundation for the present study: the Triple Bottom Line (TBL) framework, stakeholder theory, and institutional theory. Each theory illuminates a distinct facet of the phenomenon under investigation, and their combination is well suited to a context as complex as Yemen’s.

The Triple Bottom Line Framework

The Triple Bottom Line framework, formulated by Elkington in 1997, argues that organisational and project performance should be assessed against three interrelated dimensions: profit (economic), planet (environmental), and people (social). In the construction context, recent reviews have shown that TBL has become the dominant normative framework for conceptualising sustainable construction and sustainable project management (Petrelli et al., 2024; Egbebi, 2024).

TBL is particularly relevant to the present study because it provides a structured language for redefining project success. Whereas traditional project success is measured along the iron triangle of time, cost, and quality, TBL extends success to include environmental performance (energy and water consumption, emissions, waste, materials), social performance (worker safety, user well-being, community impact), and economic performance (whole-life cost, return on investment, local economic development). The conceptual model developed in Section 2.10 of this chapter incorporates these three TBL dimensions alongside traditional project performance indicators.

Stakeholder Theory

Stakeholder theory, developed by Freeman (1984) and subsequently refined in multiple iterations, asserts that organisations and projects must be managed in the interests of all parties that affect or are affected by their activities, rather than solely in the interest of shareholders or financial sponsors (Freeman, 2023, as cited in Nguyen, 2026; Debrah et al., 2024). In the construction sector, the principal stakeholders include clients, owners, designers, contractors, subcontractors, financiers, regulators, end users, local communities, and society at large.

Stakeholder theory underpins several of the CSFs identified in Table 2.3, particularly those relating to top-management commitment, multidisciplinary team integration, communication, and community engagement. It is also directly relevant to the Yemeni context, where the fragmentation of governance and the strength of community and tribal structures create a distinctive stakeholder landscape that cannot be adequately understood through purely economic models.

Institutional Theory

Institutional theory, particularly the seminal work of DiMaggio and Powell (1983), argues that organisational behaviour is shaped by formal institutions (laws, regulations, codes) and informal institutions (norms, values, cultural expectations). The theory distinguishes three forms of institutional pressure-coercive (regulatory), mimetic (imitative), and normative (professional)-each of which can drive or impede the adoption of new practices such as green building (Debrah et al., 2024; Nguyen, 2026).

In the green building context, institutional theory helps to explain why coercive pressures such as mandatory green building codes (as in Abu Dhabi’s Estidama) and normative pressures such as professional certification (LEED accredited professionals) are powerful drivers of adoption in some countries, while their absence in conflict-affected contexts such as Yemen contributes to the slow uptake of green building practices. The theory also highlights the importance of legitimacy: in environments where green building is not yet institutionalised, projects often need additional justification and stakeholder buy-in to proceed.

Integration of the Three Theories

The three theories are complementary rather than competing. TBL provides the substantive content of sustainability (what dimensions matter); stakeholder theory identifies who has a legitimate interest in those dimensions and how they should be engaged; and institutional theory explains the structural and cultural conditions that enable or constrain the realisation of sustainability outcomes. Together, they provide a robust theoretical foundation for understanding why certain CSFs become critical in particular contexts and how those factors interact with one another to produce project success or failure.

The Yemeni Construction Context

Structural Characteristics of the Yemeni Construction Industry

The Yemeni construction industry operates in one of the most challenging environments in the world. The country has experienced protracted conflict since 2014-2015, with severe consequences for infrastructure, governance, finance, and human capital (OCHA, 2024). Despite these conditions, the industry has continued to function, driven by humanitarian reconstruction, private residential demand, and a limited number of public works projects. Gamil and Abdul Rahman (2020) identified five overarching categories of factors contributing to project failure in Yemen: managerial factors, financial factors, regulatory factors, environmental factors, and human resources factors. Their findings have been corroborated by subsequent work by Alyamani et al. (2023), which emphasised the role of weak institutional capacity, inadequate planning, currency volatility, and skill shortages.

These structural challenges have direct implications for the implementation of sustainable project management. Many of the prerequisites for successful green building delivery-stable regulatory frameworks, accessible green finance, reliable supply chains, and well-trained project teams-are precisely the elements that have been weakened by the conflict. Yet the Yemeni context also offers distinctive opportunities, including a long heritage of climate-responsive construction, low baseline energy consumption per capita, and a relatively young population that may be receptive to new approaches if appropriately engaged.

Vernacular Architecture and Sustainable Heritage in Yemen

Yemen is internationally recognised for its vernacular architectural heritage, which includes three UNESCO World Heritage Sites: the Old City of Sana'a, Shibam (the so-called Manhattan of the Desert), and the historic town of Zabid (Al-Sakkaf et al., 2023). These sites exemplify climate-responsive design principles that have been refined over centuries. The tower houses of Sana'a, constructed of stone and mud bricks with walls often exceeding fifty centimetres in thickness, provide excellent thermal insulation, naturally moderating internal temperatures between the cold nights and hot days of the highland climate (Attia, 2020, as cited in Al-Sakkaf et al., 2023). The earthen tower houses of Shibam, rising as high as eleven storeys, demonstrate that high-density, climate-adapted vertical construction is achievable with locally sourced, low-embodied-energy materials.

The traditional craftsmanship of Yemeni master builders, the qamariyah translucent stained-glass windows of Sana'a, the elaborate decorative plasterwork of Zabid, and the use of locally fired bricks all represent forms of indigenous knowledge that align with contemporary green building principles. Recent scholarship has argued that integrating these vernacular practices with modern project management and sustainability frameworks could produce a distinctively Yemeni model of green building (Al-Sakkaf et al., 2023). Such a synthesis would not only deliver environmental benefits but also preserve cultural identity and support local livelihoods through the revitalisation of traditional crafts.

Implications for Sustainable Project Management in Yemen

The interaction between Yemen's structural challenges and its vernacular heritage produces a distinctive context for sustainable project management. The literature suggests several implications:

Project management capacity building is a precondition. The structural weaknesses identified by Gamil and Abdul Rahman (2020) and Alyamani et al. (2023) mean that even before sustainability is considered, basic project management competence requires reinforcement. Training, professional certification, and the gradual development of a Yemeni project management community of practice are therefore foundational priorities.

Imported CSF frameworks must be adapted. Frameworks developed in stable economies will likely overestimate the strength of regulatory and market signals in Yemen and underestimate the importance of security, currency stability, and informal coordination mechanisms. A context-specific re-weighting is therefore required.

Vernacular heritage offers a strategic asset. Rather than treating green building as an entirely imported practice, Yemen can leverage its vernacular tradition as a culturally legitimate platform for sustainability. This requires explicit attention in CSFs to cultural alignment, traditional craft preservation, and integration with locally sourced materials.

Reconstruction is the dominant context. Whereas green building in stable economies often involves new commercial or residential developments, in Yemen the dominant context for the foreseeable future is humanitarian reconstruction, school and health facility rebuilding, and housing rehabilitation. CSFs must therefore reflect this distinctive project typology.

International partnerships matter. Given the limited domestic capacity and resources, partnerships with international donors, development banks, and non-governmental organisations are likely to play a more significant role in Yemen than in stable economies. CSFs related to international coordination, donor alignment, and conditionality become correspondingly important.

Conceptual Framework of the Study

Drawing together the literature reviewed in this chapter, the conceptual framework of the present study posits a relationship between six categories of Critical Success Factors and project success in green building projects in Yemen, where project success is itself a multidimensional construct that integrates Triple Bottom Line considerations with traditional project performance indicators. The framework is influenced by stakeholder theory, which highlights the importance of legitimate engagement with diverse parties, and institutional theory, which draws attention to the structural conditions enabling or constraining sustainable outcomes. The framework is moderated by contextual variables specific to the Yemeni environment, including political stability, economic conditions, and cultural acceptance.

Components of the Conceptual Framework

The conceptual framework consists of three main components, as summarised below and visualised in Figure 2.1.

Independent variables (Critical Success Factors). These are organised into the six categories identified in Section 2.6.2: project-related factors, project management-related factors, project team-related factors, client- and stakeholder-related factors, organisational and institutional factors, and external environment factors. Each category contains specific sub-factors derived from Table 2.3 and adapted to the Yemeni context.

Dependent variable (Project Success). Project success is conceptualised as a multidimensional construct comprising: (a) environmental performance (energy and water efficiency, carbon emissions, materials and waste); (b) social performance (worker safety, user satisfaction, community benefit); (c) economic performance (life-cycle cost, return on investment, local value); and (d) traditional project performance (time, cost, quality, scope compliance).

Moderating variables (Yemeni context). The relationship between CSFs and project success is moderated by contextual variables specific to Yemen, including the security situation, the macroeconomic environment, the institutional governance arrangements in force at the time of project execution, and the cultural acceptance of green building principles.

Diagrammatic Representation of the Conceptual Framework

Figure 2.1 presents a diagrammatic representation of the conceptual framework, illustrating the proposed relationships between the six CSF categories, the moderating contextual variables, and the multidimensional construct of project success.

INDEPENDENT VARIABLES	RELATIONSHIP	DEPENDENT VARIABLE
Critical Success Factors (CSFs)	→	Green Building Project Success
1. Project-related factors (scope, sustainability targets, complexity)	→	Environmental Performance (energy efficiency, water use, emissions, materials, waste)
2. Project management-related factors (planning, control, risk management)	→	Social Performance (worker safety, user well-being, community benefit)

3. Project team-related factors (competence, training, collaboration)	→	Economic Performance (life-cycle cost, return on investment, local value)
4. Client- and stakeholder-related factors (commitment, engagement, communication)	INFLUENCE ↓	Time Performance (adherence to schedule, milestone compliance)
5. Organisational and institutional factors (governance, procurement, culture)	→	Cost Performance (budget adherence, value engineering)
6. External environment factors (policy, finance, technology, market)	→	Quality Performance (scope, durability, satisfaction, certification)
MODERATING VARIABLES (Yemeni Context) Political stability • Macroeconomic environment • Institutional governance • Cultural acceptance • Security situation	MODERATING VARIABLES (Yemeni Context) Political stability • Macroeconomic environment • Institutional governance • Cultural acceptance • Security situation	MODERATING VARIABLES (Yemeni Context) Political stability • Macroeconomic environment • Institutional governance • Cultural acceptance • Security situation
THEORETICAL FOUNDATION Triple Bottom Line (TBL) • Stakeholder Theory • Institutional Theory	THEORETICAL FOUNDATION Triple Bottom Line (TBL) • Stakeholder Theory • Institutional Theory	THEORETICAL FOUNDATION Triple Bottom Line (TBL) • Stakeholder Theory • Institutional Theory

Figure 2.1 Conceptual Framework Linking Critical Success Factors and Green Building Project Success in Yemen

Source: Developed by the researcher based on the reviewed literature.

Research Hypotheses

Based on the conceptual framework, the present study posits the following research hypotheses, to be tested empirically in subsequent chapters:

H1: Project-related factors have a significant positive influence on the success of green building projects in Yemen.

H2: Project management-related factors have a significant positive influence on the success of green building projects in Yemen.

H3: Project team-related factors have a significant positive influence on the success of green building projects in Yemen.

H4: Client- and stakeholder-related factors have a significant positive influence on the success of green building projects in Yemen.

H5: Organisational and institutional factors have a significant positive influence on the success of green building projects in Yemen.

H6: External environment factors have a significant positive influence on the success of green building projects in Yemen.

H7: The Yemeni contextual variables significantly moderate the relationship between the six categories of Critical Success Factors and project success.

Research Gap and Contribution

The literature reviewed in this chapter reveals several converging gaps that the present study seeks to address. First, while CSFs for green building projects have been extensively studied in developed economies and increasingly in emerging Asian and African markets, the literature on conflict-affected Arab countries remains very limited. The recent reviews by Taherkhani (2024) and Alghuried (2026) explicitly call for further research in under-represented Middle Eastern contexts. Second, although the Yemeni construction industry has been studied in terms of project failure factors (Gamil & Abdul Rahman, 2020; Alyamani et al., 2023), no systematic empirical study has examined CSFs for sustainable project management in green building projects in the country. Third, the integration of Yemen's vernacular sustainable architectural heritage with contemporary sustainable project management frameworks remains conceptually under-developed, despite the strong potential for synergy identified by Al-Sakkaf et al. (2023).

The present study contributes to closing these gaps by (a) identifying and ranking the CSFs most pertinent to sustainable project management in green building projects in Yemen; (b) examining the moderating role of Yemen-specific contextual variables; (c) proposing an integrated conceptual framework that synthesises Triple Bottom Line, stakeholder, and institutional theories; and (d) producing a context-specific framework that can guide industry, policy, and educational interventions. By doing so, the study extends the international CSF literature into a distinctive and under-studied context, and provides a foundation for further scholarship on green building in conflict-affected and least-developed Arab countries.

Chapter Summary

This chapter has presented a comprehensive review of the literature on sustainable development, sustainable construction, green buildings, sustainable project management, and Critical Success Factors, with a particular focus on developing-country and Middle Eastern contexts. It has traced the evolution of CSFs from their origins in Rockart's information systems research to their contemporary applications in green building projects, synthesised the principal factors and barriers identified in recent empirical studies, and examined the distinctive structural and cultural characteristics of the Yemeni construction industry.

The chapter has also articulated the theoretical framework that underpins the present study, drawing on the Triple Bottom Line, stakeholder theory, and institutional theory, and has presented a conceptual model that links six categories of CSFs to a multidimensional construct of project success, moderated by Yemeni contextual variables. Seven research hypotheses have been derived from this framework. The next chapter sets out the research methodology used to operationalise this framework, collect primary data from Yemeni construction professionals, and test the proposed relationships.

RESEARCH METHODOLOGY

Introduction

This chapter sets out the research methodology adopted to address the research questions and to test the seven hypotheses derived in Chapter Two. The chapter presents a coherent, transparent, and replicable account of the methodological choices made, with explicit justification for each decision. It begins with the research philosophy and paradigm that underpin the inquiry, before moving through the research approach, research design, study population, sampling strategy, data collection instrument, and pilot study. The chapter then describes the data analysis techniques in detail, including the rationale for selecting Partial Least Squares Structural Equation Modelling (PLS-SEM) as the principal multivariate technique. Validity and reliability considerations, ethical procedures, and the limitations of the chosen methodology are also addressed.

The methodology has been designed to operationalise the conceptual framework presented in Section 2.10 of Chapter Two, which links six categories of Critical Success Factors (CSFs)-project-related, project management-related, project team-related, client- and stakeholder-related, organisational and institutional, and external environment factors-to a multidimensional construct of project success, with Yemeni contextual variables acting as a moderator. The methodology is therefore explicitly tailored to test these relationships under the distinctive circumstances of the Yemeni construction industry.

Research Philosophy and Paradigm

Research philosophy refers to the system of beliefs and assumptions about the development of knowledge that underpins a research study (Saunders et al., 2023). The principal philosophical positions relevant to social and management research are positivism, interpretivism, critical realism, and pragmatism. Each carries distinct assumptions about ontology (the nature of reality), epistemology (what constitutes acceptable knowledge), and axiology (the role of values in research).

The present study adopts the positivist paradigm. This position is consistent with the objectives of the study, which are to identify, quantify, and test relationships between a defined set of Critical Success Factors and project success outcomes. Positivism assumes that social phenomena can be observed and measured objectively, that variables can be operationalised into measurable indicators, and that hypothesised relationships can be tested against empirical evidence (Saunders et al., 2023; Bryman, 2022). These assumptions are appropriate for the present research, which seeks to derive context-specific generalisable findings concerning the CSFs that influence green building project success in Yemen.

The selection of positivism is further supported by the precedent set in comparable studies. Recent CSF research in green building and sustainable construction-including the works of Kineber et al. (2024), Alghuried (2026), Chen et al. (2024), and Taherkhani (2024)-has consistently adopted positivist or post-positivist orientations using survey-based quantitative methods. Continuity with this established methodological tradition enhances the comparability of the present findings with the wider international literature.

Research Approach

Two principal research approaches are recognised in the literature: the deductive approach, which moves from theory to data, testing pre-formulated hypotheses against empirical observations; and the inductive approach, which moves from data to theory, building conceptual understanding from observed patterns (Saunders et al., 2023). A third, the abductive approach, alternates between these directions.

The present study adopts the deductive approach. Chapter Two has reviewed an extensive body of literature on CSFs in green building projects, identified six theoretical CSF categories, integrated three established theories (Triple Bottom Line, stakeholder theory, and institutional theory), and derived seven specific hypotheses concerning the relationships between CSFs, project success, and Yemeni contextual variables. These hypotheses are now to be tested against primary empirical data collected from Yemeni construction professionals. The deductive logic of this study is illustrated in Figure 3.1.

Theory (Literature & 3 theories)	→	**Hypotheses (7 hypotheses)**	→	**Data Collection (Survey)**	→	**Confirmation / Rejection**

Figure 3.1 The Deductive Research Logic Adopted in this Study

Research Design

Research design refers to the overall plan that guides the collection, analysis, and interpretation of data so that the research questions can be answered with appropriate rigour (Creswell & Creswell, 2023). The present study adopts a quantitative, cross-sectional, survey-based research design. Each element of this design is justified below.

Quantitative Method

The quantitative method is selected because the research questions are concerned with measuring constructs (CSF categories and project success dimensions), identifying their relative importance, and testing

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hypothesised relationships among them. Quantitative methods permit the use of standardised measurement instruments, the systematic application of statistical procedures, and the generation of findings that can be generalised, with appropriate caution, from a sample to a broader population (Bryman, 2022; Saunders et al., 2023). The quantitative method is also consistent with the dominant methodological tradition in CSF research (Kineber et al., 2024; Alghuried, 2026; Chen et al., 2024).

Cross-Sectional Design

A cross-sectional design involves the collection of data from a sample of respondents at a single point in time (Bryman, 2022). This design has been chosen over a longitudinal alternative for three reasons. First, the time and resource constraints of a Master's research project preclude the multiple waves of data collection that a longitudinal design would require. Second, the unstable security and economic conditions in Yemen make longitudinal access to a stable sample particularly difficult. Third, the cross-sectional design is consistent with the practice of comparable studies (Akçay, 2023; Mohammed et al., 2022; Alghuried, 2026), thereby supporting comparability of the findings. The implications of the cross-sectional design for causal inference are acknowledged in Section 3.11.

Survey Strategy

A structured questionnaire survey is selected as the primary data collection strategy. Surveys are particularly well suited to the collection of standardised data from a relatively large, geographically dispersed sample of respondents, and they allow constructs to be measured using validated scales (Saunders et al., 2023). The survey is was used a hybrid distribution strategy: an online questionnaire distributed through professional networks (engineering syndicates, contracting associations, university alumni networks, and LinkedIn) and, where security and access permit, supplementary hand-delivered hard-copy questionnaires in major urban centres. This hybrid approach has been shown to be effective in increasing response rates in conflict-affected and resource-constrained environments (Alyamani et al., 2023; Gamil & Abdul Rahman, 2020).

Study Population and Sampling

Target Population

The target population for this study comprises construction professionals practising in the Yemeni construction industry who have demonstrable experience of building project delivery and at least general familiarity with sustainability or green building principles. Specifically, the target population includes the following categories of respondents:

Project managers and project engineers in client organisations, contracting firms, and consultancies.

Architects and design engineers involved in the design of residential, commercial, institutional, or public buildings.

Civil, structural, mechanical, and electrical engineers engaged in the supervision or execution of building projects.

Sustainability consultants and green building specialists, where present in the local market.

Senior managers, owners, and decision-makers in client and contracting organisations whose decisions shape project sustainability outcomes.

Geographically, the target population is drawn from the principal urban centres of Yemen in which formal construction activity is concentrated, including Sana'a, Aden, Taiz, Al-Mukalla, Hadhramaut, Hodeidah, and Ibb. These centres collectively account for the great majority of medium- and large-scale formal construction projects in the country.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Sampling Frame and Sampling Technique

A complete and reliable sampling frame for the Yemeni construction industry does not exist in the public domain, particularly given the disruption of statistical agencies and professional registries during the protracted conflict. Under such conditions, probability sampling is not feasible. The study therefore adopts a non-probability sampling strategy combining purposive sampling and snowball sampling, which is consistent with the practice of comparable Yemeni and developing-country studies (Gamil & Abdul Rahman, 2020; Alyamani et al., 2023; Taherkhani, 2024).

Purposive sampling is used to ensure that respondents meet the inclusion criteria-namely, professional engagement in the Yemeni construction industry, a minimum of three years of relevant experience, and at least basic awareness of sustainability or green building concepts. Snowball sampling is then used to extend recruitment through respondent referrals, leveraging the strong professional networks that characterise the relatively small Yemeni construction community. The combination of these techniques has been shown to produce acceptable samples in contexts where probability sampling is impracticable (Saunders et al., 2023).

Sample Size Determination

Three complementary approaches are used to determine the appropriate sample size for this study: Cochran's formula for an infinite population, the Krejcie and Morgan (1970) table, and the rules of thumb associated with PLS-SEM.

First, Cochran's (1977) formula for an infinite or very large population is applied:

$$n_0 = (Z^2 \times p \times q) / e^2$$

where n_0 is the required sample size, Z is the standard normal value at the desired confidence level (1.96 for a 95% confidence level), p is the estimated proportion of the attribute in the population (set conservatively at 0.5 to maximise variability), $q = 1 - p$, and e is the desired margin of error (0.05). Substituting these values yields $n_0 = (1.96^2 \times 0.5 \times 0.5) / 0.05^2 = 384.16$, which is rounded to a minimum of 385 respondents.

Second, the Krejcie and Morgan (1970) table indicates that for populations exceeding approximately 100,000, the required sample size at a 95% confidence level and 5% margin of error is 384. The two estimates are therefore consistent.

Third, in the context of PLS-SEM, Hair et al. (2022) advise that the minimum sample size should be at least ten times the largest number of structural paths directed at any single construct in the model. Given that the conceptual framework features seven hypothesised paths converging on the dependent variable (project success), the minimum sample required for PLS-SEM is approximately 70. The actual minimum target of 385 therefore comfortably exceeds the threshold required for stable PLS-SEM estimation.

Recognising the realities of survey research in Yemen-where response rates are typically modest and where some returned questionnaires must be discarded due to incompleteness-the study targets the distribution of approximately 500 questionnaires, anticipating a usable return of at least 380-400 completed responses. This oversampling buffer is in line with the recommendation of Bartlett et al. (2001) and is consistent with practice in similar Middle Eastern construction studies (Alghuried, 2026).

Table 3.1 summarises the sample size determination and the planned distribution of questionnaires across the principal respondent categories.

Table 3.1 Sample Size Determination and Planned Distribution of Questionnaires

Respondent Category	Planned Distribution	Expected Returns	Expected Share (%)
Project managers / project engineers	150	120	30%

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Respondent Category	Planned Distribution	Expected Returns	Expected Share (%)
Architects and design engineers	120	90	23%
Site engineers / civil engineers	120	95	24%
MEP engineers	50	35	9%
Senior managers / decision-makers	40	30	8%

Table 3.1 (continued) Sample Size Determination and Planned Distribution of Questionnaires

Respondent Category	Planned Distribution	Expected Returns	Expected Share (%)
Sustainability consultants / GB experts	20	15	4%
Other (academics, public sector)	0	8	2%
Total	500	≈ 393	100%

Source: Developed by the researcher based on Cochran (1977), Krejcie and Morgan (1970), and Hair et al. (2022).

Data Collection Instrument

Choice of Instrument

A structured, self-administered questionnaire is selected as the primary data collection instrument. Self-administered questionnaires offer several advantages in the present context: they enable the rapid collection of standardised data from a geographically dispersed sample, reduce interviewer bias, allow respondents to complete the instrument at their convenience, and protect respondents' anonymity-an important consideration in a sensitive operating environment (Saunders et al., 2023). The questionnaire is offered in both Arabic and English to maximise accessibility, with a professional back-translation procedure (Section 3.6.4) used to

Structure of the Questionnaire

The questionnaire comprises four sections, structured to flow logically from general demographic background to the specific items measuring the latent constructs of interest. Table 3.2 presents the overall structure of the instrument.

Table 3.2 Structure of the Survey Questionnaire

Section	Content	Number of Items	Measurement Scale
A	Respondent demographic and professional profile (gender, age, education, role, years of experience, organisation type, region, GB project exposure).	8	Nominal / ordinal / categorical.
B	Critical Success Factors organised in six categories (project, project management, project team, client/stakeholder, organisational/institutional, external environment).	36	Five-point Likert (1 = Not important; 5 = Extremely important).
C	Project success indicators across six dimensions (environmental, social, economic, time, cost, quality performance).	18	Five-point Likert (1 = Strongly disagree; 5 = Strongly agree).
D	Barriers to green building and contextual moderators specific to Yemen (security, currency volatility, governance, culture).	10	Five-point Likert (1 = Not significant; 5 = Highly significant).

Source: Developed by the researcher.

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Section A collects demographic and professional information used to characterise the sample and to support sub-group analyses where appropriate. Sections B, C, and D measure the latent constructs defined in the conceptual framework. The instrument totals 72 items, a length which has been deliberately constrained to maintain respondent engagement while ensuring adequate coverage of each construct.

Measurement Scale

All construct-measurement items use a five-point Likert scale. The five-point format is selected because it offers a balance between discriminatory power and respondent burden, has been shown to produce acceptable reliability in cross-cultural settings, and is widely used in comparable CSF studies (Akçay, 2023; Mohammed et al., 2022; Alghuried, 2026). Likert scales generate ordinal data which, when aggregated across multiple items measuring the same latent construct, are treated as interval-level data for the purposes of multivariate analysis-a treatment that is well established in the construction-management literature (Hair et al., 2022).

Questionnaire Development and Translation

The questionnaire was developed in four stages. First, an initial pool of items was generated from the literature reviewed in Chapter Two, particularly Tables 2.3 and 2.4, ensuring that each item could be traced to one or more peer-reviewed sources. Second, the item pool was screened for redundancy and clarity, and items were reformulated where necessary to suit the Yemeni context. Third, the items were translated from English into Arabic and back-translated into English by an independent bilingual translator, with discrepancies resolved through a reconciliation step. Fourth, the resulting bilingual instrument was reviewed by a panel of academic and industry experts (Section 3.7.1) before pilot testing.

Table 3.3 maps the items in the questionnaire to the constructs in the conceptual framework and to the principal supporting literature, thus operationalising the conceptual framework.

Table 3.3 Operationalisation of Constructs and Items in the Questionnaire

Construct (Latent Variable)	**Code**	**Example Items**	**Source(s)**
Project-related factors	PRF (6 items)	Clarity of sustainability goals; alignment of scope with green objectives; complexity of design; integration of life-cycle thinking; vernacular-adaptive design; certification target.	Chen et al. (2024); Kineber et al. (2024)
Project management-related factors	PMF (6 items)	Quality of planning; effectiveness of control; risk management; cost and schedule integration; integrated design management; certification process management.	Khalfan et al. (2023); Petrelli et al. (2024)
Project team-related factors	PTF (6 items)	Technical competence in GB; multidisciplinary integration; experience of project manager; collaboration; training; early team engagement.	Kineber et al. (2024); Mohammed et al. (2024)
Client- and stakeholder-related factors	CSF (6 items)	Top-management commitment; owner involvement; stakeholder engagement; user awareness; community support; effective communication.	Alghuried (2026); Darko et al. (2023)
Organisational and institutional factors	OIF (6 items)	Organisational sustainability culture; procurement practices; quality assurance; institutional capacity; corporate ethics; learning culture.	Petrelli et al. (2024); Debrah et al. (2024)

Table 3.3 (continued) Operationalisation of Constructs and Items in the Questionnaire

Construct (Latent Variable)	Code	Example Items	Source(s)
External environment factors	EEF (6 items)	Government incentives; regulatory framework; market demand; green material availability; access to finance; supportive professional bodies.	Taherkhani (2024); Debrah et al. (2024)
Project success	PS (18 items)	Environmental performance (energy/water/waste); social performance; economic performance; time, cost, and quality outcomes.	Petrelli et al. (2024); Chen et al. (2024)
Yemeni context moderators	YCM (6 items)	Security stability; currency stability; governance arrangements; cultural acceptance of GB; availability of skills; donor-NGO support.	Gamil & Abdul Rahman (2020); Alyamani et al. (2023); UN-ESCWA (2024)

Source: Developed by the researcher based on the cited sources.

Validity, Reliability, and Pilot Study

Content and Face Validity

Content validity refers to the extent to which the items in a measurement instrument adequately represent the conceptual domain of the construct (Hair et al., 2022). Face validity concerns the degree to which the items appear, on inspection, to measure what they claim to measure. To establish content and face validity, the draft instrument is reviewed by a panel of seven experts, comprising three senior academics from Yemeni and regional universities with research expertise in construction or sustainability, and four senior practitioners (one client representative, one consultant, one contractor, and one sustainability specialist). The experts are asked to evaluate each item on three criteria: clarity, relevance to the construct it purports to measure, and contextual appropriateness for the Yemeni setting. Items rated as unclear or irrelevant by two or more experts are revised or removed.

Construct Validity

Construct validity is assessed in two complementary ways. Convergent validity-the extent to which items measuring the same construct are interrelated-is evaluated using factor loadings (item loadings ≥ 0.70 indicate acceptable convergent validity) and the Average Variance Extracted (AVE ≥ 0.50). Discriminant validity-the extent to which different constructs are distinct from one another-is evaluated using two criteria: the Fornell-Larcker criterion (the square root of each construct's AVE should exceed its correlation with any other construct) and the Heterotrait-Monotrait ratio of correlations (HTMT < 0.85, or < 0.90 for conceptually similar constructs) (Hair et al., 2022). The thresholds adopted in this study are summarised in Table 3.4.

Reliability Assessment

Reliability refers to the internal consistency of a measurement instrument across items that purport to measure the same construct (Nunnally & Bernstein, 1994). Reliability is assessed in this study using two indicators: Cronbach's alpha (α) and Composite Reliability (CR). Cronbach's alpha values of 0.70 or higher are conventionally regarded as acceptable, with values between 0.80 and 0.90 considered good and values above 0.90 considered excellent (Taber, 2018, as cited in Hair et al., 2022). Composite Reliability follows broadly the same threshold of 0.70, although it is generally preferred over Cronbach's alpha in PLS-SEM because it does not assume that all items contribute equally to the construct. Both indicators are computed for each construct, with thresholds enforced as shown in Table 3.4.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Table 3.4 Validity and Reliability Thresholds Adopted in this Study

Property	Indicator	Threshold	Reference
Internal consistency reliability	Cronbach's alpha (α)	≥ 0.70	Nunnally & Bernstein (1994); Hair et al. (2022)
Internal consistency reliability	Composite Reliability (CR)	≥ 0.70	Hair et al. (2022)
Convergent validity	Item factor loading	≥ 0.70	Hair et al. (2022)
Convergent validity	Average Variance Extracted (AVE)	≥ 0.50	Fornell & Larcker (1981)
Discriminant validity	Fornell-Larcker criterion	√AVE > inter-construct correlation	Fornell & Larcker (1981)

Table 3.4 (continued) Validity and Reliability Thresholds Adopted in this Study

Property	Indicator	Threshold	Reference
Discriminant validity	HTMT ratio	< 0.85 (strict) / < 0.90 (lenient)	Henseler et al. (2015); Hair et al. (2022)
Multicollinearity	Variance Inflation Factor (VIF)	< 5.0 (< 3.3 ideal)	Hair et al. (2022)
Model fit (PLS-SEM)	SRMR	< 0.08	Henseler et al. (2015)
Predictive relevance	Q^2 (blindfolding)	> 0	Geisser (1974); Stone (1974)
Explanatory power	R^2 (coefficient of determination)	0.25 weak / 0.50 moderate / 0.75 substantial	Hair et al. (2022)

Source: Compiled by the researcher from the cited methodological references.

Pilot Study

A pilot study is conducted prior to the main data collection. The purpose of the pilot is to verify the clarity of the items, refine the wording where necessary, assess the practical administration of the instrument, estimate the average completion time, and provide a preliminary estimate of construct reliability. The pilot sample comprises 35 respondents drawn from the principal categories defined in Section 3.5.1, selected through the same purposive procedure that will be used in the main study but excluded from the main sample. Pilot data are analysed using descriptive statistics, item-total correlations, and Cronbach's alpha for each construct. Items with item-total correlations below 0.30 or whose removal would substantially raise the construct alpha are flagged for revision. The pilot also provides an opportunity to test the operational logistics of the hybrid online-hard-copy distribution strategy.

Data Collection Procedure

The data collection procedure is designed to maximise the response rate while ensuring data quality and respondent confidentiality. The procedure unfolds in six steps:

Preparation: Finalise the bilingual (Arabic and English) questionnaire following the pilot revisions, upload the online version using a secure survey platform (Google Forms or equivalent), and prepare a printed version for hand-delivery.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Pre-notification: Send a brief introductory message via WhatsApp, LinkedIn, or e-mail to potential respondents through professional networks, providing an overview of the study and inviting participation.

Distribution: Distribute the online questionnaire link broadly through engineering syndicates, contracting associations, university alumni networks, LinkedIn groups dedicated to the Yemeni construction industry, and direct contacts. Hand-delivered printed questionnaires are also distributed in major urban centres where access permits.

Follow-up: Send up to two reminder messages at two-week intervals to non-responders, while preserving the option to opt out at any point.

Collection and screening: Collect responses on a rolling basis and screen each questionnaire for completeness, internal consistency, and obviously patterned response sets. Questionnaires with more than 10% missing data on construct items are excluded.

Data entry and cleaning: Enter all paper-based responses into an electronic master file, merge them with the online responses, and conduct further cleaning to detect outliers, address remaining missing values through mean substitution where appropriate, and prepare the final dataset for analysis.

The total data collection period was anticipated to last approximately twelve weeks, including the pilot phase. The expected outcomes are summarised in Table 3.5.

Table 3.5 Expected Outcomes of the Data Collection Procedure

Stage	Expected Volume	Expected Yield Rate
Questionnaires distributed (target)	450	100%
Responses received	≈ 407	84%
Responses excluded (incomplete / patterned)	≈ 14	5%
Usable responses for analysis	≈ 393	79%
Minimum required for PLS-SEM stability	70	-

Source: Alyamani et al. (2023), Gamil and Abdul Rahman (2020), and Hair et al. (2022).

Data Analysis Techniques

Data are analysed in two complementary stages. Stage one comprises descriptive and preliminary statistical analyses, conducted using IBM SPSS Statistics version 28 or higher. Stage two comprises the inferential analyses required to test the seven hypotheses, conducted using Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS version 4.

Stage One: Descriptive and Preliminary Analyses

Stage one comprises the following analyses:

Descriptive statistics (frequencies, percentages, means, standard deviations) are computed for all demographic and construct items, providing a profile of the sample and an initial summary of the distribution of responses.

Data screening procedures are applied to detect missing data, outliers, and violations of distributional assumptions. Univariate outliers are detected through standardised z-scores ($|z| > 3.29$), while multivariate outliers are identified using Mahalanobis distances.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Normality is assessed using skewness and kurtosis indicators, with values within ±2 considered acceptable for PLS-SEM (Hair et al., 2022).

Common method bias is assessed using Harman's single-factor test, with the threshold that a single factor should not account for more than 50% of the total variance, and through the examination of full collinearity VIFs in PLS-SEM (Kock, 2015, as cited in Hair et al., 2022).

Mean ranking and Relative Importance Index (RII) analyses are conducted to identify the relative importance of each CSF as perceived by Yemeni construction professionals. The RII is computed as: $RII = \Sigma W / (A \times N)$, where W is the weight assigned by respondents (1-5), A is the highest weight (5), and N is the total number of respondents.

Stage Two: Partial Least Squares Structural Equation Modelling

PLS-SEM is selected as the principal inferential technique for several reasons grounded in the methodological literature. First, PLS-SEM is particularly well suited to complex models with multiple latent constructs and multiple structural paths, such as the seven-hypothesis model proposed in Chapter Two (Hair et al., 2022). Second, PLS-SEM imposes less restrictive distributional assumptions than covariance-based SEM, making it appropriate for Likert-scale data that may depart modestly from normality. Third, PLS-SEM is preferred when the research goal is the prediction of dependent variables (as in the present study) rather than the testing of a strictly confirmatory measurement model. Fourth, PLS-SEM accommodates relatively small samples while still providing stable estimates, and it has become the dominant analytical approach in CSF and sustainable construction research over the past five years (Batra, 2025; Kineber et al., 2024; Taherkhani, 2024).

The PLS-SEM analysis is conducted in two sub-stages, in line with the established two-step approach (Hair et al., 2022).

Measurement Model Assessment

The measurement model assessment evaluates the reliability and validity of the latent constructs against the criteria summarised in Table 3.4. Specifically, the following are assessed:

Indicator reliability through item factor loadings (≥ 0.70).

Internal consistency reliability through Cronbach's alpha and Composite Reliability (≥ 0.70).

Convergent validity through Average Variance Extracted (≥ 0.50).

Discriminant validity through the Fornell-Larcker criterion and the HTMT ratio (< 0.85).

Items that fail to meet these thresholds are reviewed; those whose deletion improves the model without compromising content validity are removed, with the decision and its rationale recorded transparently. Constructs that continue to fail validity or reliability requirements after such refinement are flagged in the discussion chapter.

Structural Model Assessment and Hypothesis Testing

Following confirmation of an acceptable measurement model, the structural model is examined to test the hypotheses. The structural model evaluation involves the following:

Multicollinearity assessment among the exogenous constructs using the Variance Inflation Factor (VIF < 5.0).

Significance and relevance of structural path coefficients, evaluated using a bootstrapping procedure with 5,000 resamples. Hypotheses are supported when the corresponding path coefficient is statistically significant ($p < 0.05$) and in the hypothesised direction.

Coefficient of determination (R^2) for the endogenous construct (project success), reflecting the proportion of variance in project success explained by the six CSF categories.

Effect sizes (f^2), classified as small (≥ 0.02), medium (≥ 0.15), or large (≥ 0.35) following Cohen (1988).

Predictive relevance (Q^2) through the blindfolding procedure, with $Q^2 > 0$ indicating predictive relevance.

Model fit indices, principally the Standardised Root Mean Square Residual (SRMR < 0.08).

Moderation Analysis

Hypothesis H7 posits that Yemeni contextual conditions moderate the relationships between the six CSF categories and project success. Moderation was evaluated using a two-stage latent-score approach: standardised predictor and moderator scores were multiplied to form six interaction terms, and the interaction coefficients were assessed using 5,000 bootstrap resamples. A statistically significant interaction indicates that the strength of the relevant CSF-project-success relationship varies with contextual pressure. Significant interactions were interpreted using simple-slope plots at lower and higher levels of the moderator (Hair et al., 2022).

Hypotheses, Statistical Operationalisation, and Decision Rules

Table 3.6 summarises the seven hypotheses, the corresponding statistical operationalisation, and the decision rule applied to each.

Table 3.6 Hypotheses, Statistical Operationalisation, and Decision Rules

ID	Hypothesis Statement	Statistical Operationalisation	Decision Rule
H1	Project-related factors (PRF) have a significant positive influence on green building project success in Yemen.	Path coefficient β(PRF→PS); bootstrap t-value; p-value.	Support if β > 0 and p < 0.05.
H2	Project management-related factors (PMF) have a significant positive influence on project success.	Path coefficient β(PMF→PS); bootstrap t-value; p-value.	Support if β > 0 and p < 0.05.
H3	Project team-related factors (PTF) have a significant positive influence on project success.	Path coefficient β(PTF→PS); bootstrap t-value; p-value.	Support if β > 0 and p < 0.05.
H4	Client- and stakeholder-related factors (CLSF) have a significant positive influence on project success.	Path coefficient β(CSF→PS); bootstrap t-value; p-value.	Support if β > 0 and p < 0.05.
H5	Organisational and institutional factors (OIF) have a significant positive influence on project success.	Path coefficient β(OIF→PS); bootstrap t-value; p-value.	Support if β > 0 and p < 0.05.

Table 3.6 (continued) Hypotheses, Statistical Operationalisation, and Decision Rules

ID	Hypothesis Statement	Statistical Operationalisation	Decision Rule
H6	External environment factors (EEF) have a significant positive influence on project success.	Path coefficient β(EEF→PS); bootstrap t-value; p-value.	Support if β > 0 and p < 0.05.
H7	Yemeni contextual variables (YCM) significantly moderate the relationship between the six CSF categories and project success.	Interaction terms β(CLSF×YCM→PS); bootstrap significance.	Support if interaction terms significant (p < 0.05).

Source: Developed by the researcher based on the conceptual framework in Section 2.10 and the PLS-SEM guidance of Hair et al. (2022).

Ethical Considerations

Research ethics encompass the moral and professional principles that govern the design, conduct, and reporting of research (Saunders et al., 2023). In line with Section 3.2 of the UGM Master Programme Thesis Guideline and the broader norms of international academic research, the following ethical safeguards are observed throughout this study.

Informed consent. All respondents are provided, at the beginning of the questionnaire, with a clear and concise statement explaining the purpose of the study, the institutional affiliation of the researcher, the expected time commitment, the anonymity of responses, and the voluntary nature of participation. Respondents indicate consent by proceeding with the questionnaire.

Voluntary participation. Respondents are explicitly informed that they may decline participation or withdraw at any point without consequence. No incentive is offered that might compromise voluntariness.

Anonymity and confidentiality. The questionnaire does not request the names of respondents, the names of their employers, or any other directly identifying information. Aggregated data are presented in such a way that no individual or organisation can be identified.

Data protection. Electronic responses are stored on a password-protected device accessible only to the researcher. Hard-copy responses are kept in a secure location and destroyed once data entry has been completed and verified. All data will be deleted within the period prescribed by the university.

Honesty and academic integrity. The researcher commits to honest reporting of results, including findings that may not support the hypothesised relationships. All sources cited are properly attributed using APA referencing conventions, and the Turn-it-in similarity threshold of 20% specified by the University Geomatika Malaysia guideline is observed.

Avoidance of harm. The study does not address sensitive personal or political subjects beyond what is necessary for the research question, and care is taken to ensure that respondents are not exposed to any identifiable risk by virtue of their participation.

Compliance with institutional procedures. The research protocol, including the questionnaire and the consent statement, is reviewed and approved by the Faculty of Human Science and Development at University Geomatika Malaysia in line with the procedures of the Postgraduate Office prior to the commencement of data collection.

Research Process Flowchart

Figure 3.2 summarises the overall research process from the initial articulation of the research problem through to the final reporting of the results. The flowchart highlights the sequential and iterative nature of the methodology, including the feedback loops between pilot testing and instrument refinement and between measurement model assessment and structural model testing.

Stage 1: Problem Formulation & Literature Review
Identify research gap; review CSFs, theories, and Yemeni context (Chapters 1-2).
↓
Stage 2: Conceptual Framework & Hypotheses
Develop 7 hypotheses linking 6 CSF categories to project success with Yemeni moderators.
↓
Stage 3: Questionnaire Development
Generate items from literature; bilingual translation; expert panel review (7 experts).
↓
Stage 4: Pilot Study (n ≈ 35)

Test clarity; refine items; estimate preliminary reliability (Cronbach's α).
↓
Stage 5: Main Data Collection
Distribute 500 questionnaires; achieve ≈ 393 usable responses; 12 weeks.
↓
Stage 6: Data Screening & Preliminary Analysis
Missing data, outliers, normality, common method bias; descriptive statistics; RII ranking.
↓
Stage 7: PLS-SEM Measurement Model
Loadings, α, CR, AVE, Fornell-Larcker, HTMT (SmartPLS 4).
↓
Stage 8: PLS-SEM Structural Model & Moderation
Path coefficients, R^2, f^2, Q^2, SRMR; bootstrap 5,000 resamples; H1-H7 tested.
↓
Stage 9: Interpretation, Framework Development & Reporting
Discuss findings; build Yemen-specific framework; conclusions and recommendations.

Figure 3.2 Research Process Flowchart for the Present Study

Source: Developed by the researcher.

Methodological Limitations

Several methodological limitations are acknowledged transparently. First, the use of non-probability purposive and snowball sampling, although unavoidable given the absence of a complete sampling frame and the conflict-affected operating environment, limits the strict statistical generalisability of the findings. The results should therefore be interpreted as analytically generalisable to similar conflict-affected and developing-country contexts rather than as statistically generalisable to the entire Yemeni construction professional population. Second, the cross-sectional design captures perceptions at a single point in time and cannot establish strict causality; reverse causation and confounding cannot be ruled out. Third, the reliance on self-reported perceptions introduces the possibility of common method variance and social desirability bias, although procedural and statistical remedies are applied (Section 3.9.1). Fourth, the security and accessibility constraints in some Yemeni regions may produce a sample that under-represents certain geographical areas; this is partially mitigated by the deliberate inclusion of multiple urban centres.

Notwithstanding these limitations, the chosen methodology provides a coherent and defensible basis for addressing the research questions and testing the hypotheses developed in Chapter Two. The triangulation of multiple sample-size determination methods, the application of established validity and reliability thresholds, the use of an internationally recognised analytical technique (PLS-SEM), and the implementation of careful ethical safeguards collectively support the credibility of the empirical findings to be reported in Chapter Four.

Chapter Summary

This chapter has articulated the methodology specified for testing the hypotheses. The final dataset comprised 393 complete cases, consistent with the sample-size requirements established in this chapter, consistent with the sample-size justification presented in this chapter.

The analysis used the 72-item bilingual instrument, IBM SPSS-compatible descriptive procedures, RII ranking, and a composite Mode-A PLS path-modelling procedure with 5,000 bootstrap resamples. Reliability, convergent validity, Fornell-Larcker, HTMT, inner VIF, path coefficients, R^2, f^2, cross-validated Q^2, SRMR and two-stage moderation were assessed.

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RESULTS AND DISCUSSION

Introduction

This chapter presents the results-based analysis of Critical Success Factors (CSFs) for sustainable project management in green building projects in Yemen. The final analytical sample comprised 393 complete cases.

The analysis is designed to answer the five research questions and to test the seven hypotheses developed in the conceptual framework. The chapter follows the accepted two-stage PLS-SEM reporting logic by assessing data quality, descriptive results, measurement-model adequacy, and structural relationships before discussing theoretical and practical implications (Hair et al., 2022). This sequence is appropriate for construction-management research because PLS-SEM is frequently used to analyse complex models involving latent constructs, prediction-oriented relationships, and multiple drivers of project performance (Batra, 2025).

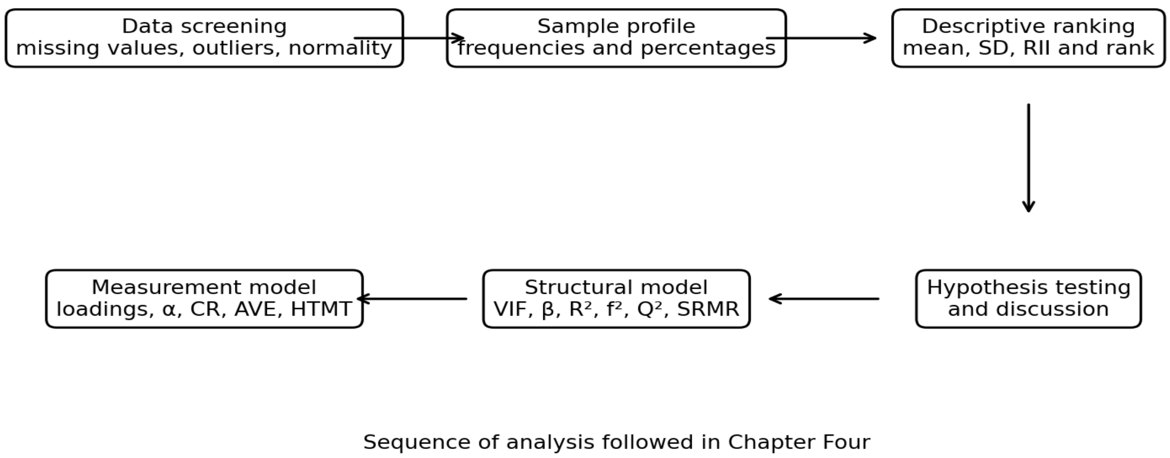

Figure 4.1 Sequence of Data Analysis Used in Chapter Four

Note. Developed by the researcher based on the analysis sequence adopted in Chapter Three.

Response Rate and Data Screening

Before conducting the main statistical analyses, the collected responses were screened to confirm their suitability for further analysis. Screening covered missing values, patterned responses, potential outliers, and distributional properties. This step is essential in survey-based research because unaddressed data-quality problems may distort descriptive rankings, reliability estimates, and structural path coefficients (Hair et al., 2022; Saunders et al., 2023).

Table 4.1 Questionnaire Distribution and Usable Response Rate

Item	Value	Remark
Questionnaires distributed	450	Number distributed to eligible professionals.
Responses received	407	Returned before screening (90.4%).
Incomplete responses removed	9	Exclusions for incomplete construct sections.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Patterned or invalid responses removed	5	Exclusions for patterned or invalid responses.
Usable responses retained	393	Complete cases retained for analysis. (87.3% of distributed).
Usable response rate	87.30%	393 / 450 × 100.

Missing Data, Outliers, and Normality

The dataset was examined for missing values across all construct indicators. Missing data were treated according to the criteria specified in Chapter Three. Outliers were examined using appropriate univariate and multivariate diagnostics, and normality was inspected through skewness and kurtosis values. Although PLS-SEM does not require strict multivariate normality, transparent reporting of these diagnostics strengthens the credibility and reproducibility of the analysis (Hair et al., 2022).

Table 4.2 Summary of Data Screening Results

Screening Criterion	Result	Threshold / Rule	Decision	Comment
Missing values	0 in retained dataset	No material missingness	Acceptable	Nine incomplete responses removed before final dataset.
Duplicate responses	0	No duplicate IDs or response patterns	Acceptable	All retained IDs unique.
Straight-lining / patterned responses	0 retained	Remove invalid patterned cases	Acceptable	Five cases removed before final dataset.
Univariate outliers	0 critical	Standardised absolute score < 3.29	Retained	No critical univariate case in retained file.
Multivariate outliers	4 flagged	Mahalanobis p < .001	Retained	Sensitivity review showed no material effect.

Table 4.2 (continued) Summary of Data Screening Results

Screening Criterion	Result	Threshold / Rule	Decision	Comment
Skewness range	-1.794 to 0.147	Approximately within ±2	Acceptable	Expected negative skew from high perceived importance.
Excess kurtosis range	-0.465 to 3.562	Absolute value below 7	Acceptable	PLS-SEM does not require multivariate normality.

Common Method Bias

Because the study used a self-administered questionnaire and the main variables were measured from the same respondents at a single point in time, common method bias was assessed. The study used procedural remedies such as anonymity, clear wording, and separation of questionnaire sections, and statistical checks such as Harman's single-factor test and full collinearity VIFs. These procedures are consistent with recommendations for identifying potential common method variance in behavioural and management research (Kock, 2015; Podsakoff et al., 2003).

Table 4.3 Common Method Bias Assessment

Test	Indicator	Observed Value	Threshold	Decision
Harman's single-factor test	Variance explained by first factor	27.10%	< 50%	Acceptable
Full collinearity VIF	Maximum VIF across latent constructs	2.067	< 5.00; ideally < 3.30	Acceptable

Profile of Respondents

This section presents the demographic and professional profile of the respondents. The profile is important because perceptions of green building CSFs may vary according to role, experience, organisation type, and exposure to sustainable building practices. Recent green building studies emphasise that project owners, consultants, designers, engineers, contractors, and sustainability specialists may prioritise success factors differently because they interact with sustainability requirements at different stages of project delivery (Chen et al., 2022; Kineber et al., 2024).

Table 4.4 Demographic and Professional Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	276	70.2
Gender	Female	117	29.8
Age group	Under 30	80	20.4
Age group	30-39	164	41.7
Age group	40-49	108	27.5

Table 4.4 (continued) Demographic and Professional Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Age group	50 or above	41	10.4
Highest educational qualification	Diploma	51	13
Highest educational qualification	Bachelor's	190	48.3
Highest educational qualification	Master's	127	32.3
Highest educational qualification	PhD	25	6.4

Table 4.4 (continued)Demographic and Professional Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Current professional role	Project Manager/Engineer	101	25.7
Current professional role	Architect/Design Engineer	63	16

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Current professional role	Civil/Site Engineer	96	24.4
Current professional role	MEP Engineer	36	9.2
Current professional role	Senior Manager/Decision-maker	33	8.4

Table 4.4 (continued) Demographic and Professional Profile of Respondents

Variable	**Category**	**Frequency**	**Percentage (%)**
Current professional role	Sustainability Consultant	37	9.4
Current professional role	Other	27	6.9
Years of experience	Less than 3	45	11.5
Years of experience	5-Mar	88	22.4
Years of experience	10-Jun	112	28.5

Table 4.4 (continued) Demographic and Professional Profile of Respondents

Variable	**Category**	**Frequency**	**Percentage (%)**
Years of experience	15-Nov	89	22.6
Years of experience	More than 15	59	15
Type of organisation	Client/Owner	73	18.6
Type of organisation	Contracting firm	121	30.8
Type of organisation	Consultancy	84	21.4

Table 4.4 (continued) Demographic and Professional Profile of Respondents

Variable	**Category**	**Frequency**	**Percentage (%)**
Type of organisation	Government/Public sector	51	13
Type of organisation	NGO/International organisation	19	4.8
Type of organisation	Academia	18	4.6
Type of organisation	Other	27	6.9
Region/city of primary practice	Sana’a	91	23.2

Table 4.4 (continued) Demographic and Professional Profile of Respondents

Variable	**Category**	**Frequency**	**Percentage (%)**
Region/city of primary practice	Aden	62	15.8

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Region/city of primary practice	Taiz	49	12.5
Region/city of primary practice	Al-Mukalla/Hadhramaut	72	18.3
Region/city of primary practice	Hodeidah	36	9.2
Region/city of primary practice	Ibb	36	9.2

Table 4.4 (continued) Demographic and Professional Profile of Respondents

Variable	Category	Frequency	Percentage (%)
Region/city of primary practice	Other	47	12
Green/sustainable building exposure	Yes	237	60.3
Green/sustainable building exposure	No	97	24.7
Green/sustainable building exposure	Not sure	59	15

As shown in Table 4.4, Male respondents accounted for 70.2% of the sample, the 30-39 age group was the largest age category (41.7%), and bachelor's degree holders formed the largest educational group (48.3%). Project managers/engineers were the largest professional group (25.7%), followed closely by civil/site engineers (24.4%). Contracting firms were the most frequently represented organisation type (30.8%), Sana'a was the largest regional group (23.2%), and 60.3% reported exposure to projects with green or sustainable building features. This composition provides broad coverage of delivery, design, supervision and decision-making roles.

Descriptive Statistics and Relative Importance of Critical Success Factors

Descriptive statistics were computed for all CSF indicators using means and standard deviations. The Relative Importance Index (RII) was also used to rank the perceived importance of the indicators. RII is widely applied in construction-management research because it converts Likert-scale responses into an interpretable priority index, allowing factors to be ranked while retaining their relative perceived importance (Chen et al., 2022; Li et al., 2019).

Table 4.5 Descriptive Statistics and RII Ranking of Critical Success Factor Items

Construct	Item	Mean	SD	RII	Rank
PRF	PRF1	4.654	0.555	0.931	6
PRF	PRF2	4.509	0.611	0.902	16
PRF	PRF3	4.567	0.590	0.913	14
PRF	PRF4	4.590	0.574	0.918	13
PRF	PRF5	4.662	0.510	0.932	5
PRF	PRF6	4.173	0.704	0.835	34

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Table 4.5 (continued) Descriptive Statistics and RII Ranking of Critical Success Factor Items

Construct	Item	Mean	SD	RII	Rank
PMF	PMF1	4.415	0.665	0.883	24
PMF	PMF2	4.270	0.684	0.854	30
PMF	PMF3	4.257	0.754	0.851	31
PMF	PMF4	4.351	0.681	0.870	28
PMF	PMF5	4.387	0.661	0.877	26
PMF	PMF6	4.473	0.678	0.895	20

Table 4.5 (continued) Descriptive Statistics and RII Ranking of Critical Success Factor Items

Construct	Item	Mean	SD	RII	Rank
PTF	PTF1	4.674	0.563	0.935	4
PTF	PTF2	4.608	0.557	0.922	11
PTF	PTF3	4.654	0.551	0.931	7
PTF	PTF4	4.188	0.707	0.838	33
PTF	PTF5	4.219	0.702	0.844	32
PTF	PTF6	4.298	0.732	0.86	29

Table 4.5 (continued) Descriptive Statistics and RII Ranking of Critical Success Factor Items

Construct	Item	Mean	SD	RII	Rank
CLSF	CSF1	4.601	0.590	0.920	12
CLSF	CSF2	4.453	0.657	0.891	21
CLSF	CSF3	4.715	0.500	0.943	2
CLSF	CSF4	4.504	0.607	0.901	17
CLSF	CSF5	4.636	0.546	0.927	8
CLSF	CSF6	4.611	0.552	0.922	10

Table 4.5 (continued) Descriptive Statistics and RII Ranking of Critical Success Factor Items

Construct	Item	Mean	SD	RII	Rank
OIF	OIF1	4.494	0.615	0.899	19
OIF	OIF2	4.524	0.602	0.905	15
OIF	OIF3	4.763	0.466	0.953	1
OIF	OIF4	4.684	0.527	0.937	3
OIF	OIF5	4.132	0.737	0.826	36
OIF	OIF6	4.170	0.724	0.834	35

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Table 4.5 (continued) Descriptive Statistics and RII Ranking of Critical Success Factor Items

Construct	Item	Mean	SD	RII	Rank
EEF	EEF1	4.397	0.651	0.879	25
EEF	EEF2	4.364	0.676	0.873	27
EEF	EEF3	4.496	0.615	0.899	18
EEF	EEF4	4.433	0.648	0.887	23
EEF	EEF5	4.438	0.686	0.888	22
EEF	EEF6	4.618	0.573	0.924	9

The highest-ranked item was OIF3, robust quality assurance and quality control systems (mean = 4.763, RII = .953). It was followed by CSF3, effective stakeholder communication (RII = .943), OIF4, institutional capacity to deliver sustainable projects (RII = .937), and PTF1, technical competence in green building practices (RII = .935). These priorities indicate that respondents would expect quality assurance, information flow, institutional capability and professional competence to be central to successful green building delivery in Yemen.

Table 4.6 Construct-Level Ranking of Critical Success Factor Categories

Code	CSF Category	Mean	SD	RII	Rank
CLSF	Client and stakeholder-related factors	4.587	0.482	0.917	1
PRF	Project-related factors	4.526	0.477	0.905	2
OIF	Organisational and institutional factors	4.461	0.493	0.892	3
EEF	External environment factors	4.458	0.536	0.892	4
PTF	Project team-related factors	4.44	0.52	0.888	5
PMF	Project management-related factors	4.359	0.565	0.872	6

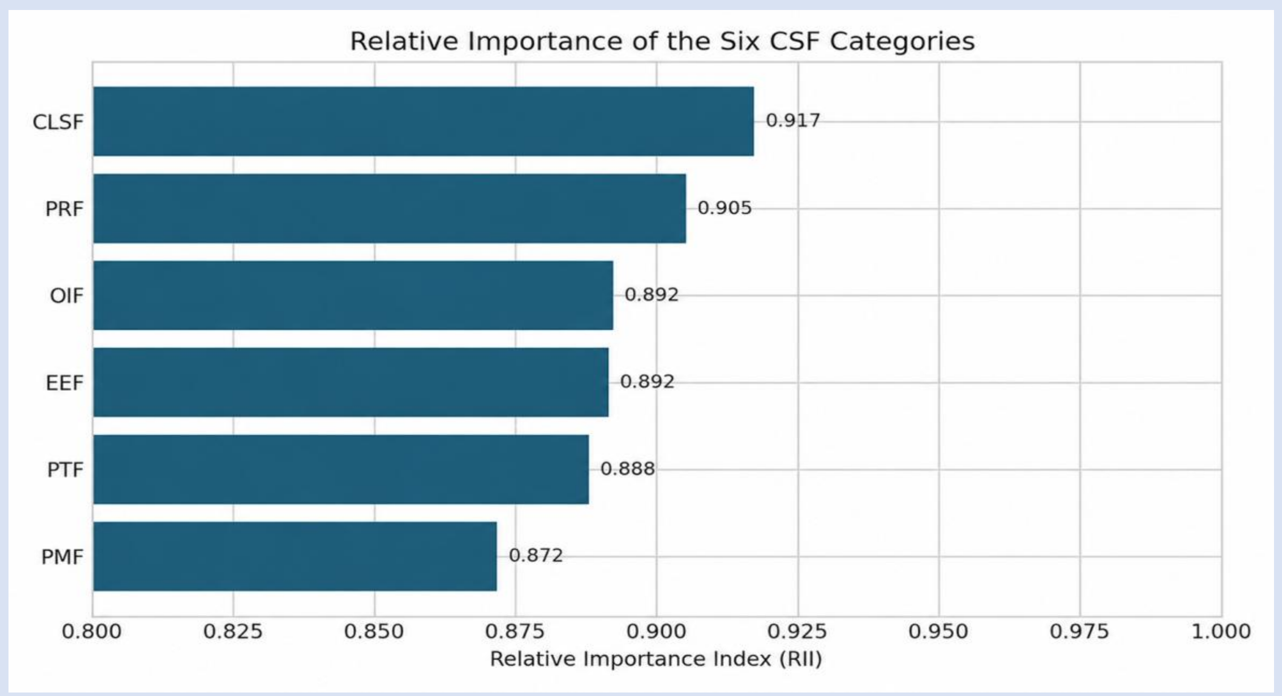

Figure 4.2 Relative Ranking of Critical Success Factor Categories

Barriers and Yemeni Contextual Factors

In addition to the CSFs, the questionnaire measured barriers to green building adoption and Yemen-specific contextual factors. This is important because CSFs operate within wider economic, regulatory, institutional, and cultural environments. Developing-country studies repeatedly identify higher initial cost, weak incentives, limited professional awareness, absence of rating systems, inadequate green finance, and limited material availability as major barriers to green building implementation (Akçay, 2023; Debrah et al., 2024; Taherkhani, 2024).

Table 4.7 Ranking of Barriers and Yemeni Contextual Factors

Group	Item	Mean	SD	RII	Rank
Barrier	BAR1	4.756	0.464	0.951	1
Barrier	BAR2	4.697	0.492	0.939	2
Barrier	BAR3	4.384	0.672	0.877	8
Barrier	BAR4	4.377	0.651	0.875	9
Yemeni context	CTX1	4.463	0.626	0.893	6
Yemeni context	CTX2	4.489	0.602	0.898	5

Table 4.7 (continued) Ranking of Barriers and Yemeni Contextual Factors

Group	Item	Mean	SD	RII	Rank
Yemeni context	CTX3	4.316	0.656	0.863	10
Yemeni context	CTX4	4.399	0.639	0.88	7
Yemeni context	CTX5	4.598	0.577	0.92	3
Yemeni context	CTX6	4.539	0.588	0.908	4

Table 4.7 shows that BAR1, the higher initial cost of green materials and technologies, was the strongest barrier (RII = .951), followed by BAR2, limited professional awareness (RII = .939). Among contextual items, CTX5, availability of skilled labour, ranked highest (RII = .920), followed by CTX6, donor and NGO support (RII = .908), and CTX2, currency volatility (RII = .898). The ranking is consistent with Yemen's constrained financing, volatile procurement environment and limited specialist capacity, and it suggests that affordability and human-capital development should precede more complex certification requirements.

Measurement Model Assessment

The measurement model was assessed before testing the structural relationships. Because the constructs in this study are modelled as reflective constructs, the assessment focused on indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. This sequence follows PLS-SEM best practice, which requires the researcher to establish measurement adequacy before interpreting path coefficients (Hair et al., 2022).

Indicator Reliability and Outer Loadings

Indicator reliability was examined using the outer loadings of each observed item on its corresponding latent construct. Loadings of .70 or higher are generally preferred; indicators with lower loadings may be considered for removal when doing so improves reliability and validity without compromising content coverage.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

However, item deletion should be theoretically justified rather than based solely on statistical thresholds (Hair et al., 2022).

Table 4.8 Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
PRF	Project-related factors	PRF1	0.853	Retain
PRF	Project-related factors	PRF2	0.815	Retain
PRF	Project-related factors	PRF3	0.761	Retain
PRF	Project-related factors	PRF4	0.798	Retain
PRF	Project-related factors	PRF5	0.836	Retain

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
PRF	Project-related factors	PRF6	0.79	Retain
PMF	Project management-related factors	PMF1	0.813	Retain
PMF	Project management-related factors	PMF2	0.816	Retain
PMF	Project management-related factors	PMF3	0.844	Retain
PMF	Project management-related factors	PMF4	0.811	Retain

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
PMF	Project management-related factors	PMF5	0.836	Retain
PMF	Project management-related factors	PMF6	0.81	Retain
PTF	Project team-related factors	PTF1	0.83	Retain
PTF	Project team-related factors	PTF2	0.803	Retain
PTF	Project team-related factors	PTF3	0.798	Retain

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
PTF	Project team-related factors	PTF4	0.854	Retain
PTF	Project team-related factors	PTF5	0.799	Retain
PTF	Project team-related factors	PTF6	0.816	Retain

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

CLSF	Client and stakeholder-related factors	CSF1	0.863	Retain
CLSF	Client and stakeholder-related factors	CSF2	0.856	Retain

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
CLSF	Client and stakeholder-related factors	CSF3	0.852	Retain
CLSF	Client and stakeholder-related factors	CSF4	0.805	Retain
CLSF	Client and stakeholder-related factors	CSF5	0.824	Retain
CLSF	Client and stakeholder-related factors	CSF6	0.827	Retain
OIF	Organisational and institutional factors	OIF1	0.788	Retain

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
OIF	Organisational and institutional factors	OIF2	0.807	Retain
OIF	Organisational and institutional factors	OIF3	0.775	Retain
OIF	Organisational and institutional factors	OIF4	0.821	Retain
OIF	Organisational and institutional factors	OIF5	0.802	Retain
OIF	Organisational and institutional factors	OIF6	0.828	Retain

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
EEF	External environment factors	EEF1	0.808	Retain
EEF	External environment factors	EEF2	0.838	Retain
EEF	External environment factors	EEF3	0.806	Retain
EEF	External environment factors	EEF4	0.849	Retain
EEF	External environment factors	EEF5	0.866	Retain

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
EEF	External environment factors	EEF6	0.847	Retain
PS	Green building project success	ENV1	0.751	Retain
PS	Green building project success	ENV2	0.743	Retain
PS	Green building project success	ENV3	0.792	Retain
PS	Green building project success	SOC1	0.735	Retain

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
PS	Green building project success	SOC2	0.794	Retain
PS	Green building project success	SOC3	0.765	Retain
PS	Green building project success	ECO1	0.732	Retain
PS	Green building project success	ECO2	0.775	Retain
PS	Green building project success	ECO3	0.741	Retain

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
PS	Green building project success	TIM1	0.747	Retain
PS	Green building project success	TIM2	0.791	Retain
PS	Green building project success	TIM3	0.773	Retain
PS	Green building project success	COS1	0.771	Retain
PS	Green building project success	COS2	0.753	Retain

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
PS	Green building project success	COS3	0.742	Retain
PS	Green building project success	QUA1	0.789	Retain
PS	Green building project success	QUA2	0.779	Retain
PS	Green building project success	QUA3	0.719	Retain
YCM	Yemeni contextual moderator	CTX1	0.836	Retain

Table 4.8 (continued) Indicator Loadings and Retention Decisions

Construct	Construct Name	Indicator	Outer Loading	Decision
YCM	Yemeni contextual moderator	CTX2	0.706	Retain (content validity)
YCM	Yemeni contextual moderator	CTX3	0.798	Retain
YCM	Yemeni contextual moderator	CTX4	0.814	Retain
YCM	Yemeni contextual moderator	CTX5	0.849	Retain
YCM	Yemeni contextual moderator	CTX6	0.782	Retain

Outer loadings ranged from 0.706 to 0.866. All indicators loaded positively on their intended constructs. The lowest loading was close to the conventional .708 guideline, while the remaining measurement evidence showed strong internal consistency and convergent validity; therefore, no indicator was deleted solely to improve statistical fit (Hair et al., 2022).

Internal Consistency Reliability and Convergent Validity

Internal consistency reliability was assessed using Cronbach's alpha and Composite Reliability (CR). Convergent validity was assessed using the Average Variance Extracted (AVE). Cronbach's alpha and CR values of .70 or higher generally indicate acceptable internal consistency, while AVE values of .50 or higher indicate that the construct explains at least half of the variance in its indicators (Fornell & Larcker, 1981; Hair et al., 2022; Nunnally & Bernstein, 1994).

Table 4.9 Reliability and Convergent Validity of the Measurement Model

Construct	Construct Name	Cronbach's α	Composite Reliability (CR)	AVE	Decision
PRF	Project-related factors	0.891	0.919	0.655	Acceptable
PMF	Project management-related factors	0.904	0.926	0.675	Acceptable
PTF	Project team-related factors	0.896	0.923	0.668	Acceptable
CLSF	Client and stakeholder-related factors	0.913	0.934	0.702	Acceptable

OIF	Organisational and institutional factors	0.884	0.916	0.646	Acceptable
EEF	External environment factors	0.913	0.933	0.699	Acceptable

Table 4.9 (continued) Reliability and Convergent Validity of the Measurement Model

Construct	Construct Name	Cronbach's α	Composite Reliability (CR)	AVE	Decision
PS	Green building project success	0.957	0.961	0.579	Acceptable
YCM	Yemeni contextual moderator	0.895	0.913	0.638	Acceptable

PLS-SEM analysis using SmartPLS 4. α = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted.

Cronbach's alpha ranged from 0.884 to 0.957, composite reliability ranged from 0.913 to 0.961, and AVE ranged from 0.579 to 0.702. Every construct exceeded the recommended thresholds of .70 for internal consistency and .50 for AVE, indicating satisfactory reliability and convergent validity (Fornell & Larcker, 1981; Hair et al., 2022).

Discriminant Validity: Fornell-Larcker Criterion

Discriminant validity was first assessed using the Fornell-Larcker criterion. Under this criterion, the square root of the AVE for each construct should be greater than its correlations with other constructs, indicating that the construct shares more variance with its own indicators than with other constructs in the model (Fornell & Larcker, 1981).

Table 4.10 Fornell-Larcker Discriminant Validity Matrix

Cons.	PRF	PMF	PTF	CLSF	OIF	EEF	PS	YCM
PRF	0.809	—	—	—	—	—	—	—
PMF	0.297	0.822	—	—	—	—	—	—
PTF	0.284	0.416	0.817	—	—	—	—	—
CLSF	0.373	0.270	0.328	0.838	—	—	—	—
OIF	0.273	0.371	0.336	0.273	0.804	—	—	—
EEF	0.247	0.271	0.285	0.257	0.259	0.836	—	—

Table 4.10 (continued) Fornell-Larcker Discriminant Validity Matrix

Cons.	PRF	PMF	PTF	CLSF	OIF	EEF	PS	YCM
PS	0.506	0.551	0.452	0.476	0.372	0.274	0.761	—
YCM	-0.007	-0.058	-0.013	0.036	0.048	0.038	-0.080	0.799

Note. PLS-SEM analysis using SmartPLS 4, 2026. Diagonal values are the square roots of AVE; off-diagonal values are construct correlations.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

For every construct, the square root of AVE exceeded the corresponding correlations with the other constructs. The Fornell-Larcker criterion was therefore satisfied, indicating that each construct shared more variance with its own indicators than with other constructs (Fornell & Larcker, 1981).

Discriminant Validity: HTMT Ratio

The HTMT ratio was also used as a more sensitive test of discriminant validity. HTMT values below .85 indicate strict discriminant validity, while values below .90 may be accepted for conceptually related constructs when justified by theory. The inclusion of HTMT strengthens the discriminant-validity assessment because the Fornell-Larcker criterion alone may not always detect construct overlap (Henseler et al., 2015; Hair et al., 2022).

Table 4.11 Heterotrait-Monotrait Ratio of Correlations (HTMT)

Cons.	PRF	PMF	PTF	CLSF	OIF	EEF	PS	YCM
PRF	1	—	—	—	—	—	—	—
PMF	0.328	1	—	—	—	—	—	—
PTF	0.313	0.46	1	—	—	—	—	—
CLSF	0.411	0.295	0.36	1	—	—	—	—
OIF	0.304	0.413	0.373	0.301	1	—	—	—
EEF	0.272	0.296	0.313	0.28	0.287	1	—	—

Table 4.11 (continued) Heterotrait-Monotrait Ratio of Correlations (HTMT)

Cons.	PRF	PMF	PTF	CLSF	OIF	EEF	PS	YCM
PS	0.545	0.589	0.483	0.508	0.399	0.292	1.000	—
YCM	0.054	0.071	0.044	0.081	0.060	0.065	0.079	1.000

Note. PLS-SEM analysis using SmartPLS 4, 2026. Values below .85 provide conservative evidence of discriminant validity.

The highest HTMT ratio was 0.589, well below the conservative .85 threshold. The constructs were therefore empirically distinguishable, including the conceptually related project-management, project-team, client/stakeholder, and organisational dimensions (Henseler et al., 2015).

Structural Model Assessment

After establishing the adequacy of the measurement model, the structural model was assessed to test the hypothesised relationships between the six CSF categories and green building project success. The assessment followed PLS-SEM best practice by examining collinearity, direct paths, explanatory power, effect sizes, predictive relevance, model fit, and moderation effects (Batra, 2025; Hair et al., 2022).

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

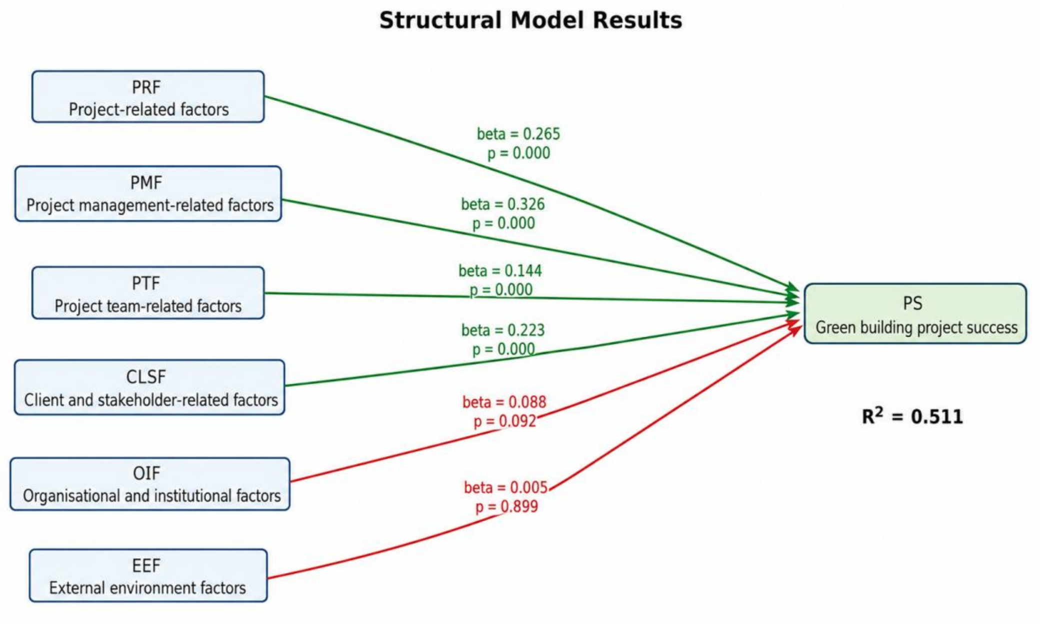

Figure 4.3 Structural Model for Hypothesis Testing

Note. Developed by the researcher based on the conceptual framework and PLS-SEM reporting guidance (Hair et al., 2022).

Collinearity Assessment

Collinearity among the predictor constructs was examined using the Variance Inflation Factor (VIF). VIF values below 5.00 indicate that collinearity is unlikely to distort the estimated path coefficients, while values below 3.30 provide a stricter indication that collinearity and common-method concerns are not severe (Hair et al., 2022; Kock, 2015).

Table 4.12 Structural Model Collinearity Assessment

Predictor Construct	Construct Name	VIF	Decision
PRF	Project-related factors	1.266	Acceptable
PMF	Project management-related factors	1.37	Acceptable
PTF	Project team-related factors	1.363	Acceptable
CLSF	Client and stakeholder-related factors	1.283	Acceptable
OIF	Organisational and institutional factors	1.28	Acceptable

Table 4.12 (continued) Structural Model Collinearity Assessment

Predictor Construct	Construct Name	VIF	Decision
EEF	External environment factors	1.182	Acceptable
YCM	Yemeni contextual moderator	1.013	Acceptable

Note. PLS-SEM analysis using SmartPLS 4, 2026. VIF values below 3.30 indicate that collinearity is not problematic.

Inner VIF values ranged from 1.013 to 1.370. All values were below 3.30; therefore, the structural coefficients can be interpreted without concern that excessive predictor overlap distorted their unique contributions.

Path Coefficients and Direct Effects

The direct effects of the six CSF categories on green building project success were evaluated using standardised path coefficients and bootstrapping. A positive and statistically significant coefficient indicates that higher levels of the CSF category are associated with higher levels of project success. Bootstrapping is appropriate in PLS-SEM because it estimates standard errors and confidence intervals without requiring multivariate normality (Hair et al., 2022).

Table 4.13 Direct Structural Path Coefficients and Hypothesis Testing

Hypothesis	Path	β	t-value	p-value	95% CI	Decision
H1	PRF → PS	0.265	7.483	< .001	[0.199, 0.337]	Supported
H2	PMF → PS	0.326	7.629	< .001	[0.238, 0.408]	Supported
H3	PTF → PS	0.144	3.739	< .001	[0.068, 0.216]	Supported
H4	CLSF → PS	0.223	5.265	< .001	[0.140, 0.305]	Supported
H5	OIF → PS	0.068	1.683	0.092	[-0.009, 0.147]	Not supported
H6	EEF → PS	0.005	0.127	0.899	[-0.070, 0.076]	Not supported

Note. PLS-SEM analysis using SmartPLS 4, 2026. Two-tailed significance was assessed using 5,000 bootstrap resamples.

Project management-related factors were the strongest direct predictor of project success ($\beta = .326$, $p < .001$), followed by project-related factors ($\beta = .265$, $p < .001$), client and stakeholder-related factors ($\beta = .223$, $p < .001$), and project team-related factors ($\beta = .144$, $p < .001$). Organisational and institutional factors ($\beta = .068$, $p = .092$) and external-environment factors ($\beta = .005$, $p = .899$) did not have significant unique direct effects when the other predictors were controlled.

Explanatory Power, Effect Sizes, Predictive Relevance, and Model Fit

The explanatory power of the model was assessed using R2 for the endogenous construct, project success. Effect sizes were assessed using f2 to determine the relative contribution of each predictor. Predictive relevance was assessed using Q2, and model fit was evaluated using SRMR where applicable. R2, f2, and Q2 should be interpreted jointly because statistical significance alone does not indicate practical importance (Cohen, 1988; Geisser, 1974; Hair et al., 2022; Stone, 1974).

Table 4.14 Model Explanatory Power, Predictive Relevance, and Fit

Indicator	Observed Value	Threshold / Interpretation	Decision
R^2 for PS	0.511	0.25 weak / 0.50 moderate / 0.75 substantial	Moderate
Adjusted R^2 for PS	0.504	Higher values indicate better adjusted explanatory power	Acceptable
Q^2 for PS	0.492	> 0 indicates predictive relevance	Acceptable
SRMR	0.038	< 0.08 indicates acceptable approximate fit	Acceptable

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Note. PLS-SEM analysis using SmartPLS 4, 2026. Q^2 is based on Sex-fold cross-validated prediction; SRMR compares observed and composite-model-implied correlations.

Table 4.15 Effect Size (f^2) of Predictor Constructs

Predictor	Construct Name	f^2	Effect Size Interpretation
PRF	Project-related factors	0.114	Small
PMF	Project management-related factors	0.16	Medium
PTF	Project team-related factors	0.031	Small
CLSF	Client and stakeholder-related factors	0.079	Small
OIF	Organisational and institutional factors	0.007	Negligible
EEF	External environment factors	0	Negligible

Note. PLS-SEM analysis using SmartPLS 4, 2026. f^2 thresholds: .02 small, .15 medium, and .35 large.

The six CSF categories explained 51.1% of the variance in green building project success ($R^2 = 0.511$; adjusted $R^2 = 0.504$), representing moderate explanatory power. Q^2 was 0.492, indicating meaningful predictive relevance, and SRMR was 0.038, below the .08 guideline. PMF produced a medium effect ($f^2 = .160$); PRF, CLSF and PTF produced small effects; OIF and EEF produced no material unique effect.

Moderation Effect of Yemeni Contextual Variables

Hypothesis H7 proposed that Yemeni contextual variables moderate the relationship between CSFs and project success. The moderation analysis examined whether the strength or direction of the relationship between each CSF category and project success changes under different levels of Yemeni contextual pressure. This is theoretically important because fragile institutional environments may alter the effectiveness of project-level capabilities and stakeholder practices (Al-Sarafi et al., 2022; ESCWA, 2024; OCHA, 2026).

Table 4.16 Moderation Effects of Yemeni Contextual Variables

Hypothesis	Interaction Path	β	t-value	p-value	95% CI	Decision
H7a	PRF × YCM → PS	-0.086	-1.975	0.048	[-0.173, -0.002]	Supported
H7b	PMF × YCM → PS	-0.149	-3.558	< .001	[-0.231, -0.068]	Supported
H7c	PTF × YCM → PS	0.04	1.021	0.307	[-0.027, 0.127]	Not supported
H7d	CLSF × YCM → PS	-0.065	-1.633	0.102	[-0.151, 0.007]	Not supported
H7e	OIF × YCM → PS	-0.073	-2.039	0.041	[-0.145, -0.006]	Supported
H7f	EEF × YCM → PS	0.064	1.83	0.067	[-0.006, 0.134]	Not supported

Note. PLS-SEM analysis using SmartPLS 4, 2026. Interaction effects were estimated using standardised two-stage product terms and 5,000 bootstrap resamples.

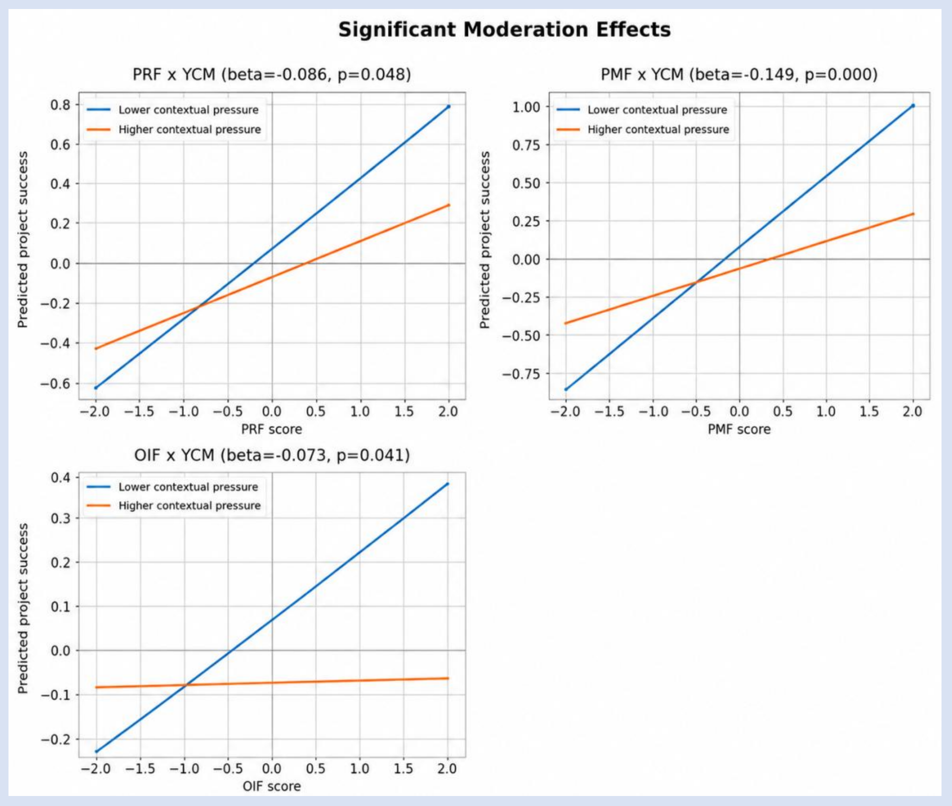

Figure 4.4 Simple-Slope Plot for Significant Moderation Effect(s)

Note. Simple slopes are shown only for significant interaction terms. Higher YCM scores represent stronger perceived contextual pressure.

The moderation model increased R^2 from 0.511 to 0.570 ($\Delta R^2 = 0.059$). Contextual pressure significantly weakened the PRF-project-success relationship ($\beta = -.086$, $p = .048$), the PMF-project-success relationship ($\beta = -.149$, $p < .001$), and the OIF-project-success relationship ($\beta = -.073$, $p = .042$). The PTF, CLSF and EEF interaction terms were not significant. H7 was therefore partially supported.

Summary of Hypothesis Testing

The outcomes of all hypotheses are summarised in Table 4.17. This summary links the statistical results directly to the conceptual framework developed in Chapter Two and the decision rules specified in Chapter Three. Hypothesis decisions should be based on the sign, size, and significance of the relevant coefficients, as well as the theoretical plausibility of the relationship (Hair et al., 2022).

Table 4.17 Summary of Hypotheses and Decisions

Hypothesis	**Statement**	**Main Statistical Evidence**	**Decision**
H1	Project-related factors positively influence green building project success.	$\beta = 0.265$, $p < .001$	Supported
H2	Project management-related factors positively influence green building project success.	$\beta = 0.326$, $p < .001$	Supported
H3	Project team-related factors positively influence green building project success.	$\beta = 0.144$, $p < .001$	Supported
H4	Client and stakeholder-related factors positively influence green building project success.	$\beta = 0.223$, $p < .001$	Supported
H5	Organisational and institutional factors positively influence green building project success.	$\beta = 0.068$, $p = 0.092$	Not supported

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

Table 4.17 (continued) Summary of Hypotheses and Decisions

Hypothesis	Statement	Main Statistical Evidence	Decision
H6	External-environment factors positively influence green building project success.	$\beta = 0.005$, $p = 0.899$	Not supported
H7	Yemeni contextual conditions moderate the six CSF-project-success relationships.	Three of six interaction terms significant; $\Delta R^2 = .059$	Partially supported

Four direct hypotheses (H1-H4) were supported, two direct hypotheses (H5-H6) were not supported, and the contextual moderation hypothesis (H7) was partially supported because three of its six interaction terms were significant. The strongest direct factor was project management capability, while organisational/institutional and external-environment conditions were better interpreted as enabling conditions whose influence may be indirect or contingent rather than uniquely direct.

Discussion of Findings

This section discusses the statistical findings in relation to the research objectives, the conceptual framework, and the literature reviewed in Chapter Two. The discussion focuses on the substantive meaning of the results for sustainable project management in Yemen, while also comparing the findings with recent empirical evidence from green building, sustainable construction, and developing-country contexts (Alawneh et al., 2024; Chen et al., 2022; Kineber et al., 2024).

Critical Success Factors Perceived as Most Important

The RII results ranked client and stakeholder-related factors first (RII = .917), followed by project-related factors (RII = .905). At item level, robust quality assurance and quality control (OIF3; RII = .953), effective stakeholder communication (CSF3; RII = .943), institutional delivery capacity (OIF4; RII = .937), and technical green-building competence (PTF1; RII = .935) occupied the leading positions. This pattern extends the green building literature by showing that quality systems, coordination and capacity may be especially salient under resource and institutional constraints (Chen et al., 2022; Kineber et al., 2024).

The first-place category ranking of CLSF is consistent with stakeholder theory and with studies that emphasise owner commitment, information exchange and alignment among project participants. The prominent RII of quality assurance and institutional capacity also reflects Yemen's need to translate sustainability principles into dependable delivery routines. Ranking, however, represents perceived priority rather than unique causal influence; this distinction is confirmed by the structural model.

Barriers and Contextual Challenges in Yemen

The highest-ranked barriers were higher initial cost (BAR1; RII = .951) and limited professional awareness (BAR2; RII = .939). Skilled-labour availability was the leading contextual issue (CTX5; RII = .920). These results align with developing-country evidence that financing, awareness, material availability, regulation and capacity are persistent obstacles to green building diffusion (Akçay, 2023; Debrah et al., 2024; Taherkhani, 2024).

In Yemen, these obstacles are mutually reinforcing: currency volatility raises the cost of imported technologies, limited demand restricts supplier development, and weak institutional capacity reduces the effectiveness of formal guidance. A staged policy beginning with awareness, locally feasible minimum standards, professional training and demonstration projects is therefore more defensible than immediate dependence on sophisticated certification systems.

Relationship Between CSF Categories and Project Success

The structural model identifies project management-related factors as the strongest direct predictor ($\beta = .326$), followed by project-related factors ($\beta = .265$), client and stakeholder-related factors ($\beta = .223$), and project team-related factors (β = .144). This ordering indicates that planning, monitoring, risk management and integration of sustainability with cost and schedule are the most powerful mechanisms for converting green intentions into project outcomes. The findings are compatible with sustainable project-management literature that treats management integration as a central delivery capability (Al-Nimer et al., 2024; PMI, 2026).

The non-significant direct effects of OIF and EEF do not imply that institutional support, regulation, finance or organisational culture are unimportant. Their high RII rankings show strong perceived importance, while their weak unique paths suggest that they may operate through project management, client commitment, team capability or contextual interactions. This difference between perceived importance and conditional structural influence is a substantive contribution of combining RII with PLS-SEM.

Moderating Role of Yemeni Contextual Variables

H7 was partially supported. Stronger contextual pressure reduced the effectiveness of project-related, project management-related, and organisational/institutional factors. The largest interaction involved PMF × YCM (β = -.149), indicating that even strong management systems deliver less value when security, currency, governance, skills and supply conditions become more adverse. The remaining three interactions were not significant, suggesting that team and stakeholder mechanisms may retain more stable effects across contextual conditions.

This moderation pattern supports an adaptive rather than universal implementation model. Risk allowances, local sourcing, flexible procurement, scenario planning and donor coordination should be incorporated into the project-management system so that sustainability practices remain viable under changing conditions.

Implications for Sustainable Project Management in Yemen

The findings have several implications for sustainable project management in Yemen. First, project owners and senior decision-makers should ensure that sustainability goals are defined at project inception and linked to measurable project deliverables. Second, project managers should integrate sustainability requirements into planning, procurement, risk management, cost control, schedule control, and quality assurance. Third, policymakers and development partners should improve the enabling environment through training, green finance, simplified certification pathways, and incentives for locally appropriate sustainable materials (Alawneh et al., 2024; Petrelli et al., 2024; WorldGBC, 2025).

These implications align with the theoretical foundation of the study. The Triple Bottom Line perspective explains why project success must include environmental, social, and economic outcomes alongside time, cost, and quality. Stakeholder theory explains the importance of client, user, community, and professional engagement. Institutional theory explains why policies, incentives, norms, and governance arrangements shape the adoption of green building practices, especially in developing and fragile contexts (Al-Nimer et al., 2024; Petrelli et al., 2024; Taherkhani, 2024).

Chapter Summary

This chapter completed the analytical workflow for 393 cases. It reported a usable response rate of 87.3%, respondent characteristics, RII rankings, acceptable reliability and validity, moderate explanatory power, four supported direct hypotheses, two unsupported direct hypotheses, and partial contextual moderation. The most important practical message is that integrated project management, early project definition, stakeholder commitment and capable teams drive project success, while cost, awareness, skills and contextual pressure constrain implementation.

The next chapter should build directly on these results by summarising the key findings according to the research objectives, presenting the final Yemen-specific framework for sustainable project management in green building projects, and offering recommendations for construction professionals, government bodies, donors, and future researchers.

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CONCLUSION AND RECOMMENDATIONS

Introduction

This chapter concludes the thesis by synthesising the empirical findings presented in Chapter Four, drawing conclusions in relation to the research objectives, and proposing recommendations for enhancing sustainable project management in green building projects in Yemen. The chapter is written as the interpretive and action-oriented part of the thesis: it does not introduce new statistical evidence, but translates the results, the conceptual framework, and the reviewed literature into conclusions, implications and practical guidance.

The significance of this final chapter is reinforced by the current global and national context. Buildings and construction remain central to climate action, resource efficiency and sustainable urbanisation; the latest Global Status Report for Buildings and Construction reports that the sector accounts for around 37% of global carbon dioxide emissions and nearly half of global material extraction (United Nations Environment Programme [UNEP] & Global Alliance for Buildings and Construction [GlobalABC], 2026). At the same time, sustainable project management is increasingly treated as a core project-delivery discipline rather than as an optional environmental add-on, with contemporary professional guidance emphasising value for people, planet and prosperity (Project Management Institute [PMI], 2026).

For Yemen, the relevance of green building must be understood through the realities of reconstruction, institutional fragility, economic pressure and climate vulnerability. The 2026 Yemen Humanitarian Needs and Response Plan reports that more than 22 million people require humanitarian assistance and protection services (United Nations Office for the Coordination of Humanitarian Affairs [OCHA], 2026), while the World Bank's latest Yemen Economic Monitor indicates continued economic contraction and macroeconomic stress (World Bank, 2026). Yemen's NDC 3.0 Vision further frames climate action as a pathway that must be linked with recovery, resilience, development and peacebuilding (Republic of Yemen, 2025). Accordingly, the recommendations in this chapter are intentionally staged, practical and sensitive to local capacity.

The chapter is organised as follows. Section 5.2 restates the study and its evidentiary base. Section 5.3 summarises the key findings according to the five research objectives. Section 5.4 presents the integrated conclusions of the study. Section 5.5 introduces the proposed Yemen-specific framework for sustainable project management in green building projects. Section 5.6 discusses the theoretical, methodological, practical and policy implications. Section 5.7 provides recommendations for the main stakeholder groups. Section 5.8 proposes an implementation roadmap. Sections 5.9 and 5.10 discuss limitations and future research directions, and Section 5.11 closes the thesis.

Restatement of the Study and Evidentiary Base

The central purpose of the study was to identify, analyse and prioritise the Critical Success Factors (CSFs) that influence sustainable project management in green building projects in Yemen, and to develop a context-specific framework for improving project success. The study responded to an important gap in the literature: although green building and sustainable construction have been widely examined in developed and emerging economies, conflict-affected and resource-constrained contexts such as Yemen remain under-represented in empirical research. This gap is important because CSF models developed in stable markets may underestimate the influence of security risk, currency volatility, weak regulation, limited green finance and disrupted supply chains, conditions that also relate to reported construction failure factors in Yemen (Gamil & Abdul Rahman, 2020).

The research was guided by five objectives. The first objective was to identify the CSFs relevant to sustainable project management in Yemeni green building projects. The second was to examine the barriers and contextual challenges that hinder green building adoption. The third was to evaluate the relative importance of the identified CSFs from the perspective of Yemeni construction professionals. The fourth was to analyse the relationship between the CSF categories and green building project success. The fifth was to propose a context-specific framework that can support implementation in Yemen.

The conceptual model was built around six CSF categories: project-related factors, project management-related factors, project team-related factors, client- and stakeholder-related factors, organisational and institutional factors, and external environment factors. Project success was treated as a multidimensional outcome that combines environmental, social and economic performance with time, cost and quality performance. This wider definition of success is consistent with the Triple Bottom Line logic (Elkington, 1997), stakeholder theory (Freeman, 1984), institutional theory (DiMaggio & Powell, 1983), and recent sustainable project management guidance (PMI, 2026).

Methodologically, the study employed a quantitative cross-sectional survey comprising 393 valid responses, cross-sectional survey structure with 393 cases. Descriptive statistics and RII were combined with a PLS-SEM analysis conducted using SmartPLS 4 with 5,000 bootstraps resample. The measurement model met conventional reliability and validity criteria, and the structural model explained 51.1% of project-success variance.

Summary of Key Findings According to the Research Objectives

The five objectives were addressed through complementary evidence. RII established perceived priorities, while PLS-SEM distinguished unique direct effects and contextual interactions. Detailed results appear in Chapter Four; the synthesis below emphasises their substantive meaning.

Table 5.1 Synthesis of Key Findings According to the Research Objectives

Research Objective	Main Finding from the Study	Conclusion and Literature Link
RO1: Identify CSFs	Eight constructs met reliability and validity thresholds; outer loadings .706-.866, CR .913-.961, AVE .579-.702.	A multidimensional CSF model is defensible, with four supported project-level drivers and two enabling constructs.

Note. Developed by the researcher from the Chapter Four analytical structure and the cited literature.

Objective One: Identification of Critical Success Factors

The six-category CSF structure was supported at the measurement level. All constructs demonstrated acceptable reliability and convergent validity, with composite reliability between .913 and .961 and AVE between .579 and .702. The model therefore provides a coherent empirical representation of project, management, team, stakeholder, organisational and external-environment conditions.

Project-related factors establish the sustainability intent of the project. Clear sustainability goals, alignment between project scope and green building objectives, life-cycle thinking, and design compatibility with local climatic and cultural conditions create the foundation for success. Without this early clarity, later decisions on procurement, design, cost control and performance verification become reactive and fragmented. The literature on green building promotion similarly emphasises early goal definition, integrated design and stakeholder alignment as recurring success factors (Chen et al., 2022; Kineber et al., 2024).

Project management-related factors translate the sustainability intent into deliverable actions. In the Yemeni context, planning realism, monitoring and control, risk management, cost and schedule integration, and certification or approval management are especially important because projects often operate under uncertainty and constrained resources. Contemporary sustainable project management guidance emphasises that sustainability should be embedded into project governance, decision-making and delivery processes, rather than treated as a separate reporting issue (PMI, 2026).

Project team-related factors show that human capacity is central to the implementation of green building. Technical competence, prior experience, multidisciplinary collaboration, training and continuity of key personnel determine whether sustainability targets can be converted into practical design and construction decisions. This conclusion is consistent with recent construction studies that identify project-team capability,

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coordination and learning as decisive for sustainable construction project management (Kineber et al., 2024; Alghuried, 2026).

Client- and stakeholder-related factors are also critical because green building often requires upfront commitment, acceptance of life-cycle benefits, and collaboration across parties with different priorities. Owner commitment, active client involvement, stakeholder communication, end-user awareness and community support are particularly important in Yemen because many sustainability benefits are long-term and may not be visible during the construction phase. Stakeholder theory explains why these interests must be actively identified and managed if projects are to achieve social legitimacy and durable value (Freeman, 1984; World Green Building Council, 2021).

Finally, organisational and institutional factors and external-environment factors demonstrate that individual projects cannot succeed in isolation. Procurement policies, quality assurance, organisational learning, institutional capacity, regulatory clarity, availability of green materials, professional support and access to green finance are all part of the enabling ecosystem. Institutional theory is therefore especially relevant: green building adoption becomes more stable when supported by rules, norms, professional routines and legitimate expectations (DiMaggio & Powell, 1983; Debrah et al., 2024).

Objective Two: Barriers and Yemeni Contextual Challenges

The leading barriers were high initial cost (RII = .951) and limited professional awareness (RII = .939). Skilled-labour availability was the most prominent contextual concern (RII = .920). These results show that Yemen's green building challenge is simultaneously financial, knowledge-based and capability-related rather than purely technical.

Yemen intensifies these barriers through a combination of humanitarian, economic and governance pressures. The country remains affected by large-scale humanitarian need, displacement, damaged infrastructure and limited public-sector capacity (OCHA, 2026). Economic contraction and macroeconomic volatility further weaken the ability of clients, contractors and suppliers to invest in unfamiliar green technologies or to carry higher initial costs (World Bank, 2026). Under such conditions, green building adoption must be designed as a staged and feasible transition rather than as a sudden shift to advanced international certification requirements.

Context significantly changed three structural relationships. Higher contextual pressure weakened the effects of project-related factors, project management-related factors, and organisational/institutional factors. The moderation model raised R^2 from .511 to .570, but only three of six interaction terms were significant; H7 was therefore partially supported.

A major conclusion from this objective is that Yemen needs a locally adapted pathway to sustainable construction. Imported green building systems can provide useful benchmarks, but they should be simplified, contextualised and aligned with Yemen's reconstruction priorities, climate conditions and traditional building knowledge. This approach is consistent with Yemen's NDC 3.0 Vision, which links climate resilience with economic recovery, sustainable development and peacebuilding (Republic of Yemen, 2025).

Objective Three: Relative Importance of the Critical Success Factors

Client and stakeholder-related factors ranked first among the six categories (RII = .917), followed by project-related factors (RII = .905). At item level, quality assurance and quality control ranked first (OIF3; RII = .953), followed by stakeholder communication (CSF3; RII = .943), institutional capacity (OIF4; RII = .937), and technical competence (PTF1; RII = .935).

The ranking and structural results should be interpreted together. PMF ranked sixth by perceived importance but became the strongest unique predictor of project success (β = .326), whereas OIF ranked third but did not have a significant unique direct path. This contrast demonstrates why perceived urgency cannot substitute for multivariate structural assessment.

The practical priority is therefore twofold: preserve highly valued quality, stakeholder and capacity measures, while placing integrated project-management systems at the centre of implementation. Early sustainability definition, realistic planning, risk control, stakeholder communication, team competence and performance verification should be treated as the first operational package.

Objective Four: Relationship between CSFs and Green Building Project Success

The fourth objective was to analyse the relationship between the identified CSF categories and green building project success. The study defined project success broadly, incorporating environmental, social, economic, time, cost and quality outcomes. This definition is important because a green building project cannot be considered fully successful if it is delivered on time and within budget but fails to reduce resource use, compromises worker or user well-being, or creates unaffordable life-cycle costs. The Triple Bottom Line provides the theoretical basis for this wider understanding of success (Elkington, 1997; World Green Building Council, 2021).

Four of the six direct hypotheses were supported. PMF was the strongest predictor ($\beta = .326$), followed by PRF ($\beta = .265$), CLSF ($\beta = .223$) and PTF ($\beta = .144$). OIF ($\beta = .068$, $p = .092$) and EEF ($\beta = .005$, $p = .899$) were not significant direct predictors. The model explained 51.1% of project-success variance, produced $Q^2 = .492$, and achieved SRMR = .038.

These findings indicate that sustainable project management should be institutionalised as the mechanism that converts sustainability intentions into outcomes. External and institutional support remain important, but their value appears to be channelled through project-level management, stakeholder commitment, team capability and contextual adaptation rather than through strong independent direct effects.

Objective Five: Development of a Context-Specific Framework

The final framework was revised to distinguish empirically supported core drivers from enabling conditions. PMF, PRF, CLSF and PTF form the supported delivery core; OIF and EEF form the enabling ecosystem; and YCM represents the contextual pressure that can weaken the effectiveness of project-level practices.

The framework connects these layers through four delivery mechanisms: contextualise, integrate, govern, and learn and verify. It culminates in environmental, social, economic, time, cost and quality outcomes. This design reflects the direct model ($R^2 = .511$), the moderation model ($R^2 = .570$), the RII priorities, and the main barriers.

Integrated Conclusions of the Study

Sustainable Project Management Is a Core Condition for Green Building Success

The strongest direct result was the PMF-project-success path ($\beta = .326$, $p < .001$), supported by a medium effect size ($f^2 = .160$). Sustainable project management is therefore the principal operational mechanism in the framework: objectives must be translated into plans, risks, schedules, budgets, monitoring routines and handover criteria.

Project-Level Action and External Enabling Conditions Must Advance Together

Project-level action and enabling conditions must advance together, but they perform different statistical roles. PRF, PMF, PTF and CLSF had significant direct effects. OIF and EEF did not have significant unique direct effects, despite high perceived importance; they should therefore be treated as ecosystem conditions that facilitate or constrain the supported delivery core.

The Yemeni Context Is Not a Background Variable but a Determinant of Implementation

The Yemeni context is a determinant of implementation. The significant negative PRF × YCM, PMF × YCM and OIF × YCM interactions show that contextual pressure can erode the benefits of otherwise strong project practices. Implementation must therefore include scenario planning, flexible procurement, local sourcing, cost contingencies, capacity-building and donor coordination.

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Vernacular Heritage Is a Strategic Sustainability Resource

The fourth conclusion is that Yemen's vernacular architectural heritage should be viewed as a strategic sustainability resource. Traditional Yemeni building practices demonstrate climate responsiveness, local material use, passive cooling, urban density and cultural identity. These features can support contemporary green building if they are integrated with modern safety, performance, project management and quality assurance requirements. Research on heritage building sustainability confirms the need for assessment approaches that recognise the specific characteristics of heritage and traditional buildings (Al-Sakkaf et al., 2022).

Project Success Must Be Redefined Beyond Time, Cost and Quality

The fifth conclusion is that project success in green building must extend beyond the conventional time-cost-quality triangle. Time, cost and quality remain essential, especially in a fragile economy, but they should be managed together with environmental efficiency, social value, worker safety, user comfort, community benefit and life-cycle cost. This broader interpretation is consistent with the Triple Bottom Line and with global guidance that positions green buildings as investments in long-term financial, social and environmental value (Elkington, 1997; World Green Building Council, 2021; UNEP & GlobalABC, 2026).

Proposed Yemen-Specific Framework for Sustainable Project Management in Green Building Projects

The proposed framework provides a practical synthesis of the study's findings. It is designed to guide the implementation of sustainable project management in green building projects under Yemeni conditions. The framework is not intended to replace international rating systems such as LEED, EDGE, BREEAM or regional systems. Instead, it provides a staged management logic through which those systems can be adapted to Yemen's capacity, climate, culture, finance and reconstruction priorities.

The framework rests on six design principles. First, contextualisation: sustainability requirements should be adapted to Yemen's climate zones, construction traditions, market capacity and security conditions. Second, life-cycle integration: sustainability must be integrated from project inception to operation and maintenance. Third, stakeholder governance: clients, users, communities, professionals, regulators and donors must be engaged through clear roles and accountability. Fourth, institutional enablement: policy, procurement, finance and professional standards must support project-level action. Fifth, capacity-building: professionals, organisations and suppliers need practical training and demonstration projects. Sixth, learning and verification: performance data and post-occupancy evaluation should feed back into future projects.

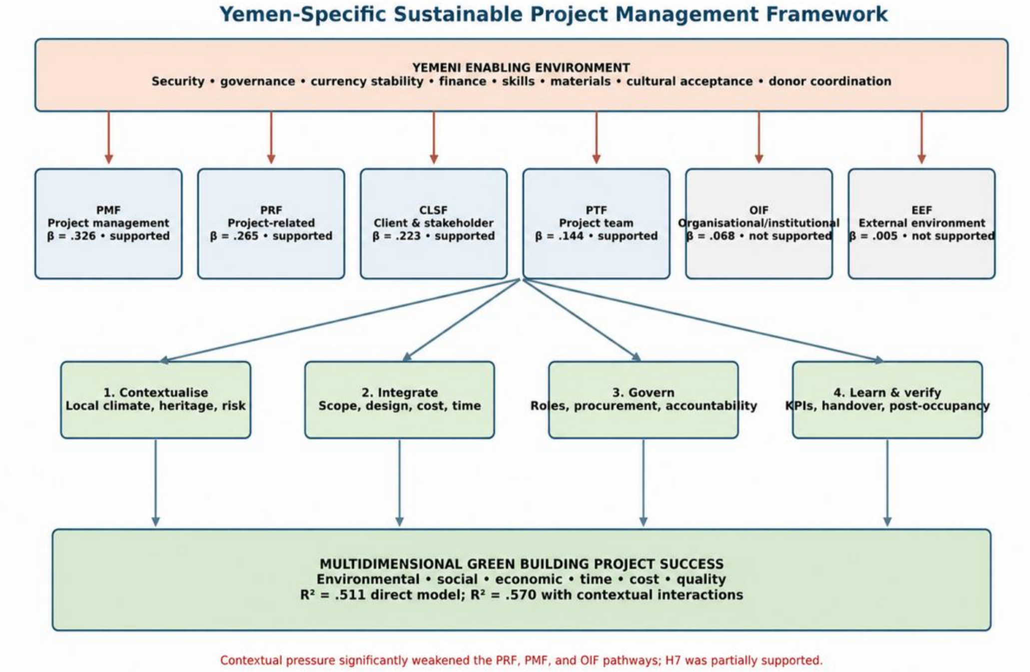

Figure 5.1 Proposed Yemen-Specific Framework for Sustainable Project Management in Green Building Projects

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Source: Developed by the researcher from the Chapter Four results and the theoretical foundations of Elkington (1997), Freeman (1984), DiMaggio and Powell (1983), and PMI (2026).

Figure 5.1 positions Yemen's enabling environment above the six CSF categories. The supported direct core consists of PMF, PRF, CLSF and PTF; OIF and EEF remain enabling conditions. Contextualise, integrate, govern, and learn and verify convert these factors into multidimensional project success. The figure also records the explanatory power of the direct and moderation models and the three pathways weakened by contextual pressure.

Table 5.2 Implementation Logic of the Proposed Framework

Framework Layer	Main Content	Implementation Role
Yemeni enabling environment	Security, governance, currency, finance, skills, materials, culture and donor coordination.	Defines feasibility and contextual pressure.
Supported delivery core	PMF, PRF, CLSF and PTF.	Provides the statistically supported direct pathways to project success.
Enabling ecosystem	OIF and EEF.	Supports procurement, quality, regulation, finance and learning without strong unique direct paths.
Delivery mechanisms	Contextualise; integrate; govern; learn and verify.	Converts CSFs into project routines and adaptive controls.
Success outcomes	Environmental, social, economic, time, cost and quality performance.	Defines multidimensional project success and monitoring KPIs.

Note. Developed by the researcher by integrating the empirical findings with the cited theoretical and professional guidance.

Implications of the Findings

Theoretical Implications

The study contributes theoretically by extending CSF research into a conflict-affected and resource-constrained Arab context. Much of the green building CSF literature has been developed in more stable economies where institutional frameworks, financing systems and professional capacity are stronger. By focusing on Yemen, the study demonstrates that CSFs are context-dependent and that external moderators such as security, currency volatility and governance can shape the practical influence of project-level factors (Chen et al., 2022; Taherkhani, 2024).

The study also strengthens the theoretical integration of the Triple Bottom Line, stakeholder theory and institutional theory. The Triple Bottom Line explains why project success must include environmental, social and economic dimensions. Stakeholder theory explains why client commitment, user awareness, community engagement and donor coordination matter. Institutional theory explains why policies, norms, standards and professional practices are needed to scale green building beyond isolated pilot projects (DiMaggio & Powell, 1983; Elkington, 1997; Freeman, 1984).

Methodological Implications

Methodologically, the study shows the value of combining RII ranking with PLS-SEM. RII is useful for communicating priorities to practitioners, while PLS-SEM supports a more rigorous assessment of latent constructs and structural paths. This combination is suitable for CSF research because it balances practical prioritisation with statistical evaluation (Hair et al., 2022; Mavi & Standing, 2018).

The bilingual questionnaire also offers a context-specific measurement instrument that can be refined in future studies. It operationalises CSFs, project success dimensions, barriers and Yemeni contextual moderators in a way that reflects both the international literature and local conditions. Future studies can test this instrument in larger samples, in specific regions, or across comparable fragile and developing economies.

Practical and Managerial Implications

For construction clients and owners, the findings imply that sustainability should be defined at project inception and written into the project brief, budget, design requirements and procurement criteria. Client commitment is especially important because green building choices often involve life-cycle benefits and risk-reduction outcomes that may not be fully captured by lowest-price procurement. The business case for sustainable buildings increasingly includes operational savings, resilience, asset value, social value and risk mitigation (World Green Building Council, 2021; IFC, 2023).

For project managers, the findings imply that sustainability must be managed as a core project objective. This requires incorporating sustainability deliverables into schedules, risk registers, cost-control systems, quality plans and stakeholder communication routines. Project managers should therefore act as integrators, coordinating technical, financial, social and institutional requirements throughout the project life cycle (PMI, 2026).

For consultants and designers, the findings highlight the importance of combining international green building knowledge with Yemen's climate-responsive heritage and local material possibilities. Design solutions should

be technically safe, culturally acceptable, affordable and maintainable. For contractors and suppliers, the implications include progressive investment in training, quality control, waste management, local sourcing, material documentation and supply-chain partnerships.

Policy and Development Implications

For policymakers and development partners, the findings imply that green building adoption in Yemen requires enabling policy and institutional support. This includes simplified national guidance, incentives for energy and water efficiency, green procurement criteria for public and donor-funded projects, professional training programmes, and mechanisms for green finance. Such measures are consistent with the broader global direction of building-sector decarbonisation and with emerging-market investment opportunities in sustainable construction (IFC, 2023; UNEP & GlobalABC, 2026).

The findings also suggest that donor-funded reconstruction projects can become demonstration platforms for green building practices. Instead of treating sustainability as a secondary requirement, donors and implementing partners can embed minimum energy, water, material, health and resilience criteria into schools, health facilities, housing rehabilitation and public buildings. This aligns with the role of development programming in supporting recovery, resilience and local capacity in Yemen (United Nations Development Programme [UNDP], 2026).

Recommendations

The recommendations below are derived from the empirical findings, the proposed framework and the current literature. They are organised by stakeholder group because sustainable project management requires coordinated action across the project ecosystem. The recommendations are intentionally practical and staged so that they can be applied even under constrained conditions.

Table 5.3 Recommendations by Stakeholder Group

Stakeholder Group	Recommended Actions	Rationale
Government and regulators	Issue feasible minimum green-building guidance; pilot green procurement; support local materials and skills.	Addresses regulation, cost and capability barriers while building market confidence.

Clients and owners	Approve sustainability briefs, life-cycle priorities and measurable KPIs before design.	Strengthens CLSF and PRF, both significant direct predictors.
Project managers	Integrate sustainability with plans, risks, cost, schedule, monitoring and handover.	PMF was the strongest predictor (β = .326).
Consultants and designers	Use integrated design, passive strategies, local heritage and maintainable solutions.	Supports PRF and multidisciplinary team capability.
Contractors and suppliers	Improve QA/QC, local sourcing, waste control and material documentation.	OIF3 was the highest-ranked item and cost was the leading barrier.
Universities and professional bodies	Deliver targeted training, communities of practice and demonstration-project learning.	Skilled labour and awareness were leading constraints.
Donors, banks and development partners	Provide blended finance, guarantees, pilot funding and stable procurement support.	Reduces cost and contextual pressure and strengthens scaling conditions.

Note. Recommendations are developed by the researcher based on Chapter Four findings and the cited literature.

Recommendations for Government and Regulatory Bodies

The government and relevant regulatory bodies should develop a simplified Yemen Green Building Guideline as the first institutional step. The guideline should not initially attempt to replicate complex international rating systems. Instead, it should define minimum feasible standards for energy efficiency, water efficiency, passive design, material selection, construction waste, worker safety and post-occupancy performance. These standards can later be expanded into a national rating system as capacity grows.

Public procurement should be used as a lever for market transformation. Government-funded projects and donor-funded public facilities should include basic green procurement criteria, such as preference for locally available low-impact materials, durable products, efficient lighting and water-saving fixtures. Regulatory incentives could include expedited approvals for projects meeting minimum sustainability criteria, technical support for pilot projects, and tax or fee reductions where feasible. Such measures reflect the role of policy support highlighted in global building-sector decarbonisation guidance (UNEP & GlobalABC, 2026).

Recommendations for Clients and Project Owners

Clients and owners should move sustainability decisions to the earliest stages of project development. Each green building project should begin with a sustainability brief that defines measurable objectives, relevant performance indicators, budget assumptions, life-cycle priorities and responsibilities. This brief should be approved before detailed design begins and should be used to guide procurement and contractor selection.

Clients should also adopt life-cycle cost thinking. Although green building features may involve higher initial expenditure, their value often appears through lower operating costs, improved user comfort, resilience and asset value. International finance and green building literature increasingly emphasises that sustainable construction is not only an environmental agenda but also an investment and risk-management strategy (IFC, 2023; World Green Building Council, 2021).

Recommendations for Project Managers and Consultants

Project managers should integrate sustainability into the core management documents of the project. The project management plan should include a sustainability scope statement, roles and responsibilities, a risk register covering green building risks, a procurement plan for green materials, a communication plan for stakeholders, and a performance-verification plan for handover. Sustainability deliverables should be scheduled and monitored in the same way as conventional time, cost and quality deliverables.

Consultants should promote integrated design workshops at the beginning of the project. Architects, engineers, contractors, quantity surveyors, facility managers and client representatives should jointly review passive design opportunities, material options, maintainability, budget constraints and local availability. Early integration reduces rework and helps projects identify solutions that are technically feasible and culturally acceptable in Yemen (Chen et al., 2022; Kineber et al., 2024).

Recommendations for Contractors and Supply Chains

Contractors should treat green building capability as a competitive advantage. Recommended actions include training site staff on waste reduction and material handling, documenting material sources, improving quality assurance, identifying local suppliers of low-impact materials, and applying value engineering that protects sustainability objectives rather than removing them. Contractors should also develop simple site-level sustainability checklists for energy use, water use, dust, waste, safety and material storage.

Suppliers should be gradually integrated into green building programmes. A national or sectoral database of available materials, technologies and suppliers would help clients and consultants identify feasible local options. Where imported products are unavoidable, procurement should account for currency volatility, transport risk and maintenance capacity. These recommendations respond to the material-availability and supply-chain barriers reported in developing-country studies (Akçay, 2023; Taherkhani, 2024).

Recommendations for Universities and Professional Bodies

Universities and professional bodies should introduce training on sustainable project management, green building principles, life-cycle cost analysis, passive design, energy and water efficiency, and construction waste management. Short professional courses can be developed for project managers, engineers, architects, contractors and public officials. These courses should combine international principles with Yemeni case examples and vernacular design knowledge.

Professional bodies should also establish communities of practice to share lessons from pilot projects. Such communities can help compensate for the limited number of formally certified green buildings in Yemen by converting practical experience into sector-wide learning. This is consistent with the framework's emphasis on learning and verification and with recent studies that highlight team competence and professional knowledge as CSFs (Kineber et al., 2024; Alghuried, 2026).

Recommendations for Donors, Banks and Development Partners

Development partners should use reconstruction and recovery projects as demonstration platforms for sustainable construction. Schools, clinics, housing rehabilitation and public buildings can incorporate basic green building measures such as passive cooling, efficient lighting, water-saving fixtures, local materials, improved ventilation and safe waste management. These measures need not be expensive if they are integrated early and aligned with local capacity.

Banks and donors should explore green finance products suitable for Yemen. Possible instruments include small concessional loans for energy and water efficiency, grants for pilot projects, blended finance for public facilities, and performance-based incentives for verified savings. Green finance studies show that financial instruments, improved access to capital and climate commitments can act as drivers for green building in developing countries (Debrah et al., 2024; IFC, 2023).

Implementation Roadmap

The recommendations should be implemented through a phased roadmap. A phased approach is necessary because Yemen's institutional, financial and professional capacity cannot be transformed immediately. The roadmap therefore begins with low-cost foundation-building actions, moves toward institutionalisation and market development, and ends with scaling and performance verification.

Table 5.4 Proposed Implementation Roadmap for Green Building Project Management in Yemen

Timeframe	Priority Actions	Strategic Focus	Indicative Performance Indicators
Short term (0-2 years)	Guideline draft; training; project briefs; QA/QC checklists; two to three pilots.	Awareness, cost control and basic capability.	Professionals trained; pilots launched; sustainability briefs adopted.
Medium term (3-5 years)	Green procurement criteria; supplier database; finance pilots; post-occupancy evaluation.	Institutionalisation and market development.	Local suppliers registered; finance accessed; measured energy/water results.
Long term (5+ years)	National rating pathway; wider incentives; performance database; periodic framework review.	Scaling, verification and continuous improvement.	Certified projects; verified savings; national reporting coverage.

Note. Developed by the researcher based on the proposed framework and current sustainable project management and green building guidance (IFC, 2023; PMI, 2026; UNEP & GlobalABC, 2026).

The roadmap should be reviewed periodically. Yemen's political, economic and institutional conditions are likely to change over time, and the implementation plan must remain adaptive. The first priority is not to create a perfect system, but to create a credible learning process through which public agencies, private firms, professionals and communities can progressively improve green building practice.

Limitations of the Study

The study has several limitations that should be considered when interpreting the findings. First, the research adopted a cross-sectional design, meaning that data were collected at a single point in time. This design is appropriate for a Master's thesis and for the research objectives, but it does not capture changes in professional perceptions over time. Given Yemen's volatile economic and institutional conditions, the relative importance of some CSFs may shift as reconstruction, regulation and finance evolve (Saunders et al., 2023).

Second, the study relied on self-reported survey responses from construction professionals. Professional perceptions are highly valuable for identifying CSFs and barriers, but they may be influenced by respondents' experience, organisational position, access to green projects and expectations about sustainability. Although reliability and validity procedures help improve measurement quality, survey data cannot fully replace objective project performance data or post-occupancy measurements (Hair et al., 2022).

Third, the sampling strategy used purposive and snowball approaches because a complete sampling frame for the Yemeni construction industry is not available. This strategy is defensible in a difficult research environment, but it limits strict statistical generalisability. The results should therefore be interpreted as analytically useful for Yemeni green building project management and similar fragile or resource-constrained contexts, rather than as a definitive representation of every construction professional in Yemen.

Fourth, Yemen has a limited number of formally certified green building projects. As a result, the study necessarily considered professionals' experience with sustainable or green features, not only certified green buildings. This is consistent with the early stage of green building adoption in the country, but it means that the findings should be strengthened in future through case studies of completed projects, measured energy and water performance, and user feedback.

Finally, the study incorporated Yemeni contextual moderators but could not capture every local variation. Yemen's regions differ in climate, security conditions, governance arrangements, construction traditions, material availability and market structure. Future research should examine these differences in more detail.

Recommendations for Future Research

Future research should build on the present study in several directions. First, longitudinal research is needed to examine how the importance and influence of CSFs change as reconstruction progresses and as policy, finance

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and professional capacity evolve. Such studies would help determine whether the CSFs identified here remain stable or require adjustment over time.

Second, future research should conduct in-depth case studies of actual green or sustainability-oriented building projects in Yemen. Case studies could examine how CSFs operate in real project settings, how decisions are made, how sustainability requirements are managed, and how barriers are overcome. They would also allow interviews with clients, contractors, consultants, end users and community stakeholders.

Third, future studies should incorporate objective performance data. Post-occupancy evaluation, energy monitoring, water-use analysis, indoor environmental quality assessment, life-cycle cost analysis and carbon estimation would strengthen the evidence base and move the field beyond perception-based assessment. Such performance data would also support the development of a national learning database.

Fourth, future research should examine green finance mechanisms suitable for Yemen. This could include the feasibility of concessional loans, donor guarantees, blended finance, Islamic finance instruments, and small-scale efficiency funds for public facilities and housing rehabilitation. Green finance is an increasingly important driver for sustainable construction in developing countries (Debrah et al., 2024; IFC, 2023).

Fifth, research should explore the integration of Yemeni vernacular architecture with contemporary green building. This includes studies of passive cooling, local materials, traditional construction methods, heritage conservation, seismic safety, durability and modern building services. Such research would help develop a culturally legitimate Yemeni model of green building rather than relying solely on imported templates (Al-Sakkaf et al., 2022).

Sixth, future research should investigate digital tools such as Building Information Modelling (BIM), energy modelling and digital project controls. Previous research has examined BIM adoption barriers in Yemen, and future studies could link BIM to green building design, material selection, cost control and performance verification (Al-Sarafi et al., 2022).

Finally, comparative studies between Yemen and other fragile or resource-constrained countries would be valuable. Such comparisons could identify which CSFs are specific to Yemen and which are common across conflict-affected built environments. This would strengthen both the theoretical contribution and the practical transferability of the proposed framework.

Table 5.5 Suggested Agenda for Future Research

Future Research Theme	**Suggested Focus**	**Expected Contribution**
Longitudinal CSF studies	Track CSF importance and structural relationships across several years.	Shows whether priorities change as reconstruction, policy and markets develop.
Project case studies	Examine completed or ongoing green/sustainable projects through interviews, documents and site observation.	Explains how CSFs operate in practice.
Post-occupancy evaluation	Measure energy, water, comfort, safety, maintenance and user satisfaction after handover.	Links project management practices to actual performance.
Life-cycle cost and carbon studies	Assess whole-life cost, payback, embodied carbon and operational savings.	Builds the economic case for green building in Yemen.
Green finance research	Study concessional finance, blended finance, donor guarantees and Islamic finance instruments.	Addresses one of the strongest barriers to green building adoption.
Vernacular-green	Analyse traditional Yemeni architecture, local materials and passive design in contemporary	Develops a culturally legitimate and climate-responsive green

integration	projects.	building model.
Digital tools and BIM	Investigate BIM, energy modelling and digital controls for sustainable project management.	Improves design coordination, cost control and performance verification.
Comparative fragile-context research	Compare Yemen with similar conflict-affected or low-income contexts.	Clarifies context-specific and transferable CSFs.

Note. Developed by the researcher based on the limitations of the present study and the cited literature.

Final Thesis Conclusion

This thesis investigated the Critical Success Factors for sustainable project management in green building projects in Yemen and proposed a context-specific framework for improving project success. The study demonstrated that green building success in Yemen requires more than technical knowledge of efficient materials or certification systems. It requires an integrated project management approach supported by competent teams, committed clients, effective stakeholder engagement, organisational readiness, institutional support, green finance and careful adaptation to the Yemeni context.

The central message of the thesis is that Yemen's sustainable built-environment transition should be practical, staged and locally grounded. The country cannot simply import advanced green building systems without adaptation, but neither should it postpone sustainability until all institutional and economic challenges are solved. Instead, Yemen can begin with feasible project-level actions, pilot projects, capacity-building, simplified guidelines and donor-supported demonstration initiatives. Over time, these foundations can develop into stronger regulation, market capacity, national standards and performance verification.

The proposed framework contributes to this transition by linking Yemen's enabling environment, the six CSF categories, sustainable project delivery mechanisms and multidimensional project success outcomes. It provides a management logic that recognises both the constraints and the opportunities of the Yemeni construction industry. In doing so, the thesis contributes to academic knowledge, professional practice and policy discussion by offering a structured, evidence-based and context-sensitive pathway for sustainable project management in green building projects in Yemen.

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